



Onshore unconventional natural gas in South Africa: regulating the water- energy-food nexus

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DEDICATION

This thesis is dedicated to my mother, **Suzette Coetzee** and father **Poen Coetzee** (15/04/1945 - 06/01/2018). Your example in living a life of compassion is immense.

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ABSTRACT

Energy security is an acute issue in South Africa. The South African government's interest in onshore unconventional natural gas (shale gas) as an additional or alternative energy source remain resolute. While numerous studies have provided progress in a better understanding of the numerous environmental impacts associated with onshore unconventional natural gas development (UGD), not many studies make use of a systems-based approach, such as a socio-ecological systems approach to make linkages between (i) human (social) and ecological systems and (ii) water, energy and food more explicit.

The original contribution of this thesis lies in its use of a mixed methodology of performing the necessary research. The approach consists of employing both legal research methodology and qualitative empirical research methodology towards analysing the extent to which the South African regulatory framework on UGD follow a WEF nexus approach. Three empirical studies that straddle the WEF nexus and UGD illustrate how trade-offs take place at local community level and the extent of integrated decision-making. The value of the three empirical studies lies in the context specific data and results. While context matters greatly, within UGD and the WEF nexus, a number of comparable findings could be made.

Since the WEF nexus approach requires integrated and coordinated governance arrangements, more qualitative studies on UGD are required to focus on this critical aspect.

Key words:

unconventional natural gas development, onshore exploration of shale gas, regulation, regulatory and governance framework, decision-making, socio-ecological, the WEF nexus, WEF-nexus governance approach, water, energy and food security, South Africa

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LIST OF ABBREVIATIONS

ASSAf	Academy of Science of South Africa
CARA	Conservation of Agriculture Resources Act 43 of 1983
CBD	Convention on Biodiversity
CCGTs	Combined-cycle gas turbines
CKDM	Central Karoo District Municipality
CLEW	Climate-land-energy-water
CMAs	Catchment management agencies
COGTA	Department of Cooperative Governance and Traditional Affairs
CSIR	Council for Scientific and Industrial Research
DALRRD	Department of Agriculture, Land Reform and Rural Development
DDMs	District Development Models
DFFE	Department of Forestry, Fisheries and Environment
DMRE	Department of Mineral Resources and Energy
DoH	Department of Health
DTIC	Department of Trade, Industry and Competition
DWS	Department of Water and Sanitation
ECA	Environmental Conservation Act 73 of 1989
EELPJ	Environmental & Energy Law & Policy Journal
EFW	Energy-food-water
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
EPA	Environmental Protection Agency
ERA	Electricity Regulation Act 4 of 2008

ESSP	Earth System Science Partnership
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FOSAD	Forum of South African Director-Generals
GDP	Gross Domestic Product
GHG	Greenhouse gasses
GUMP	Gas Utilisation Master Plan
HFIAS	Household Food Inaccess Scale
HWISE	Household Water Insecurity Experiences
I&APs	Interested and affected parties
ICCPR	International Covenant on Civil and Political Rights
ICESCR	International Covenant on Economic, Social and Cultural Rights
IDP	Integrated Development Plan
IEA:PLE	International Environmental Agreements: Politics, Law and Economics
IEP	Integrated Energy Plan
IESBS	International Encyclopedia of the Social & Behavioural Sciences
IGRFA	Intergovernmental Relations Framework Act 13 of 2005
IJSDWE	International Journal of Sustainable Development and World Ecology
IMCs	Inter-Ministerial Committees
IPAP	Industrial Policy Action Plan
IRNM	Integrated natural resource management
IRP	Integrated Resource Plan
IWRM	Integrated Water Resources Management
JSAL	Journal of South African Law
LEFWM	Land-energy-food-water-minerals
LGMSA	Local Government: Municipal Systems Act 32 of 2000

LNG	Liquefied natural gas
MDGs	Millennium Development Goals
MEPI	Multidimensional Energy Poverty Index
MoU	Memorandum of understanding
MPRDA	Mineral and Petroleum Resources Development Act 28 of 2002
MTSF	Medium Term Strategic Framework
NCCAS	National Climate Change Adaptation Strategy
NCCR-WP	National Climate Change Response White Paper
NDC	Nationally Determined Contributions
NDP	National Development Plan
NEA	National Energy Act 34 of 2008
NECOM	National Energy Crisis Committee
NEMA	National Environmental Management Act 107 of 1998
NEMAQA	National Environmental Management: Air Quality Act 39 of 2004
NEMPA	National Environmental Management: Protected Areas Act 57 of 2003
NEMWA	National Environmental Management: Waste Act 59 of 2008
NERSA	National Energy Regulator of South Africa
NFNSP	National Food and Nutrition Security Plan
NGOs	Non-governmental organisations
NIP	National Infrastructure Plan
NO _x	Nitrogen oxides
NPDP	National Policy Development Framework
NPFNS	National Policy on Food and Nutrition Security
NRF	National Research Foundation
NSDF	National Spatial Development Framework
NWA	National Water Act 36 of 1998

NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
NWRS	National Water Resource Strategy
OGEL	Oil, Gas and Energy Law Intelligence
PAIA	Promotion of Access to Information Act 2 of 2000
PAJA	Promotion of Administrative Justice Act 3 of 2000
PASA	Petroleum Agency of South Africa
PCC	Presidential Climate Change Commission
PELJ	Potchefstroom Electronic Law Journal
PFAS	Per-and-polyfluoroalkyl substances
PMG	Parliamentary Monitoring Group
PNAS	Proceedings of the National Academy of Sciences
PTO	Permission to occupy
RECIEL	Review of European Community and International Environmental Law
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RISDP	Regional Indicative Strategic Development Programme
S&EIR	Scoping and environmental impact report
SADC	Southern African Development Community
SAHRC	South African Human Rights Commission
SAJELP	South African Journal of Environmental Law and Policy
SAJS	South African Journal of Science
SALGA	South African Local Government Association
SAREM	South African Renewable Energy Masterplan
SDGs	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SEMA	Specific environmental management acts
SES	Socio-ecological systems

SO ₂	Sulphur dioxide
SPLUMA	Spatial Planning and Land Use Management Act 16 of 2013
UDHR	Universal Declaration of Human Rights
UGD	Unconventional gas development
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNU	United Nations University
USA	United States of America
VOCs	Volatile organic compounds
WEF nexus	Water-energy-food nexus
WEF	Water-energy-food
WEL	Water-energy-land
WHO	World Health Organisation
WSA	Water Services Act 108 of 1997
WUL	Water use licence

CHAPTER 1 INTRODUCTION

1.1 Background

Basic human needs and the advancement of human society depend on and are inextricably linked to water, energy¹ and food resource systems.² Global resources of water, energy and food are under stress and the future demand for water, energy, and food is set to increase significantly.³ This ever-increasing demand is driven by population growth, economic growth, cultural change, technological changes, changing consumption trends and climate change.⁴ Global projections point to an energy and water demand increase of 40 to 60 percent by 2050, and a 60 percent increase in agricultural demand.⁵ Globally, some 1.3 billion people are without access to modern forms of energy, without adequate access to safe water, and are undernourished.⁶ Referred to as the "bottom billion" these people are water, energy

¹ Sources of energy are classified either as non-renewable or renewable. Examples of non-renewable energy sources include petroleum, hydrocarbon gas liquids, natural gas, coal and nuclear. Renewable energy sources include solar, wind, biomass, hydropower, and geothermal energy. See EIA 2021 <https://bit.ly/3Ww3J9W>.

² Core aspects of human life such as the ability to work, live, survive and execute tasks are all dependent on water, energy and food resource systems. Olawuyi 2020 *Environmental Science and Policy* 1; Das Gupta "WEF Nexus and Sustainable Development" 238; Kumar *et al* "Water-food-energy nexus" 211; Ahmad *et al* 2021 *Water* 2; Chen and Xu 2021 *Water* 1; Zarei *et al* 2021 *Journal of water supply: research and technology* 138; Olawuyi 2020 *Environmental Science and Policy* 1; Hua *et al* 2022 *Energy Conversion and Management* 1; Allouche, Middleton and Gyawali "The Water-Food-Energy-Nexus" 2.

³ Das Gupta "WEF Nexus and Sustainable Development" 223; Beddington "Food, Energy, Water and the Climate: A Perfect Storm?" 1-9; Beddington 2015 "The Perfect Storm Revisited"; Kumar *et al* "Water-food-energy nexus" 1; SIWI Report 2014 "Shale gas and hydraulic fracturing" 13-14; Salam *et al* "The Need for the Nexus Approach" 9; Hua *et al* 2022 *Energy Conversion and Management* 1; Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 143; Kemp *et al* 2022 *Current Research in Environmental Sustainability* 1.

⁴ Salam *et al* "The Need for the Nexus Approach" 4 & 9; Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 129; Das Gupta "WEF Nexus and Sustainable Development" 223; Kumar *et al* "Water-food-energy nexus" 1; Pahl-Wostl *Environmental Science and Policy* 356; Hua *et al* 2022 *Energy Conversion and Management* 1; Brouwer "The water-energy-food nexus" 1.

⁵ Kemp *et al* 2022 *Current Research in Environmental Sustainability* 1; Das Gupta "WEF Nexus and Sustainable Development" 223. Also, see Beddington "Food, Energy, Water and the Climate: A Perfect Storm?" 1-9; Beddington 2015 "The Perfect Storm Revisited"; Butare "From Bonn 2011 Nexus" xix; SIWI Report 2014 "Shale gas and Hydraulic fracturing" 13-14; Larson, Holley and Bowman 2018 *Jurimetrics* 3.

⁶ Salam *et al* "The need for the nexus approach" 9; Butare "From Bonn 2011 Nexus" xix; IRENA "The water, energy and food nexus" 21. Different measuring criteria are used for global estimations – for example, Sharma and Kumar indicate that 900 million people lack access to safe drinking water, three billion people do not have access to modern fuels for heating and cooking, two billion people lack food security intermittently, and more than 800 million people are chronically hungry. See Sharma and Kumar 2020 *IEA:PLE* 377-378.

and food insecure and as a result are trapped in poverty.⁷ Notably, the growing demands for water, energy and food resources will likely exacerbate socio-economic inequality within populations.⁸ This is because an increase in the demand for these resources inevitably leads to cost and price increases.⁹ The poor's access to water, energy and food resources will likely be severely hampered by the issue of affordability and hence water, energy and food insecurity.¹⁰

This is particularly true for developing countries (where almost 95% of the global population growth occurs and severe economic inequality exists),¹¹ including South Africa.¹² South Africa, like other countries, is increasingly facing societal and ecological pressures attributed to patterns of unsustainable production and consumption.¹³ Water, energy and food security is of particular concern in Southern Africa where dependence on climate-sensitive sectors of energy and agriculture rely heavily on water resources.¹⁴ Although all three resources (water, energy, and food) are under pressure, it is the lack of energy security that is arguably topping the list in South Africa.¹⁵ On 9 February 2023 the government declared a state of disaster¹⁶ due to

⁷ Butare "From Bonn 2011 Nexus" xix.

⁸ Kemp *et al* 2022 *Current Research in Environmental Sustainability* 1-2.

⁹ Grafton "Global risks and opportunities in food, energy, environment and water" 73-74.

¹⁰ Grafton "Global risks and opportunities in food, energy, environment and water" 73-74. The issue of affordability is identified as a main driver of water, energy and food insecurity in South Africa. See the empirical study for the Water Research Commission of South Africa July 2021 Methner *et al* "(eds) "Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and wellbeing in South Africa" viii, x, xi, xii, xiv, xv, xvi.

¹¹ In socio-economic terms, South Africa is one of the most unequal societies in the world (the gap between the rich and the poor). StatsSA "03-10-25 - Subjective Poverty in South Africa: Findings from General Household Survey 2019, 2019" (Report 2020) <https://www.statssa.gov.za/?p=15224>; World Population Review "Income Inequality by Country 2022" Income Inequality by Country 2022.

¹² Beddington "A Perfect Storm of Global Events?" 1-9; Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 129; Kumar *et al* "Water-food-energy nexus" 211; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 2; Von Bormann and Gulati "The Food Energy Water Nexus" 4. There are examples of developed countries, such as the US that also struggles with water, energy and food security. This applies to the state of California. See Pradhang "Water-Energy-Food Nexus: Examples from the USA" 141-149.

¹³ Staupé-Delgado 2020 *EDS*(22) 6131; Pereira and McElroy "Food-energy-water nexus thinking" 3.

¹⁴ Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 143.

¹⁵ Obeng-Darko and Crossley 2018 *OGEL* 5; Orthofer, Huppmann and Krey 2019 *Frontiers in Energy Research* 1-2; Heinberg *Blackout: Coal, Climate and the Last Energy Crisis* 95-98.

¹⁶ In terms of sections 3 and 27(2) of the *Disaster Management Act* 57 of 2002. Emergency declared on 9 February 2023. GN 3019 in GG 48009 of 9 February 2023 in terms of section 27(5)(b) of the *Disaster Management Act* 57 of 2002 as amended.

electricity supply constraints.¹⁷ This was followed on 6 March 2023 by the introduction of a new Minister of Energy to deal exclusively with electricity supply.¹⁸ The country's failure to provide energy security by way of its almost exclusive reliance on coal-based energy, is well-documented.¹⁹ In its quest for energy security, the South African government has identified onshore unconventional natural gas, particularly, shale gas as a potential alternative energy resource.²⁰

Unconventional natural gas is promoted as a bridging fuel (i.e. between fossil fuels and "cleaner" renewable energy).²¹ Proponents of unconventional natural gas indicate that it is a cleaner alternative to coal because, among other, it reduces reliance on coal and therefore lead to lower carbon emissions.²² The argument goes that natural gas, consisting essentially of methane, is a cleaner burning fuel than coal because it does not have the sulphur content of coal.²³ This however is contested because methane leakage into the atmosphere from UGD take place throughout its life-cycle without it having been combusted (during drilling, extraction, processing and transport).²⁴ Notably, fugitive emissions from natural gas, being methane, is a much more potent GHG than CO₂.²⁵ The bridging or transitional role that is ascribed to unconventional natural gas is not without contestation.²⁶ The use of bridging or

¹⁷ The national state of disaster was subsequently lifted on 5 April 2023 (see GN R3265 and GN R 3266 in GG 48400 of 5 April 2023) with the introduction of the new Minister of Energy (see announcement by President Ramaphosa on "New members of the National Executive" on 6 March 2023).

¹⁸ While the new Minister's mandate is that of exclusively dealing with electricity supply, other notable ministries that plays key roles in addressing the energy crisis include the Department of Public Enterprises (manages the government-owned Eskom that is the country's largest electricity producer) and the Department of Mineral Resources and Energy, as well as the National Energy Regulator of South Africa (NERSA).

¹⁹ See Chapter 3.5.5. Obeng-Darko and Crossley 2018 *OGE* 5; Langerman *et al* 2022 *CAJ* 1-2; Orthofer, Huppmann and Krey 2019 *Frontiers in Energy Research* 1-2; Heinberg *Blackout: Coal, Climate and the Last Energy Crisis* 95-98. See Chapter 2.

²⁰ Humby "Environmental Assessment of Shale Gas" 95. Gulati 2004 "Understanding the food energy water nexus" 14; Clark *et al* 2022 *JESA* 28. Most of South Africa's oil is imported. Since 2006, gas is also imported (from e.g. Mozambique). See Wakeford "South African Energy Context" 144-146; Clark *et al* 2022 *JESA* 22-35. By diversifying its energy mix, the South African government is in effect reducing its dependence on coal. Also see Holley and Kennedy 2019 *Jurimetrics* 234.

²¹ Chapter 2.4.2. Gürsan and de Gooyert 2021 *RSER* 14.

²² Chapter 2.4.2.

²³ Wakeford "South African Energy Context" 157; Glazewski "Looking forward" 438.

²⁴ Wakeford "South African Energy Context" 158; Glazewski "Looking forward" 438.

²⁵ The Intergovernmental Panel on Climate Change (IPCC) estimates methane to have a global warming potential 25 times that of CO₂. See Wakeford "South African Energy Context" 158.

²⁶ Chapter 2.4.2.

transitional fuels, such as unconventional natural gas, has an inherent risk of lock-in into fossil fuels and the resultant lock-out of emerging renewable technologies.²⁷

The exploitation and development of onshore unconventional natural gas rests on unconventional mechanical and chemical techniques that include, among others, multi-directional drilling combined with repeated hydraulic fracturing.²⁸ The use of unconventional exploitation techniques, such as hydraulic fracturing has a number of social and ecological impacts.²⁹ Notably, impacts associated with onshore unconventional natural gas development (hereafter UGD) place specific stress on water resource systems and the linkages that exist between water, energy and food resource systems.³⁰ The interactions (inter-connectivity and inter-dependence) between water, energy and food resource systems, within the development process of onshore unconventional natural gas, create a nexus among them.³¹

1.2 Interconnected and interlinked nature of water, energy and food resource systems

Before the connection to UGD is discussed, it is necessary to refer to the many connections and intersections that exist between water, energy and food resource systems.³² For example, energy is needed to produce water (extraction, transportation and treatment) and food (activities related to processing, distribution, preparation and cooking), while water is needed to produce energy (production of fuels from fossils and generation of energy such as electricity from fossil fuels) and food (irrigation,

²⁷ See Chapter 2.4.2.

²⁸ See Chapter 2.3 and 2.4. Peel "Regulation of the nexus" 206-207. Also see Holley and Kennedy 2019 *Jurimetrics* 11.

²⁹ Humby "Environmental assessment of shale gas development" 114; Ahamed *et al* 2019 *Case Studies in the Environment* 2. See Chapter 2.4.

³⁰ Olusola, Esterhuyse, and Levine "The Water-Energy-Food Nexus" 132-133. Pandey and Shrestha "Evolution of the Nexus" 11.

³¹ Olusola, Esterhuyse, and Levine "The Water-Energy-Food Nexus" 132-133. Pandey and Shrestha "Evolution of the Nexus" 11. It, (the word nexus) "refers to a connection or series of connections linking two or more things". See Pandey and Shrestha "Evolution of the Nexus" 11; Pereira and McElroy "Food-energy-water nexus thinking" 5.

³² Pandey and Shrestha "Evolution of the Nexus" 11; Salam *et al* "The Need for the Nexus Approach" 6; Shinde "Water-Energy-Food nexus" 67; Benson *et al* "Governing for the Nexus" 77; Pradhanang "Nexus: Examples from the USA" 141-142; Dodds and Bartram "The Water, Food, Energy and Climate Nexus" 22-23; Ahamed *et al* 2019 *Case Studies in the Environment* 3.

processing, distribution, retailing and consumption).³³ The interconnected nature of these interactions can be described as follows:³⁴

... there is no energy production without water, no water supply without energy, and no food production without these key resources. Therefore, the WEF systems are fully intertwined and interdependent. Impacts on one resource, whether from the demand or supply side, affect all others and thereby, the entire production or consumption chain.

Conventional agriculture is, for example, known to extract large amounts of fresh water and although some water is returned to surface or groundwater, the use of fertilizers and pesticides leads to pollution.³⁵ Water purification of polluted or wastewater in turn requires energy.³⁶ In the food sector, energy is needed for activities related to processing (heating and cooling), distribution, preparation and cooking.³⁷ Energy-intensive products include fertilizers (which are synthetic and nitrogen-based) and pesticides.³⁸ A collapse of an energy system could result in the disruption of water services and food supply.³⁹ Likewise, water shortages could negatively impact the production of energy and food.⁴⁰ Furthermore, without food, human and animal contributors to the water and energy supply value chain may not be able to function well.⁴¹ Without water humans cannot produce energy and food; and without energy humans cannot process nor distribute water and food.⁴² Empirical case studies from regions all over the world confirm the existence of strong interdependence between water, energy and food resource systems.⁴³ Because energy and food production is

³³ Salam *et al* "The Need for the Nexus Approach" 6-9; Olusola, Esterhuise, and Levine "The Water-Energy-Food Nexus" 133.

³⁴ Lazaro *et al* 2022 *Frontiers in Water* 2.

³⁵ Von Bormann and Gulati "The Food Energy Water Nexus" 4; Salam *et al* "The Need for the Nexus Approach" 8.

³⁶ Von Bormann and Gulati "The Food Energy Water Nexus" 4; Salam *et al* "The Need for the Nexus Approach" 8.

³⁷ Salam *et al* "The Need for the Nexus Approach" 9; Von Bormann and Gulati "The Food Energy Water Nexus" 4.

³⁸ Von Bormann and Gulati "The Food Energy Water Nexus" 4; Salam *et al* "The Need for the Nexus Approach" 9.

³⁹ Olawuyi 2020 *Environmental Science and Policy* 1. Examples of this is evident in South Africa. See Chapter 3.5.5.

⁴⁰ Olawuyi 2020 *Environmental Science and Policy* 1.

⁴¹ Olawuyi 2020 *Environmental Science and Policy* 1.

⁴² Salam *et al* "The Need for the Nexus Approach" 6-9; Olawuyi 2020 *Environmental Science and Policy* 1.

⁴³ Report to the Water Research Commission 2021 *Exploring the evidence of water-energy-food nexus linkages in South Africa* 1-353; Leese and Meisch 2015 *Water Alternatives* 698; Granit *et*

interlinked with and interdependent on water use, any action (such as policy and governance) in one sector (water, energy, and food) has implications on the other, and vice versa.⁴⁴ In addition, climate change impacts on water (in the form of higher temperatures, droughts and water scarcity) and this in turn has an impact on food (less water available for irrigation and feedstock). Further, activities related to food, such as conventional agriculture methods,⁴⁵ require the use of energy (pumping of water, transport of goods, etc.) that are for the most part still in the form of fossil fuels.⁴⁶ This leads to the release of more GHG emissions into the atmosphere and exacerbates climate change. Other negative impacts from conventional agricultural methods on the environment are numerous and include land degradation, water pollution, over extraction of water, soil pollution and contamination, biodiversity completion, and the release of GHG emissions (climate change).⁴⁷ Conventional agriculture and farming methods differ from organic/regenerative farming in a number of ways.⁴⁸ These are notable in the different water and energy inputs required from conventional to organic/regenerative farming.⁴⁹

The same is true for UGD. The impacts of UGD include, for example, impacts on water resources (extracting and possible pollution) and general energy use (pumping of water, purification and decontamination of wastewater, drilling etc.).⁵⁰ Water quantity and quality issues emanating from UGD in turn negatively impact on agriculture.⁵¹ Notably, UGD is linked to the leakage of methane (a much more potent GHG than

al 2012 *IJWRD* 419-432; Bach *et al* 2012 "Addressing water, energy and food security" 1-63; Stucki and Sojamo 2012 *IJWRD* 399-418; Hermann *et al* 2012 *Natural Resources Forum* 245-262; Yan, Fang and Mu 2020 *Science of the Total Environment* 1-14.

⁴⁴ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 1; Olusola, Esterhuyse, and Levine "The Water-Energy-Food Nexus" 133; Salam *et al* "The Need for the Nexus Approach" 6; Pandey and Shrestha "Evolution of the Nexus" 11; Olawuyi 2020 *Environmental Science and Policy* 1.

⁴⁵ Chapter 3.5.7. Both commercial and subsistence agriculture in South Africa remains heavily based on conventional methods. See Meyer *et al* "Soil, Land and Agriculture" 314-316; Cheteni and Umejesi 2022 *EMS* 70-85.

⁴⁶ Cheteni and Umejesi 2022 *EMS* 78-79.

⁴⁷ Chapter 3.5.7.

⁴⁸ Chapter 3.5.7. Meyer *et al* "Soil, Land and Agriculture" 316.

⁴⁹ Chapter 3.5.7.

⁵⁰ See Chapter 2.3 and 2.4. Mrou *et al* "Water-Energy Nexus" 22; Olusola, Esterhuyse, and Levine "The Water-Energy-Food Nexus" 133.

⁵¹ See Chapter 2.4. Salam *et al* "The Need for the Nexus Approach" 8; Ong 2014 *EJSD* 64-70; Hitaj, Boslett and Weber 2020 *Energy Policy* 2-3.

CO₂) and therefore it aggravates climate change impacts.⁵² These impacts include higher temperatures, less water, and less food. UGD is therefore a contested issue.⁵³ Against this background, UGD by way of horizontal drilling and hydraulic fracturing, is a key issue at the intersection of water, energy and food resource systems.⁵⁴

1.3 Governance of natural resources – previous integrative approaches

In an effort to manage these interconnections between natural resource- sectors and systems (e.g. water, energy, and food), policy-makers and scholars have been exploring legal and governance tools that have a cross-sectoral approach. Various models of integrated, holistic, cross-sectoral, ecosystem-based and polycentric approaches have been explored in legal and governance literature.⁵⁵ Examples of cross-sectoral natural resource governance are to be found in concepts such as integrated water resource management (IWRM),⁵⁶ and integrated natural resource management (INRM).⁵⁷ These attempts at cross-sectoral management of natural resources either did not succeed or had mixed results.⁵⁸ The main reason for this was that these concepts focus on a specific natural resource and do not adequately account for interactions with other natural resources (e.g. IWRM is water-centric and therefore engages other sectors from a water management perspective).⁵⁹ None of the existing cross-sectoral natural resource governance tools (IWRM and INRM) can account for and manage the interlinked and interdependent nature of water, energy and food resource sectors in a sustainable way.⁶⁰ Ultimately, sectoral approaches, including sectoral governance and regulatory approaches to natural resource management, are unsustainable.⁶¹ With this realisation came a renewed focus on finding a cross-sectoral

⁵² Chapter 2.2.3 and 2.4.2.

⁵³ Chapter 2.2.3 and 2.4.2.

⁵⁴ Ahamed *et al* 2019 *Case Studies in the Environment* 2.

⁵⁵ Larson, Holley and Bowman 2018 *Jurimetrics* 3-4.

⁵⁶ Chapter 3.3.

⁵⁷ Chapter 3.3.

⁵⁸ Simpson and Jewitt 2019 *Frontiers in Environmental Science* 3; Bach *et al* "Addressing water, energy and food security" 10; Chapter 3.3.

⁵⁹ Bach *et al* "Addressing water, energy and food security" 10; Chapter 3.3.

⁶⁰ Holley and Kennedy 2019 *Jurimetrics* 3.

⁶¹ Chapter 3.10. Kemp *et al* 2022 *Current Research in Environmental Sustainability* 7; Holley and Kennedy 2019 *Jurimetrics* 3; Olawuyi 2020 *Environmental Science and Policy* 1-2.

governance approach that acknowledges and manages the integrated nature of water, energy and food resource systems more effectively and sustainably.⁶²

1.4 The nexus approach

This focus on understanding and managing the interlinked and interdependent actions and impacts between resource sectors and systems is based on an integrated and holistic systems approach (or a form thereof) known as the nexus approach.⁶³ More specifically, the nexus approach is associated with any number of interactions between water, energy, and food resource sectors or systems.⁶⁴ The nexus approach submits that water, energy and food systems are intricately linked and therefore integrated approaches are necessary to move past sectoral or silo-management approaches.⁶⁵ Notably, it is departing from conventional resource-centric approaches (such as IWRM) to a multi-centric approach that aims to provide equal weighting to water, energy and food resource systems.⁶⁶ The nexus approach is about identifying, understanding and managing the many complex interactions that take place between water, energy and food resource systems.⁶⁷ While interactions between water, energy and food resource systems can take many forms, they are usually described in terms of trade-offs and synergies.⁶⁸ Because the nexus approach is about the interconnections that exist

⁶² Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 1, 8; Peel "Regulation of the Nexus" 198-217; Stein, Barron and Moss "Governance of the Nexus" 4.

⁶³ Von Braun and Mirzabaev "Nexus scientific research" 58; Brouwer "The water-energy-food nexus" 2; Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 141; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 21.

⁶⁴ This depends on the specific developmental aspects. Examples of other sector interlinkages include climate and land use. See Chapter 3. Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 2; Pandey and Shrestha "Evolution of the Nexus" 11; Salam *et al* "The Need for the Nexus Approach" 6; Shinde "Water-Energy-Food nexus" 67; Benson *et al* "Governing for the Nexus" 77; Pradhanang "Nexus: Examples from the USA" 141-142; Dodds and Bartram "The Water, Food, Energy and Climate Nexus" 22-23; Ahamed *et al* 2019 *Case Studies in the Environment* 3.

⁶⁵ This includes both policy and disciplinary silos. See Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 1; Dodds and Bartram "History of the Nexus" 43.

⁶⁶ Brouwer "The water-energy-food nexus" 2; Proctor, Tabatabaie and Murthy 2021 *Science of the Total Environment* 3; Bach *et al* "Addressing water, energy and food security" 33; Simpson and Jewitt 2019 *Frontiers in Environmental Science* 3. For example, IWRM followed a resource-centric approach (water).

⁶⁷ Pereira and McElroy "Food-energy-water nexus thinking" 2; Von Braun and Mirzabaev "Nexus scientific research" 62; Allouche, Middleton and Gyawali "The water-food-energy nexus" 21-22.

⁶⁸ Pahl-Wostl *et al* 2021 *Sustainability science* 615; Proctor, Tabatabaie and Murthy 2021 *Science of the total environment* 2; Farah and Ibrahim "Water-energy-food nexus" 381; Olawuyi 2020 *Environmental science and policy* 1; Brouwer "The water-energy-food nexus" 2. See Chapter 3.7.

between resource systems, it is generally accepted to be more holistic than earlier cross-sectoral approaches.⁶⁹ The water-energy-food nexus (WEF nexus) approach is increasingly recognised as a novel way to address sustainability issues, particularly complex resource and development challenges.⁷⁰

1.5 Governance and the nexus

The WEF nexus approach recognises that the governance of water, energy and food resource systems should reflect the interconnected and interdependent nature thereof.⁷¹ Regulatory and decision-making frameworks (being specific elements of governance) that do not reflect the nexus (inter-connectedness) between water, energy and food resource sectors as a system or a set of systems, could, instead of ensuring water, energy and food security, achieve the opposite.⁷² The nexus approach acknowledges that governance plays a key-role in bridging fragmented water, energy and food practices (at numerous levels and scales) and ultimately ensures that development is sustainable.⁷³ In order to deal with horizontal and vertical fragmentation issues (that tend to make up single silo or sectoral approaches), governance of the WEF nexus is a decidedly multi-level and multi-scale construct.⁷⁴

Systems-thinking, generally, in so far as it views social and ecological aspects in a holistic manner (in contrast to a sectoral view or views) underpins much of the nexus

⁶⁹ Such as IWRM etc. See Holley and Kennedy 2019 *Jurimetrics* 235; Pahl-Wostl *et al* 2021 *Sustainability science* 615.

⁷⁰ Kotzé and Kim 2022 *Global Policy* 86-97; Pereira and McElroy "Food-energy-water nexus thinking" 1-2; Albrecht, Crootof and Scott 2018 *Environmental Research* (1) 21; McGrane *et al* 2018 *Geographical Journal* 2.

⁷¹ Brouwer "The water-energy-food nexus" 1-2; Pahl-Wostl *et al* 2021 *Sustainability Science* 615-617; Olawuyi 2020 *Environmental Science and Policy* 3; McGrane *et al* 2018 *Geographical Journal* 2; Scott "Making governance work for water–energy–food nexus approaches" 6; Stein, Barron and Moss "Governance of the Nexus" 4.

⁷² Peel "Regulation of the Nexus" 198; OECD 2013. While the drivers of water, energy and food security risk include socio-economic factors (such as population growth and economic activity) and natural phenomena (such as natural disaster, climate change impacts), it is the policies of each sector that are the biggest causes of risk. See Grafton *et al* 2013 *Nature Climate Change* 315-321.

⁷³ Fragmentation can exist at both horizontal and vertical levels. Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 2.

⁷⁴ Pahl-Wostl *et al* 2021 *Sustainability science* 616-617; Harwood 2018 *Environmental Science and Policy* 79. See Chapters 3.8 and 3.9.

approach.⁷⁵ In this regard, literature that acknowledges the reciprocal interactions and interdependencies between the human (social) and non-human (ecological), is growing within sustainability studies to include approaches, such as the socio-ecological systems (SES) approach.⁷⁶ This approach should be considered in conjunction with the WEF nexus approach.⁷⁷

South Africa is an example of a country already struggling to maintain security of water, energy and food and consequently the WEF nexus is related to the country's goal of achieving water, energy and food security.⁷⁸ UGD may have unintended impacts on water and food security.

1.6 Onshore unconventional natural gas development (UGD)

As stated above, in its bid to secure energy security, the South African government is looking for alternative energy resources, such as onshore unconventional natural gas in the form of shale gas and coalbed methane in the geographical area of the Karoo⁷⁹ (and likely in parts of KwaZulu-Natal Midlands, the Eastern Cape and an area in the North-West which straddles the South African, Namibian and Botswana

⁷⁵ Kotzé 2020 *Transnational Legal Theory* 75-104; Harwood 2018 *Environmental Science and Policy* 79; Siddiqi "Leveraging the water-energy-food security nexus" 308-309; Pereira and McElroy "Food-energy-water nexus thinking" 9-10. See Chapter 3.8.

⁷⁶ Chapters 2.4 and 3.8. Pereira and McElroy "Food-energy-water nexus thinking" 3-4. Interdependent social and ecological systems should also be seen within context or backdrop of Anthropocene - Larson, Holley and Bowman 2018 *Jurimetrics* 14. On the Anthropocene, see Kotzé *Environmental Law and Governance for the Anthropocene*.

⁷⁷ Pereira and McElroy "Food-energy-water nexus thinking" 3-4. Literature in social-ecological systems indicates its usefulness as an intertwined complex adaptive system (CAS). See Chapter 2.

⁷⁸ South Africa is an example of how resource insecurity (energy) in one sector has consequences for other sectors (water and food). See Chapters 3.4 and 3.5. World Energy Council 2013 *World Energy Issues Monitor* 28.

⁷⁹ As per *Encyclopedia Britannica* "Karoo also spelled Karroo, arid to semi-arid geographic region of Eastern Cape, Western Cape, and Northern Cape provinces, South Africa. The Karoo is best defined by its vegetation, which consists of assorted succulents and low scrub bushes spaced from one foot to several feet apart. The area is devoid of surface water, and its name is derived from the Khoisan word meaning "land of thirst." Its sub regions include the intermontane values of Little Karoo and Great Karoo in the lesser-elevated areas of Western and Eastern Cape provinces and the main Karoo (or Upper Karoo) spanning the vast highland plateau of the Northern Cape province to the north and east of the Great Escarpment. Altogether the Karoo occupies about 153,000 square miles (395,000 square km) -- about one-third of the total area of South Africa".

borders).⁸⁰ Since the initial application⁸¹ for a technical cooperation permit brought under the MPRDA to start undertaking hydraulic fracturing, a number of noteworthy developments took place. This includes the declaring of a number of moratoriums on hydraulic fracturing (seemingly due to pressure by civil society groups)⁸² and the continuation of the development and publishing of draft regulations on a number of aspects relating to hydraulic fracturing. A number of studies was also commissioned on UGD namely, (i) the Academy of Science of South Africa (ASSAf) and the Council for Scientific and Industrial Research (CSIR) published the "South Africa's Technical Readiness to Support the Shale Gas Industry"⁸³ and the "Strategic Environmental Assessment for Shale Gas Development" respectively.⁸⁴ Recent press reports indicate that the government is looking to lift the moratorium on hydraulic fracturing to enable UGD.⁸⁵ Notably, the chief operating officer at the Petroleum Agency of South Africa (PASA)⁸⁶ indicated that a minimum of 10 shale gas blocks in the Karoo area will be made available for bidding once the bidding legislation has been passed.⁸⁷ This is

⁸⁰ See "Petroleum Potential of the Karoo Basins" as per the Petroleum Agency of South Africa www.petroleumagency.co.za. For specific locations, see maps as per the Petroleum Agency of South Africa and the South African Oil & Gas Alliance. Also, see Esterhuysen, Kemp and Redelinghuys 2013 *Water International* 687-700; Savides *Times Live* news report. Rhino Oil and Gas Exploration South Africa (Pty) Ltd lodged an application with the Petroleum Agency of South Africa (PASA) for an exploration right covering an area of over 1 million hectares (includes more than 6,000 farms) within Central Drakensberg and Free State area. The area extends from Mooi River and Estcourt northwards to Winterton, Bergville and Van Reenen (all within the KZN Central Drakensberg) to the south of Memel in the Free State province. It also includes areas of the Lesotho border, Phuthaditjhaba and Clarens to beyond the towns of Bethlehem and Lindley. See Rhino Oil and Gas Exploration South Africa (Pty) Ltd "Background Information on Proposed Petroleum Exploration on various farms in Northern Kwazulu-Natal" February 2016; Comins "Global petroleum company brings fracking threat to Drakensberg" *IOL Mercury* 16 November 2018; Esterhuysen "How fracking plans could affect shared water resources in Southern Africa" 18 October 2020 in *The Conversation Africa*; McGranahan and Kirkman 2021 *Resources Policy* 1.

⁸¹ The initial application was brought by multi-national companies to include Bundu Gas and Oil, Falcon Oil and Gas Ltd, and Shell Exploration Company B.V.

⁸² Such as the Treasure the Karoo Action Group (TKAG) via its critical report on UGD: A Critical review of the application for a gas exploration right by Shell Exploration Company BV.

⁸³ For the ASSAf and CSIR study see <http://dx.doi.org/10.17159/assaf.2016/0003>.

⁸⁴ For the Strategic Environmental Assessment see <http://seasgd.csir.co.za/>. Also, see the Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa <https://gasnetwork.csir.co.za/final-sea-reports/>. Notice of proposed investigation in terms of s 50 of the *Mineral and Petroleum Resources Development Act* 28 of 2002 (MPRDA) to confirm the results of previous geoscientific surveys on geochemical anomalies for the possible exploration and exploitation thereof was published for comment (GN 1269 in GG 43942 of 27 November 2020).

⁸⁵ Roelf 2023 "Reuters" and Erasmus 2023 "Business Day".

⁸⁶ COO at PASA is Bongani Sayidini.

⁸⁷ Roelf 2023 "Reuters" and Campbell 2023 "Engineering News".

echoed by the Minister of Mineral Resources and Energy, Gwede Mantashe, who indicated that the groundwork has been done for proceeding with the onshore extraction of shale gas in the Karoo.⁸⁸ South Africa's first competitive auction for oil and gas resources could potentially already take place in 2024-2025.⁸⁹

The main benefits of natural gas from unconventional hydrocarbon reservoirs are those of enabling economic growth, job creation, which would ensure energy security and energy independence, and assist efforts at the decarbonising of energy systems.⁹⁰ Much is made of the significance of these benefits to society at large, namely enhancement of energy security, lower natural gas prices, a cleaner environmental footprint than some other fossil fuels (e.g. coal), and general economic development.⁹¹ This is also evident from government policy such as the *National Development Plan* (NDP),⁹² the *Integrated Resource Plan* (IRP),⁹³ the *Integrated Energy Plan* (IEP),⁹⁴ the *Framework for a Just Transition in South Africa - A Presidential Climate Commission Report*,⁹⁵ (hereafter the Just Transition Framework) regulatory developments such as the amendment of petroleum regulations,⁹⁶ the completion of a strategic

⁸⁸ Campbell 2023 "Engineering News" and Afriforum 2023 "Government's renewed appetite for fracking".

⁸⁹ Roelf 2023 *Reuters*.

⁹⁰ Sovacool 2014 *Renewable and Sustainable Energy Reviews* 251-253; Habib, Hinojosa and Hinojosa "Societal Implications" 184; Irene *Socio-Economic and Environmental Implications* 99; Sovacool and Vivoda 2013 *OGE* 23.

⁹¹ MIT "The Future of Natural Gas" 4; Irene *Socio-Economic and Environmental Implications* 99; Sovacool 2014 *Renewable and Sustainable Energy Reviews* 250.

⁹² The NDP 2030 "Our Future – Make it Work" is the overarching planning document for the development of South Africa. It confirms in Chapter 4 at actions 16 and 17 the need for incorporating shale gas and coal seam gas into the energy mix via the fast-tracking of gas development projects. Also see the NDP 2030 "Our Future – Make it Work" 160, 167, 172, 173, 175, 177, 201, 211 and 212.

⁹³ The IRP is South Africa's national electricity infrastructure plan in which the country's energy mix is determined (IRP2019). GG 42784 in GN 1360 of 18 October 2019. A new IRP is expected end 2023 or early 2024.

⁹⁴ The IEP guides future energy infrastructure investments. GN 1430 in GG 40445 of 25 November 2016.

⁹⁵ "A Framework for a Just Transition in South Africa" (September 2022) sets the framework for reaching South Africa's vision for a just and equitable transition towards climate resilience and zero-emissions development. It is a continuation of Chapter 5 of the NDP, namely "Ensuring Environmental Sustainability and an Equitable Transition to a Low Carbon, Climate Resilient Economy Society" whereby the National Planning Commission identified the water, energy and land-use sectors as of particular importance to a just and equitable transition. In this vein the Presidential Climate Commission identifies a number of policy measures and actions to give effect to a just and equitable transition.

⁹⁶ For petroleum exploration and production regulations "so called fracking regulations" see GN R466 in GG 38855 of 3 June 2015 that augmenting the MPRDA Regulations. GN R466 amended

environmental assessment (SEA) on UGD in the Karoo,⁹⁷ as well as from speeches by the President of the Republic of South Africa,⁹⁸ and the Minister and Director-General of the Department of Mineral Resources and Energy.⁹⁹ Other new regulatory developments include the publishing of the *Upstream Petroleum Resources Development Bill*¹⁰⁰ and the *Gas Amendment Bill*.¹⁰¹

In the context of UGD in South Africa, the nexus approach to water, energy and food resource systems have a very specific role to play in the promotion of more sustainable outcomes. The nexus approach focuses on understanding connections, synergies and trade-offs among any number of resource sectors and is therefore vis-à-vis fragmented non-systems approaches, better geared towards sustainable outcomes.¹⁰² This is in contrast to existing silo-based regulatory and governance frameworks that focus on sectoral approaches that do not acknowledge the interlinked and interconnected nature of water, energy and food resource systems.¹⁰³ Put differently, a strictly sector-specific approach where regulatory frameworks are aimed at resource

GN R527 in GG 26275 of 23 April 2004. See Du Plessis 2015 *PER* 1140-1478. On 4 July 2019, the South African Supreme Court of Appeal set aside the petroleum regulations in its entirety because the then Minister of Mineral Resources acted *ultra vires* when he included environmental matters under his domain. See *Minister of Mineral Resources v. Stern; Treasure the Karoo Action Group v. Department of Mineral Resources* [2019] 3 All SA 684 (SCA) at para 46-48 where the court found that the Minister of Mineral Resources did not have the power to make regulations regarding the management of environmental impacts relating to UGD. The Constitutional Court has not yet responded regarding its unconstitutionality. Also, see 2020 *Commonwealth Law Bulletin* 46(4) 662-688.

⁹⁷ For the Strategic Environmental Assessment see <http://seasgd.csir.co.za/>. Also, see the Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa <https://gasnetwork.csir.co.za/final-sea-reports/>. Notice of proposed investigation in terms of s 50 of the MPRDA to confirm the results of previous geoscientific surveys on geochemical anomalies for the possible exploration and exploitation thereof was published for comment (GN 1269 in GG 43942 of 27 November 2020).

⁹⁸ Comrie 2022 <https://bit.ly/3yY8wIb>; Creamer 2022 <https://bit.ly/37UWzI0>; Erasmus 2022 <https://bit.ly/37SeRcN>; Bega 2022 <https://bit.ly/3LnndH7>. Note that the title of the Minister has previously been the Minister of Minerals and Energy, the Minister of Mineral Resources and the most recent, the Minister of the Department of Mineral Resources and Energy. These titles will be used interchangeably depending on the timeframe. Mbete "A national dialogue to pave the way for oil and gas projects in South Africa" July 2022 <https://youtu.be/Fm23uXeGXZU>.

⁹⁹ Budget speech delivered on 18 May 2021 by Minister Mantashe. See Anon 18 May 2021 BusinessTech <https://bit.ly/3XHp3ts>.

¹⁰⁰ GN 494 in GG 44694 of 11 June 2021. See Chapter 4.

¹⁰¹ GN 332 in GG 44438 of 13 April 2021. See Chapter 4.

¹⁰² Liu *et al* 2018 *Nature Sustainability* 466.

¹⁰³ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 1.

security in one area, may result in less resource security in another.¹⁰⁴ In other words, separate regulation within a resource sector operates without any regard to its possible impact on other resource sectors.¹⁰⁵ While socio-ecological impacts associated with UGD can be minimised, they cannot be eliminated.¹⁰⁶ There is growing recognition that it is becoming increasingly difficult to meet the demand for water, energy and food resources by following a sectoral governance approach.¹⁰⁷ Such an approach misses opportunities for improving interactions between resource sectors, and could in some instances lead to unsustainable outcomes.¹⁰⁸ For example, water use restrictions could severely impact energy and food production because both energy generation and food production are heavily dependent on a certain quality set and quantity of water.¹⁰⁹

1.7 South African regulatory framework

Several South African laws and policies are applicable to the water, energy and food nexus. The Bill of Rights¹¹⁰ via sections 24 and 27 of the *Constitution of the Republic of South Africa* 1996 (Constitution) defines particular environmental rights in relation to water and food security.¹¹¹ The Constitution does not specifically provide for a right to energy.¹¹² Legislation that in general addresses the energy, water and food aspects includes, amongst others, the *Electricity Regulation Act* 4 of 2008 (ERA); the *National*

¹⁰⁴ OECD 2013. This is the result of spill-over effects – for example, the creation of incentives to meet energy security objectives results in the distortion of the demand for water (OECD 2013). Managing water, energy and food security risks necessitates the managing of trade-offs between separate or sector policy instruments (OECD 2013). Uncoordinated policy aimed at security in one area may result in less security in another: for example, greater energy security through UGD may be at the cost of water and food security.

¹⁰⁵ Peel "Regulation of the Nexus" 198.

¹⁰⁶ Walton and Woocay 2013 *Journal of Green Building* 71.

¹⁰⁷ Allouche, Middleton and Gyawali "The Water-Food-Energy-Nexus" 53; Butare "From Bonn 2011 Nexus" xix.

¹⁰⁸ Peel "Regulation of the Nexus" 199. Also, policies calling for an increase in agriculture production (irrigation) may not take note of the impacts on the water sector.

¹⁰⁹ Peel "Regulation of the Nexus" 199.

¹¹⁰ See ss 24 and 27 of the *Constitution of the Republic of South Africa*, 1996.

¹¹¹ "Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

¹¹² In *Joseph v City of Johannesburg*; 2010 (3) BCLR 212 (CC); 2010 (4) SA 55 (CC) the court construed a right to energy.

Energy Act 34 of 2008; the *National Water Act* 36 of 1998 (NWA); the *National Environmental Management Act* 107 of 1998 (NEMA); the *National Environmental Management: Waste Act* 59 of 2008 (NEMWA); the *Conservation of Agriculture Resources Act* 43 of 1983; the *Conservation of Agriculture Resources Bill*, 2013; the *Preservation and Development of Agricultural Land Bill*, 2016; the *Regulation of Agricultural Land Holdings Bill*, 2017;¹¹³ and the *Food and Nutrition Security Policy*, 2013.¹¹⁴

Within the context of UGD, the *Mineral and Petroleum Resources Development Act* 28 of 2002 (MPRDA) and the NEMA apply.¹¹⁵ The MPRDA lists the technical regulations for UGD by way of multi-directional drilling combined with hydraulic fracturing.¹¹⁶ The MPRDA also sets a number of regulatory approvals for UGD, namely: a reconnaissance permit, technical co-operation permit exploration right, and a production right.¹¹⁷ All but the technical co-operation permit, require prior environmental assessment in the form of an environmental impact assessment (hereafter EIA).¹¹⁸ The EIA regulations are central to the NEMA.¹¹⁹ In terms of the EIA regulations, UGD (as a range of activities) cannot commence without the approval and granting of an environmental authorisation.¹²⁰ While the listed regulatory frameworks are applicable to water, energy and food, it is not certain to what extent they follow a nexus approach. Section 240 of the NEMA obliges the decision-maker (at least on paper) to take a holistic approach¹²¹ and some policies and strategies indicate that a WEF nexus approach

¹¹³ See Chapter 4. According to Parliamentary Monitoring Group, no further action took place after these bills had been submitted.

¹¹⁴ GN 637 in GG 37915 of 22 August 2014. See also Government of the Republic of South Africa "National Food and Nutrition Security Plan for South Africa" 2018-2023 (November 2017). The *National Gas Act* 48 of 2001 deals with the transmission, storage, distribution, liquefaction and re-gasification of gas.

¹¹⁵ The MPRDA applies to all petroleum resources and according to its definition (section 1) includes shale gas.

¹¹⁶ Published as GN R466 in GG 38855 of 3 June 2015.

¹¹⁷ Sections 74(4), 79(4) and 83(4) read with section 5A of the MPRDA. See Humby "Environmental Assessment of Shale Gas" 88.

¹¹⁸ See Chapter 4.

¹¹⁹ Published as GNR 324-327 in GG 40772 of 7 April 2017 as amended.

¹²⁰ The purpose of an EIA is to "avoid or mitigate detrimental impacts on the environment, and to optimise positive environmental impacts". See regulation 2 of GNR 326 in GG 40772 of 7 April 2017 as amended.

¹²¹ See e.g. *Earthlife Africa Johannesburg v Minister of Environmental Affairs* [2017] 2 All SA 519 (GP) where the Minister required climate change considerations in addition to all the other considerations that needed to be taken into account.

should be followed.¹²² That said, the legal framework dealing with UGD remains fragmented. The proposed new Bills also do not solve this issue.¹²³

Questions exist on how South Africa's regulatory framework integrates and addresses these interlinked multi-recourse system impacts. Research by Kotzé¹²⁴ indicates that the environmental regulatory framework in South Africa has been and continues to be known by both horizontal and vertical fragmentation (that is fragmentation between departments at the same level (either national, provincial or local government level), and at vertical level (between national, provincial and local government)). The South African regulatory framework is operating within a distinct single sector or silo approach. It does not recognise system dynamics. This points to a lack of integration between departments at all levels and therefore the South African regulatory regime is not geared towards nexus governance. This is particularly relevant against the background of resource insecurity in the country (water, energy and food) and social inequity (the poor's access to water, energy and food resources) as referred to above, as well as the trade-offs that might arise with decision-making on onshore unconventional gas exploration and production.¹²⁵

1.8 Problem statement

South Africa faces the challenge of meeting the socio-economic needs of its growing population, and of doing it in a sustainable way, namely, without affecting/impeding the ability of future generations to meet their needs.¹²⁶ Energy plays a central role in this regard because of its significance to human security and development, which is

¹²² See Chapter 4.

¹²³ See Chapter 4.

¹²⁴ Kotzé "Environmental Governance" 103-125.

¹²⁵ Von Bormann and Gulati "The Food, Energy, Water Nexus" 7. See also Chapters 3, 4 and 5.

¹²⁶ Natural resources, as instruments for socio-economic growth, have been the focus of global, regional and local development policies and plans. See Barbier 2002 *Australian Economic Papers* 253-272; OECD 2011 "Economic Significance of Natural Resources" 9-18; Gylfason and Zoega "Natural Resources and Economic Growth" 1-46; Toman "The Roles of the Environment and Natural Resources" 1-7; Hennicke and Khosla "Decoupling Economic Growth from Resource Consumption" 1-33; UN Report SDSN 2013 "Harnessing Natural Resources for Sustainable Development" 1-32; Van der Ploeg 2011 *Journal of Economic Literature* 366-420.

based on the many interfaces with, and the various areas where energy impacts on other critical sustainability issues such as water and food security.¹²⁷

While numerous studies have provided progress in a better understanding of the numerous environmental impacts associated with UGD, not many studies make use of a systems-based approach, such as a socio-ecological systems approach to make linkages between (i) human (social) and ecological systems and (ii) water, energy and food more explicit.¹²⁸ While more recent literature on the WEF nexus approach acknowledges the importance of governance (understood here to include policies, legislation, regulations, rules, institutions and decision-making frameworks), most studies still focus on the technical aspects of the nexus approach.¹²⁹ This is reflected in the numerous quantitative studies on the nexus that typically uses measurement models and tools to quantify relational use of water, energy and food.¹³⁰ Since the nexus approach requires integrated and coordinated governance arrangements, more qualitative studies are required to focus on this critical aspect.¹³¹ Indeed, there are increasing calls for studies that focus on critical governance aspects of the nexus.¹³² Within this WEF nexus construct, research and practice on the regulation thereof is at

¹²⁷ See Chapter 3.5. Bierbaum and Matson 2013 *Daedalus* 146-181; Carbonnier and Brugger "The Development Nexus" 64; Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 129-140.

¹²⁸ Holley and Kennedy 2019 *Jurimetrics* 10. One exception in part is the book chapter by Ololade, Esterhuyse and Levine "The Water-Energy-Food Nexus" 129-140 that examined policy frameworks on the WEF nexus in South Africa. They identified the Karoo as an example where water, energy and food nexus issues exist. The comprehensive book of Glazewski and Esterhuyse discusses the scientific and legal aspects of hydraulic fracturing but does not address the nexus aspect *per se*. See Glazewski and Esterhuyse (eds) *Hydraulic fracturing in the Karoo - critical legal and environmental perspectives*.

¹²⁹ Holley and Kennedy 2019 *Jurimetrics* 5; Brouwer "The water-energy-food nexus" 3; Pereira and McElroy "Nexus thinking and sustainability governance" 7; Allouche, Middleton and Gyawali "The Water-Food-Energy-Nexus" 9, 131.

¹³⁰ See Chapter 3.6. *Vis-à-vis* qualitative or mixed method studies that employ both quantitative and qualitative methods. Numerous measurement tools exist in the nexus literature to assess and analyse relational impacts within a set nexus parameter. For example, the production of sugar involves the collection of data on inputs (land use, energy, water, manpower) and external drivers such as climate change, water quality, electricity/energy use, etc. These are scaled at levels to quantify or measure the input and output funds and flows. See Shinde "Selected tools and models" 67-76. A popular approach is that of the "Multi-Scale Integrated Analysis of Societal and Ecological Metabolism" (MuSIASEM). This approach is widely used to quantify relational nexus interactions.

¹³¹ Simpson and Jewitt 2019 *Frontiers in Environmental Science* 5; Holley and Kennedy 2019 *Jurimetrics* 5; Olawuyi 2020 *Environmental Science and Policy* 1.

¹³² Olawuyi 2020 *Environmental Science and Policy* 1; Holley and Kennedy 2019 *Jurimetrics* 5; Simpson and Jewitt 2019 *Frontiers in Environmental Science* 5.

an even more nascent stage.¹³³ The strong interlinkages that exist between water, energy and food resource systems mean that any regulatory effort at sustainability within current silo and/ or sectoral approaches will lead to unintended consequences, likely in the form of trade-offs between named resource systems.¹³⁴

As stated above, water, energy and food resource systems are governed by separate sets of policies, laws (legislation), rules, institutions and decision-making frameworks, that do not necessarily take the many interlinked and interdependent impacts between resource sectors into account and less so in the case of UGD.¹³⁵ There is accordingly a need for a more integrated approach to regulating the interlinked social-ecological impacts from UGD. Furthermore, regulatory frameworks focus on conventional extraction methods and therefore it is not familiar with unconventional extraction methods, particularly multi-directional drilling combined with repeated hydraulic fracturing.¹³⁶ UGD therefore poses new challenges to regulatory frameworks.¹³⁷ It seems therefore necessary to determine whether or if, the regulation of onshore unconventional natural gas in South Africa addresses the WEF nexus.

1.9 Research question

In light of the foregoing, this study seeks to answer the following central question: to what extent does the South African regulatory framework on UGD promote a nexus approach to water, energy and food, and if it does so insufficiently, how could it be reformed to more comprehensively embrace a nexus approach?

1.10 Objectives of the study

The primary objective of this study is to determine the extent to which the South African regulatory framework on UGD follows a nexus approach to water, energy and

¹³³ Peel "Regulation of the nexus" 198; Olawuyi 2020 *Environmental Policy and Science* 1.

¹³⁴ Larson, Holley and Bowman 2018 *Jurimetrics* 3; Holley and Kennedy 2019 *Jurimetrics* 235.

¹³⁵ See Chapter 3.6. Olawuyi 2020 *Environmental Science and Policy* 1; Peel "Regulation of the nexus" 198; Allouche, Middleton and Gyawali "The Water-Food-Energy-Nexus" 53; Peel "Regulation of the nexus" 198; Holley and Kennedy 2019 *Jurimetrics* 235.

¹³⁶ Peel "Regulation of the nexus" 206-207. See also Holley and Kennedy 2019 *Jurimetrics* 11.

¹³⁷ Peel "Regulation of the nexus" 206-207. See also Holley and Kennedy 2019 *Jurimetrics* 11.

food resource systems. In order to fulfil this objective, the following subsidiary objectives are set:

- To identify and describe regulatory challenges posed by UGD in South Africa.
- To critically consider the origins, development and elements that make up the nexus approach to water, energy and food resource systems.
- To define the WEF nexus within a social-ecological context.
- To identify and describe the regulatory framework applicable to UGD in South Africa.
- To assess the South African regulatory framework on UGD against the main elements of the WEF nexus approach.
- To make recommendations to the regulation of UGD following a WEF nexus approach.

1.11 Hypothesis, assumptions and caveats

The hypothesis of the study is that the water-energy-food nexus pertaining to UGD is not clearly defined and regulated in South Africa and does not address the WEF nexus.

The study is based on the following assumptions:

- The WEF nexus approach is a new approach to address water, energy and food trade-offs.
- The WEF nexus is not defined within a socio -ecological context.
- There is a need that the South African regulation of UGD is framed in such a manner that it addresses the social-ecological context and the WEF nexus.

1.12 Research methodology

While this research is primarily based on a literature review it also has an empirical element.¹³⁸ The literature review includes findings from a number of empirical studies that are applicable to this research. In order to understand the nature and definitive features of the WEF nexus approach to regulating onshore unconventional natural gas, this study has been informed by the literature from a number of scientific

¹³⁸ For literature reviews in law, see Venter *Legal Research - Purpose, Planning and Publication* and Fisher *Legal Reasoning in Environmental Law*.

disciplines including that of law.¹³⁹ The study does not purport to be a study of disciplines other than that of law, but rather that these disciplines provide background to the research. The law cannot be studied in isolation and must take other disciplines into account.¹⁴⁰ The literature survey consists of an analysis of policies, legislation, regulations and decision-making processes (such as applications for approval of licences, permits, and environmental impact assessments) and is supported by textbooks, journal articles, books, chapters in books and electronic material. The literature review provides an overview of current knowledge pertaining to the regulation of the WEF nexus on UGD, generally, and specifically in South Africa. The literature review refers to the human-environmental interaction process, landscape science, environmental study, sociology and demography, economy, atmosphere and climatology, geology and geomorphology, geo-engineering, and geochemical engineering, hydrology, and ecological systems.¹⁴¹

The issue of UGD is complex and contentious.¹⁴² It is an example of a problem that is technically complex, multi-faceted and highly polarised within the public interest.¹⁴³ It straddles both the environmental (nature), technical and social domains, and not surprisingly, a number of scholars¹⁴⁴ refer to it as being a wicked problem¹⁴⁵ (where

¹³⁹ The author does not pretend to be an expert of all of these disciplines, but law cannot be studied without acknowledging the context within it operates (i.e. humans cannot be removed from the society they live in). See Pope, Bonatti and Sieber *Earth System Governance* 5. In science, different methodologies inform natural, social and human sciences. Natural sciences make use of a mostly empiricist methodology, human sciences (law) make use of a mostly rationalists' methodology and the social sciences make use of a combination of the two methodologies. Holm *et al* 2013 *Environmental Science & Policy* 26; Richards "Interdisciplinary environmental inquiry" 776-781; Black 1973 *Journal of Legal Studies* 125-149; Comaroff J and Comaroff J "Reflections on the Anthropology of Law, Governance and Sovereignty" in Von Benda-Beckmann F, Von Benda-Beckmann K and Eckert J (eds) *Rules of Law and Laws of Rule: On the Governance of Law* (Ashgate Farnham 2009) 31-60.

¹⁴⁰ Höffken, Pols and Kumar "Energy transitions in the global South" 156; Du Plessis and Du Plessis "Supervision of doctoral level research in environmental law" 210-224; Kroeze 2017 *PELJ* 35-65; Menkel-Meadow 2017 *Florida State University Law Review* 91-119.

¹⁴¹ Meng 2017 *STE* 955.

¹⁴² Sovacool 2014 *Renewable and Sustainable Energy Reviews* 249-250; Scholes, Schreiner and Snyman-Van der Walt 2017 *Bothalia* 3; Glazewski and Esterhuyse "Introduction" 1; Du Plessis "Governance of hydraulic fracturing" 118; Atkinson 2018 *Extractive Industries and Society* 441.

¹⁴³ Scholes, Schreiner and Snyman-Van der Walt 2017 *Bothalia* 3; Meng 2017 *Science of the Total Environment* 953-957.

¹⁴⁴ Brantley *et al* 2018 *Science* 395; Lanning *The wicked problems of America's hydraulic fracturing landscape* 2; Newman and Head 2017 *Policy and Society* 422.

¹⁴⁵ Chapter 3.6. Newman and Head 2017 *Policy and Society* 416.

complexity is used as a measurement of the wicked tendencies of the problem).¹⁴⁶ In order to understand complex issues (such as UGD) decision-makers rely on scientific assessments to understand causal factors.¹⁴⁷ The numerous social-ecological impacts emanating from UGD points to the integrated (nexus), complex and non-linear nature of interactions between water, energy and food resource systems.¹⁴⁸ In this sense WEF nexus research (being an integrated approach) is described as a multi-dimensional means of scientific enquiry which seeks to describe (i) interactions between water, energy and food, and (ii) the implications for society.¹⁴⁹ Research on the WEF nexus necessarily acknowledges the inter-connections among society, nature, and technology and the disciplines that underscore each.¹⁵⁰ WEF nexus research is therefore generally associated with inter-disciplinary and trans-disciplinary approaches.¹⁵¹

The study first identifies the regulatory challenges of UGD in South Africa. The WEF nexus process is then discussed as an approach to address regulatory and decision-making challenges in relation to water-energy-food in South Africa. The WEF nexus is then defined within a socio-legal context.¹⁵² The challenges and the analysis of the WEF nexus then inform the discussion on the South African regulatory framework in order to make recommendations as to how the WEF nexus can address the regulatory and legal challenges raised.

¹⁴⁶ Chapter 3.6. Newman and Head 2017 *Policy and Society* 416; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 62-64.

¹⁴⁷ Scholes, Schreiner and Snyman-Van der Walt 2017 *Bothalia* 1.

¹⁴⁸ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 62. Also, see paras 1.1 and 1.2 above and Chapters 2.4 and 2.5.

¹⁴⁹ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 62.

¹⁵⁰ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 62-63.

¹⁵¹ This research piece (thesis) is by definition interdisciplinary in nature. Von Braun and Mirzabaev "Nexus Scientific Research" 58; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 62-64.

¹⁵² Socio-legal studies acknowledges that law is not self-executing and depends on human actors for its implementation. In this sense, socio-legal scholars are aware of the social construction of knowledge and the variability and often contradictory nature of human interaction around law and legal issues. See Menkel-Meadow 2017 *FSULR* 93, 116.

The study also refers to empirical research¹⁵³ undertaken in relation to the WEF nexus.¹⁵⁴ The researcher is involved in a project focusing on the water-energy-food nexus at the household level in South Africa.¹⁵⁵ The empirical research done on the household level (1182 household interviews) is not directly applicable to this study. However, the Matatiele community in the Eastern Cape managed to prevent UGD in their area (which is one of the study areas in this project).¹⁵⁶ This makes this study relevant to the project. The researchers in the project undertook, in addition to the household surveys, special qualitative empirical research via focus group discussions with national government officials and representatives of Eskom, as well as with provincial government officials of the Eastern Cape, Northern Cape and North-West.¹⁵⁷ The focus group discussions followed upon the writing of a *status quo* report reflecting the legal framework pertaining to water, energy and food in these areas.¹⁵⁸ The *status quo* report informed the focus group discussions. At the workshops where the focus group discussions took place, the researchers first presented a paper on the findings of the household surveys in a specific province, as well as a combination of the findings

¹⁵³ See Chapter 4.8. The Covid-19 pandemic and lockdown restrictions hampered any empirical research in the Karoo area where hydraulic fracturing might take place in future and where there is still active resistance against any such endeavours.

¹⁵⁴ A qualitative research method (i.e. interviews with actors) has value in getting to a deeper insight into WEF nexus governance within UGD issues in South Africa. The need for and value of mixed-method studies (combination of qualitative and quantitative methods) to augment knowledge on WEF nexus issues are growing. See Sušnik and Staddon 2021 *JAWRA* 1189; Albrecht, Crootof and Scott 2017 *Environmental Research Letters* 10-12; Purwanto *et al* 2021 *Sustainability* 10; McGrane *et al* 2018 *The Geographical Journal* 5; Brouwer "The water-energy-food nexus" 2-3.

¹⁵⁵ This work is based on the research supported in part by the National Research Foundation (NRF) of South Africa and the Dutch Research Council (de Nederlandse Organisatie voor Wetenschappelijk Onderzoek - NWO) Project UID 129352 , entitled Water-Energy-Food communities in South Africa: multi-actor nexus governance for social justice, and NRF Project UID 93331, entitled Renewable and Sustainable Energy Scholarship (RSES). The NRF and NWO are thanked for their financial contribution to the workshops. Any opinion, finding, conclusion or recommendation expressed in this material is that of the author, and the NRF and NWO do not accept any liability in this regard. Ethics approval number NW-01216-21-A3 (as approved by the Law Research Ethics Committee of the North West University).

¹⁵⁶ Environmental Justice Atlas <https://ejatlas.org/conflict/fracking-exploration-in-matatiele-south-africa>.

¹⁵⁷ The other case study area is Vaalharts that straddles both the Northern Cape and North West Provinces. The workshops were held in East London on 25 October 2022, Kimberley on 28 October 2022, Mahikeng on 1 November 2022 and Pretoria on 3 November 2022.

¹⁵⁸ This specific study contributes to the legal framework analysis pertaining to the WEF nexus, but also in relation to the danger posed by UGD.

at the national workshop that was held in Pretoria.¹⁵⁹ This paper was then followed by a presentation on the legal framework and the possibility of introducing the concept of WEF communities in South Africa. A focus group discussion followed. Part of the focus group discussion was also to determine the knowledge of the attendees in relation to legislation on the WEF nexus and to determine whether the officials and other attendees could provide examples of where the WEF nexus is taken into account in the decision-making. The relevant findings of this workshop with regard to WEF nexus governance, is explored in Chapter 4.

The findings of another two empirical studies are also explored in Chapter 4. While these two studies differ in scope and focus, they combine to provide insight into the governance of the WEF nexus. The study by Methner *et al* "Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and well-being in South Africa" informed a report submitted to the Water Research Commission of South Africa.¹⁶⁰ This study focused on how the WEF nexus is interlinked with livelihoods, namely at the scale/level of individuals and households in vulnerable communities in South Africa. A number of case studies (spanning rural and urban communities) targeted three geographical catchment areas that are experiencing major development pressures and resource competition.¹⁶¹ Results from the case studies were interpreted within the context of governance systems for the WEF nexus. This in turn had a focus on integrated natural resource management by way of informed decision-making. Findings from this empirical study is useful in that it identifies a number of WEF nexus nuances on the local (individual and community) scale. This

¹⁵⁹ Ngarava "Cross-sectional survey: Matatiele Local Municipality" Ngarava "Cross-sectional survey: Majeng, Magareng Local Municipality"; Ngarava "Cross-sectional survey: Greater Taung Local Municipality"; Ngarava "Cross-sectional survey: Matatiele Local Municipality, Magareng Local Municipality and Greater Taung Local Municipality"; Mauger, Mugadza and Rantlo "Legal framework analysis and options for WEF communities"; Mauger, Mugadza, Rantlo and Viljoen "Legal framework analysis and options for WEF communities". The final workshop with government and community representatives were held on 19 October 2023 in Pretoria.

¹⁶⁰ Report to the Water Commission WRC Report No 2718/1/21 July 2021 Methner *et al* (eds) "Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and well-being in South Africa" 1-353.

¹⁶¹ The three catchments identified are: Keiskamma (located in the Eastern Cape Province); uMngeni (located in Kwazulu-Natal province) and the Berg (located in the Western Cape). A number of communities (five in total) were identified as case studies within the three catchment areas, namely (i) Noordhoek (Berg River estuary), Pniel and Lanquedoc (upper Berg), (ii) Melani (upper Keiskamma) and Hamburg (Keiskamma River mouth) and (iii) Sobantu (mid-uMngeni) and Mpophomeni (upper uMngeni).

potentially has important implications for decision-making within governance and regulatory frameworks on development projects, including that of UGD.

The thesis "The socio-economic and environmental implications of shale gas development in the Karoo, South Africa" by Julius Omokhudu Irene¹⁶² used a mixed-method approach (a combination of qualitative and quantitative methods) to examine public and "expert" perceptions about environment risks (and economic benefits) of shale gas development in South Africa.¹⁶³ While the specific focus of the study turned on perceptions of environment risks stemming from shale gas development, some of the data include references to water, energy and food interlinkages. Specifically, empirical findings from the study on environmental risks to water, energy and food inform governance aspects of shale gas development. Findings from this study are therefore applicable to this thesis. Data collection related to public perceptions took place in the Beaufort West area of the Central Karoo. Beaufort West is relatively centrally located within the geographical shale gas development area and is one of the three bigger settlements that fall within the expected geographical shale gas development area (Graaff-Reinet and Middelburg being the other two). Data collection from policy makers and industry practitioners (such as geologists, reservoir and drilling engineers) straddled different areas of the country (policy makers and industry practitioners reside and work in bigger metros, towns and cities).¹⁶⁴

1.13 Structure of the study

Chapter two identifies and describes a number of social and ecological impacts emanating from the development process of onshore unconventional natural gas. This chapter starts by listing and briefly describing some of the main drivers for and benefits associated with the development of onshore unconventional natural gas. It continues to provide a description of what UGD entails, particularly the use of multi-directional drilling in combination with hydraulic fracturing. This is done to get an understanding of the range and extent of social and ecological impacts emanating from UGD,

¹⁶² Irene *The socio-economic and environmental implications of shale gas development in the Karoo, South Africa* 1-311.

¹⁶³ For the qualitative and quantitative analysis, see Irene *Socio-economic and environmental implications* 140-154 and 154-172 respectively.

¹⁶⁴ For limitations of study, see Irene *Socio-economic and environmental implications* 183-184.

particularly its relation to water, energy and food resource systems. This chapter lays the foundation for the need of a regulatory and decision-making approach (governance) that acknowledges the integrated (nexus) nature of water, energy and food resource systems within UGD, generally, and in South Africa specifically.

Chapter three identifies a number of key governance elements of the WEF nexus. It does so by providing a theoretical overview of the drivers and development of the nexus approach. The development of the nexus approach is explored by focusing on concepts of resource security, scarcity, uncertainty, risk, trade-offs and synergies, socio-ecological systems, sustainable development (including the SDGs), integration, and governance, amongst others. These concepts make up key-aspects of the WEF nexus. In this vein a number of broader nexus and more specific WEF nexus definitions are examined. In addition, a description of water, energy and food insecurity in South Africa provides examples and evidence of the many complex interactions within nexus resource systems, and specifically how the interdependent and interlinked nature of water, energy and food resource systems manifests into trade-offs; this in turn leads to resource insecurity that straddles national, provincial and local levels which ultimately impacts households and individuals.

Chapter four identifies and describes the regulatory framework applicable to UGD in South Africa. It is necessary to understand the workings of the regulatory framework applicable to UGD in South Africa. This includes the identification of possible water, energy and food links that exist within the regulatory framework on UGD. The need for this approach is to provide a well defined framework against which the key WEF nexus elements can be tested in the following chapter (Chapter five). Chapter four therefore describes South Africa's international and regional commitments on water, energy and food. This also includes (i) South Africa's response to climate change via its adoption of the Paris Agreement on Climate Change (the Paris Agreement), (ii) the Constitutional provisions applicable to water, energy, food and the environment, (iii) the overarching policy framework at a general strategic level, a water strategic level, an energy strategic level and a food strategic level. This is followed by the government structure in South Africa, specifically on the application of cooperative government instruments within and between the three spheres of government, namely, national,

provincial and local/municipal. This is followed by an explanation of which legislation is generally applicable to an UGD authorisation. This consists of authorisations that are directly applicable to UGD and other authorisations specific to water, energy and food. The final part of this chapter incorporates the findings of the two empirical studies that straddles the WEF nexus and UGD in South Africa. By examining multiple sets of empirical data that covers different geographical, cultural and socio-economic realities, a number of conclusions are drawn on the extent of WEF nexus integration.

Chapter 5 provides an assessment of whether and to what extent the South African regulatory framework on UGD follows or promotes a nexus (integrated) approach to water, energy and food resource systems. It does so by applying the key governance WEF nexus elements (identified in Chapter three) to the regulatory framework applicable to UGD in South Africa (identified and described in Chapter four). The level of WEF nexus integration in relation to the South African regulatory framework applicable to UGD is described in terms of a spectrum spanning from weak integration to strong integration.

Chapter 6 critically reflects on some of the findings that can be drawn on the basis of the review of the South African regulatory framework on UGD to the extent that it follows a nexus approach to water, energy and food resource systems. Recommendations are made for the use and or implementation of the nexus approach to ensure more sustainable outcomes in the regulation of UGD in South Africa. Finally, this chapter identifies and reflects on areas for future research and on the general contribution that this thesis makes to the knowledge system of applying a nexus approach to regulating UGD, generally, and more specifically, in the context of South Africa.

CHAPTER 2 REGULATORY CHALLENGES EMANATING FROM ONSHORE UNCONVENTIONAL NATURAL GAS DEVELOPMENT

2.1 Introduction

The aim of Chapter two is to identify and describe regulatory challenges to water, energy and food resource systems that emanate from the development of onshore unconventional natural gas, generally and locally in South Africa. In order to attain this aim it is first necessary to provide the rationale for UGD. This is done by listing and briefly describing a number of drivers for and benefits of UGD. Thereafter, a description of the unique characteristics associated with UGD follows. To this end the origins and specific development activities of unconventional natural gas towards a contemporary description, namely, from vertical to horizontal drilling and the combining of horizontal drilling with hydraulic fracturing, are investigated. This includes a description of the different sets of exploitation techniques available within different contexts of unconventional natural gas development. This is done to facilitate a contextual understanding of the unique features of UGD. This understanding in turn leads to the identification of a range of social and ecological impacts emanating from UGD to include impacts related to water, air quality, seismicity and environmental baseline data. This informs the nature and extent of regulatory challenges posed by UGD.

In this chapter the benefits and drivers of UGD will first be discussed, followed by the identification and description of a number of unique characteristics of UGD. Thereafter UGD impacts related to water, air quality, seismicity and earthquakes, as well as lack of environmental baseline data resulting in a number of social and ecological impacts, will be discussed. Lastly, a number of conclusions will follow.

2.2 Benefits and drivers

Numerous studies identify the benefits associated with and the drivers of the development of onshore unconventional natural gas (shale gas, tight gas, geo-

pressured gas and coalbed methane).¹⁶⁵ The United States of America (hereafter the USA) started large scale development of onshore unconventional natural gas in the late 1990s and early 2000s.¹⁶⁶ It is the leading country to produce unconventional natural gas on a large commercial scale.¹⁶⁷ Since then, it has experienced numerous socio-economic benefits associated with onshore unconventional natural gas.¹⁶⁸ It is routinely used as an example of how the onshore unconventional natural gas industry could potentially create socio-economic benefits for countries and their citizens.¹⁶⁹

It should be noted that while the example of the USA has value for other countries and regions, one should be careful of generalisation. This is because context matters and therefore the drivers for and possible benefits on unconventional development are not necessarily the same for all countries and regions. For example, a key aspect of the success of UGD in the USA is based on the country's use of existing infrastructure.¹⁷⁰ A diverse network of gas (and oil) pipelines were already in place that supplied energy (from conventional natural gas reservoirs) to major centres in the country.¹⁷¹ About half of the current mainline transmission network and a large part of the local distribution network had already been installed in the 1950s and 1960s.¹⁷² In this sense UGD in the USA is described as having a "plug and play" characteristic because of its relative hassle-free linking with existing infrastructure.¹⁷³ This is not the same for other countries where, in many instances, infrastructure for

¹⁶⁵ Most studies are based on the experiences of large scale UGD industry in the USA. See Buse *et al* 2019 *The Extractive Industries and Society* 620-629; Sovacool 2014 *Renewable and Sustainable Energy Reviews* 249-264; McClung and Moran 2018 *Environmental Science and Health* 19-26; Thomas, Partridge, Harthorn, and Pidgeon 2017 *Nature Energy* 1-7; May and Dernbach (eds) *Shale Gas and the Future of Energy* 1-329; Hepburn "Unconventional gas regulation" 175-233; Glazewski and Esterhuyse (eds) "Hydraulic Fracturing in the Karoo" 1-494; Mason, Muehlenbachs and Olmstead 2015 *Annual Review of Resource Economics* 269-289; Bista, Jennings and Anda 2019 *Energy Technology* 1-16; Irene *Socio-Economic and Environmental Implications* 99-101.

¹⁶⁶ May and Dernbach "Introduction" 3; Obeng-Darko and Crossley 2018 *OGE* 1.

¹⁶⁷ Other countries that produce at scale include Canada, Argentina and China. Cooper, Stamford and Azapagic 2016 *Energy Technology* 773.

¹⁶⁸ Cooper, Stamford and Azapagic 2016 *Energy Technology* 773; Irene *Socio-Economic and Environmental Implications* 84-85.

¹⁶⁹ May and Dernbach "Introduction" 3; Obeng-Darko and Crossley 2018 *OGE* 1.

¹⁷⁰ Scholl "The Shale Boom" 6; Fakir 2014 <https://bit.ly/3WiVA8X>; DiSavino 2017 <https://reut.rs/3WeiJJw>.

¹⁷¹ May and Dernbach "Introduction" 3; Scholl "The Shale Boom" 6; EIA 2021 <https://bit.ly/3SSWHcp>; MIT "The Future of Natural Gas" 134-136.

¹⁷² EIA 2021 <https://bit.ly/3SSWHcp>.

¹⁷³ Fakir 2014 <https://bit.ly/3WiVA8X>.

the piping of natural gas does not exist.¹⁷⁴ The cost of building gas infrastructure such as distribution and transmission pipelines is economically substantial, particularly for developing countries. From a purely economic perspective the benefits derived from UGD will therefore likely not be the same for all countries. Having indicated such, some drivers and benefits are likely applicable, at least to some degree, for numerous countries looking to develop unconventional gas.

What follows is therefore a brief description of some of the main drivers for and benefits associated with UGD. Drivers and benefits are listed and described in terms of the following: abundance of supply, flexibility, socio-economic growth, decarbonisation, energy security and energy independence.

2.2.1 Abundance of supply

Unconventional natural gas is certainly available in relative large quantities throughout the world and contribute significantly to world gas production.¹⁷⁵ This is unlike conventional fossil fuels that are mainly concentrated in a few regions of the world.¹⁷⁶ Estimations of recoverable unconventional hydrocarbon resources per regions include: 23% in North America, 22% in Russia, 21% in Asia, 17% in South America, 13% in Africa, and 4% in Europe.¹⁷⁷ As indicated earlier, the USA is the leading commercial producer of unconventional natural gas followed by Canada, Argentina and China.¹⁷⁸ While numerous other countries are looking to develop their technically recoverable unconventional natural gas reservoirs, Saudi-Arabia seems set to be the future largest producer outside the USA.¹⁷⁹ The consumption of natural gas, from unconventional

¹⁷⁴ For example, South Africa. See Clark *et al* 2022 *JESA* 33; Cooper, Stamford and Azapagic 2016 *Energy Technology* 777.

¹⁷⁵ Muther *et al* 2021 *JPEPT* 1464; Markey *et al* 2022 *Energy Research and & Social Science* 3; Sovacool and Vivoda 2014 *OGE* 14; Holley and Kennedy 2019 *Jurimetrics* 234; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 11.

¹⁷⁶ Muther *et al* 2021 *JPEPT* 1464; Markey *et al* 2022 *Energy Research and & Social Science* 3.

¹⁷⁷ Kokkinos *et al* 2022 *JESTR* 23; Anon 2021 <https://bit.ly/3NNEhZP>; Anon 2022 <https://bit.ly/3UDtIuq>.

¹⁷⁸ Canada, Argentina and China produce at a smaller scale than the US. Stamford and Azapagic 2016 *Energy Technology* 773; Cooper, Stamford and Azapagic 2016 *Energy Technology* 773; Anon 2021 <https://bit.ly/3NNEhZP>; Anon 2022 <https://bit.ly/3UDtIuq>.

¹⁷⁹ Shabaneh and Suwailem 2020 <https://bit.ly/3tbhNsd>; Gamal and Webb 2020 <https://reut.rs/3WEKTgW>; Anon 2020 <https://bit.ly/3htCA7F>.

hydrocarbon reservoirs is expected to significantly increase in future.¹⁸⁰ The general shift to more "green" or renewable energy sources is in conjunction with the impact of the war in Ukraine (due to Russia's invasion) likely to increase the demand for natural gas. South Africa is known to have onshore unconventional natural gas reserves, particularly located in the Karoo area. Although estimations on these reserves vary considerably, the potential value of these reserves for the country remain significant.¹⁸¹

2.2.2 Flexibility

Natural gas is flexible in a number of aspects. This entails, amongst others, the relative ease of transporting natural gas via pipelines or as liquefied natural gas (LNG) via ships.¹⁸² While some complexities exist regarding the storage of gas (whether in gas or liquid form), it is, in comparison to other fossil fuels, such as coal, more flexible and easier to handle.¹⁸³ Furthermore, gas turbines and gas engines (as a form of power station) are technically flexible which translates to running low power output without much deterioration in efficiency.¹⁸⁴ The use of natural gas straddles a number of sectors, namely, industrial, residential, commercial and electrical power.¹⁸⁵ It is flexible in its end-use (power generation, heat and transport) and as an energy resource it is less likely to create an energy block such as occurs with other fossil fuels (e.g. oil and coal).¹⁸⁶ Natural gas from unconventional hydrocarbon reservoirs could therefore be used in different ways for different purposes.¹⁸⁷ The potential use of natural gas reservoirs in South Africa includes the following: feedstock for electricity generation in combined-cycle gas turbines (CCGTs), processed heat as well as petrochemical

¹⁸⁰ EIA "Annual Energy Outlook 2022" 1; Cooper, Stamford and Azapagic 2016 *Energy Technology* 772; May and Dernbach "Introduction" 3; MIT "The Future of Natural Gas" 4.

¹⁸¹ Estimations differ from 40 – 450 trillion cubic feet of gas (tcf). Glazewski and Esterhuyse "Introduction" 5.

¹⁸² CSIR "Effects on National Energy Planning and Energy Security" Chapter 2 of SEA 3; Irene "Socio-economic and Environmental Implications" 84.

¹⁸³ Clark *et al*/2022 *JESA* 29-30; Irene "Socio-economic and Environmental Implications" 88; CSIR "Effects on National Energy Planning and Energy Security" Chapter 2 of SEA 3.

¹⁸⁴ CSIR "Effects on National Energy Planning and Energy Security" Chapter 2 of SEA 3.

¹⁸⁵ MIT "The Future of Natural Gas" 4.

¹⁸⁶ MIT "The Future of Natural Gas" 4; CSIR "Effects on National Energy Planning and Energy Security" Chapter 2 of SEA 3; Sovacool 2014 *Renewable and Sustainable Energy Reviews* 182.

¹⁸⁷ Wakeford "South African Energy Context" 156.

feedstock (industrial consumption), and feedstock to PetroSA's Mossel Bay gas-to-liquid plant.¹⁸⁸

2.2.3 Decarbonisation

The role of natural gas in making a positive contribution to decarbonisation of the energy system is also one of contestation. This is clear from two conflicting viewpoints. The argument supporting the use of natural gas as a decarbonising mechanism turns on the basis that natural gas burns more cleanly than coal and oil and therefore has less of an impact on climate change and associated negative impacts on human health.¹⁸⁹ This is because natural gas has a cleaner greenhouse gas emission footprint than that of other fossil fuels.¹⁹⁰ Consisting essentially of methane, natural gas is a cleaner burning fuel than coal because it does not have the sulphur content of coal.¹⁹¹ In terms of its ability to assist the decarbonising of energy systems it is touted as a convenient "bridging" or "transition" fuel between fossil and renewable energy sources.¹⁹² This is based on the principle that "no single energy source can currently ensure accessible, reliable and affordable energy while also slowing the greenhouse gas emissions lock-in of coal power".¹⁹³ Decarbonising the energy system implies a reduction of greenhouse gases and natural gas (from unconventional hydrocarbon reservoirs) and is viewed as an important aspect of climate change mitigation.¹⁹⁴

The argument against the use of natural gas as a suitable decarbonising mechanism in the energy system is based on a combination of methane's potency compared to CO₂ and the risk of fossil fuel lock-in. Fugitive emissions from natural gas, being

¹⁸⁸ Options depend on infrastructure and costs – see Wakeford "South African Energy Context" 156.

¹⁸⁹ May and Dernbach "Introduction" 5; Holley and Kennedy 2019 *Jurimetrics* 234; De Wit 2011 *SAJS* 2; Albrecht and Schneemann 2014 *CLLR* 247.

¹⁹⁰ Sovacool 2014 *Renewable and Sustainable Energy Reviews* 250.

¹⁹¹ Wakeford "South African Energy Context" 157; Glazewski "Looking forward" 438.

¹⁹² May and Dernbach "Introduction" 5; Holley and Kennedy 2019 *Jurimetrics* 234; De Wit 2011 *SAJS* 2; Albrecht and Schneemann 2014 *CLLR* 247; CIWEM "Shale gas and water 2016" 15; Irene *Socio-Economic and Environmental Implications* 100.

¹⁹³ Holley and Kennedy 2019 *Jurimetrics* 234; Rasch and Köhne 2016 *Energy Research & Social Science* 106.

¹⁹⁴ Irene *Socio-Economic and Environmental Implications* 101; Holley and Kennedy 2019 *Jurimetrics* 234; De Wit 2011 *SAJS* 2; Albrecht and Schneemann 2014 *CLLR* 247; Clark *et al* 2022 *JESA* 23.

methane, is a much more potent GHG than CO₂.¹⁹⁵ Notably, methane leakage into the atmosphere from UGD (natural gas) take place throughout its life-cycle without it having been combusted (during drilling, extraction, processing and transport).¹⁹⁶ Earlier studies did not take note of this and therefore underestimated the amount of methane leakage.

Natural gas use has lead to competition within the fossil fuel market whereby a reduction in the price of coal lead to an increase in the use of it.¹⁹⁷ The risk of increasing investments in natural gas is that of a delay in the use of renewable technologies and ultimately a move away from the aim of a sustainable energy transition.¹⁹⁸ Without leveraging a transition fuel or supporting technology, decarbonisation of the energy system may not materialise.¹⁹⁹ In this manner a lock-in of fossil fuels use may occur at the expense of renewables. The EU, for example, has changed its laws with the aim to phase out natural gas entirely and instead accelerate the shift from natural gas to renewable and low-carbon gases, especially hydrogen and decarbonised gas.²⁰⁰

While natural gas can certainly play an important part in South Africa's move from coal to a more just energy transition, there are inherent risks such as the potential lock in of fossil fuel use and the lock-out of renewable technologies.

2.2.4 Socio-economic growth

Large scale production of onshore unconventional natural gas in the USA led to a drastic decrease in the price of natural gas that in turn translated into more affordable electricity and an improvement in the standard of human well-being.²⁰¹ Economic benefits include those that are generated directly by the extraction and selling of the product (i.e. natural gas) and indirectly by way of income received by the government

¹⁹⁵ The Intergovernmental Panel on Climate Change (IPCC) estimates methane to have a global warming potential 25 times that of CO₂. See Wakeford "South African Energy Context" 158.

¹⁹⁶ Wakeford ""South African Energy Context" 158; Glazewski "Looking forward" 438.

¹⁹⁷ Gürsan and de Gooyert 2021 *RSER* 15.

¹⁹⁸ Gürsan and de Gooyert 2021 *RSER* 15.

¹⁹⁹ Gürsan and de Gooyert 2021 *RSER* 12.

²⁰⁰ EPRS "Energy transition in the EU" 5.

²⁰¹ Walton and Woocay 2013 *Journal of Green Building* 70; Sovacool and Vivoda 2014 *OGEL* 14; SEA 2-3; Cooper, Stamford and Azapagic 2016 *Energy Technology* 773.

from taxes applied.²⁰² For South Africa, potential sources of income include that of foreign direct investment, export earnings and job creation, income revenue (tax, etc.); infrastructure and tax revenue for the government.²⁰³ It should be noted that unlike other jurisdictions, such as that in the USA, private land-owners in South Africa do not have ownership over the petroleum and resources located on their land.²⁰⁴ The State is the custodian of all of South Africa's mineral and petroleum resources.²⁰⁵

2.2.5 Energy security and energy independence

By developing its unconventional natural gas resources, the USA managed to break away from its previous dependency of importing petroleum during the 1980s and 1990s.²⁰⁶ It has proven to significantly strengthen energy security and energy independence in the USA.²⁰⁷ A more recent driver that speaks to energy security and energy independence is the creation of the energy crisis in Europe.²⁰⁸ Russia's invasion of the Ukraine in February 2022 has resulted in the interruption of the gas supply (from Russia) to many European countries.²⁰⁹ Russia is the largest supplier of gas to Europe and a large number of European countries rely heavily on gas imports from Russia.²¹⁰ The total gas imports from Russia by European countries are expressed as a percentage namely: Germany (66%), Poland (54%), Italy (43%), Finland (67%), Estonia (46%), Latvia (100%), Lithuania (41%), Slovakia (85%), Hungary (95%),

²⁰² Alvarez-Ramos *et al* 2020 *Energy Reports* 14.

²⁰³ Steenkamp and Glazewski "Revenue and Tax Policy" 176-177; Walton and Woocay 2013 *Journal of Green Building* 70; Sovacool and Vivoda 2013 *OGE* 23; Alvarez-Ramos *et al* 2020 *Energy Reports* 14.

²⁰⁴ Unless an official application for a mineral right to the DMRE has been made and had been successful. On aspects of mineral rights and public trusteeship in South Africa see Van der Schyff 2019 *PELJ* 1-29; Van der Schyff 2010 *PELJ* 122-189; Van der Schyff *Property in Minerals and Petroleum* 1-737.

²⁰⁵ Section 3(2) of the MPRDA. On aspects of mineral rights and public trusteeship in South Africa see Van der Schyff 2019 *PELJ* 1-29; Van der Schyff 2010 *PELJ* 122-189; Van der Schyff *Property in Minerals and Petroleum* 1-737.

²⁰⁶ Klare *Blood and Oil* 1-25; Scanlon 1992 *CWRJIL* 115-138; May and Dernbach "Introduction" 3; Obeng-Darko and Crossley 2018 *OGE* 1.

²⁰⁷ Obeng-Darko and Crossley 2018 *OGE* 1; May and Dernbach "Introduction" 5; Du Toit "Experiences from Other Jurisdictions" 16-21.

²⁰⁸ Hampton 2022 <https://reut.rs/3MNsKCI>; McWilliams *et al* 2022 *Policy Contribution* 14.

²⁰⁹ See Eurostat 2021 <https://bit.ly/3l6s0C5>. Aljazeera 2022 <https://bit.ly/3wr4Uex>; Nasr and Wacket 2022 <https://reut.rs/38iZISh>. Also see Wehrmann and Wettengel 2022 <https://bit.ly/3G032hu>.

²¹⁰ Wehrmann and Wettengel 2022 <https://bit.ly/3G032hu>; Eurostat 2021 <https://bit.ly/3l6s0C5>. Aljazeera 2022 <https://bit.ly/3wr4Uex>.

Romania (44%), Greece (38%), Luxembourg (27%), the Netherlands (26%), and the Czech Republic (100%). Other European countries that rely to a lesser extent on Russian gas imports include: Spain (10%), Portugal (9%), France (16%), Belgium (6%) and Sweden (13%). Seen from an energy supply side, European countries are facing an energy crisis.²¹¹ There is a big drive for European countries to ultimately move away from relying on Russia for their gas supply.²¹² The European Union (EU) has called for efforts to cut reliance on Russian gas by two-thirds in 2022.²¹³ Not surprisingly, a number of European countries are revisiting their energy policies and regulatory frameworks to either permit UGD or allow natural gas imports from countries such as the USA, Qatar, Norway, Japan and Algeria.²¹⁴

For South Africa, natural gas from onshore unconventional hydrocarbon reservoirs could boost the security of the energy supply by limiting reliance on energy imports, particularly of oil.²¹⁵ The country will likely benefit from exporting its natural gas to European countries that are in need of energy sources due to Russia's invasion of Ukraine. Related to this, European countries may decide to invest in South Africa's unconventional natural gas industry and projects.

2.3 Unique characteristics of unconventional natural gas development

The following paragraphs identify and describe the unique characteristics associated with the development of onshore unconventional natural gas. By getting an understanding of its unique characteristics, some possible challenges to regulatory frameworks could potentially be ascertained.

²¹¹ This specific energy crisis builds on previous gas supply shortage issues (Russia-Ukraine conflict) in 2006, 2009 and 2014. Aljazeera 2022 <https://bit.ly/3wr4Uex>; Reuters 2022 <https://reut.rs/38iZISh>; Fleming 2021 <https://bit.ly/3Pgc0eH>; Energy and Technology 2022 <https://bit.ly/3LalrsI>. Also see Wehrmann and Wettengel 2022 <https://bit.ly/3G032hu>.

²¹² In practice this may not be a straight-forward or an easily attainable target. This is due to a number of economic and logistical issues. See Dempsey *et al* 2022 <https://bit.ly/3fiwOFI>; Abnett 2022 <https://reut.rs/3Wvw8NF>.

²¹³ In the medium term, the European Union is planning to end any remaining reliance on Russian gas before 2030. See Abnett 2022 <https://reut.rs/3Wvw8NF>; and Dempsey *et al* 2022 <https://bit.ly/3fiwOFI>.

²¹⁴ Fox 2022 <https://bit.ly/3MiXCAA>; Anon 2022 <https://bit.ly/3LalrsI>; Grijalva 2022 <https://bit.ly/3yIe6ZWv>; Jaffe 2022 <https://bit.ly/3TTMLk2>.

²¹⁵ Wakeford "South African Energy Context" 143.

2.3.1 The need for unconventional exploitation techniques

Natural gas exists in a variety of hydrocarbon²¹⁶ mixtures located in a variety of geological settings (also known as reservoir rock).²¹⁷ Natural gas exists either in a gaseous or liquid state.²¹⁸ Its chemical composition is primarily that of methane (CH₄).²¹⁹ These hydrocarbons²²⁰ are found in what is known as "reservoir rock" a specific type of subsurface formation.²²¹ These geological settings differ from one another, particularly in terms of the permeability of the reservoir rock. The quality and character of the reservoir rock are determined according to its permeability (level of inter-connectedness between pores in a reservoir rock) and porosity (empty space between the rock). While porosity refers to the possible capacity of the reservoir rock to contain fluids, permeability is an indication of the reservoir rock's ability to transmit or move the fluids.²²² Named after Henry Darcy, permeability is measured by using a method known as the "Darcy". While a conventional natural gas reservoir will have a permeability in the region of one Darcy, an unconventional reservoir will measure around a few dozen micro-Darcy. Unconventional natural gas refers to those gas fields where permeability is low.²²³ The main types of unconventional natural gas include shale gas (gas trapped within shale formations of sedimentary rocks), coal-bed methane (contained in coal seam), tight gas (gas in low permeable formations), geo-pressured gas (gas trapped in deep high-pressured reservoirs) and gas hydrates (methane in the form of crystalline solid).²²⁴ Because unconventional natural gas reservoirs are located in low-permeable reservoir rock, it is therefore difficult for the

²¹⁶ Being an organic chemical compound or compounds composed solely of hydrogen (H) and carbon (C) elements, Hydrocarbons (HCs) are the key components of natural gas and petroleum. It has a number of additional uses, such as making up the raw materials for the production of plastics, fibers, rubbers, solvents, explosives and industrial chemicals. See Speight "Production of hydrocarbons from natural gas" 135.

²¹⁷ Sovacool 2014 *Renewable and Sustainable Energy Reviews* 250.

²¹⁸ Gas of a liquid nature has a higher proportion of heavier molecules like ethane, propane, octane, butane, and pentane. See Sovacool 2014 *Renewable and Sustainable Energy Reviews* 250.

²¹⁹ Natural gas tends to also contain nitrogen (N₂), carbon dioxide (CO₂), and hydrogen sulphide (H₂S). Hepburn *Mining and Energy Law* 178.

²²⁰ Although mainly gas, oil deposits also exist. See Hepburn *Mining and Energy Law* 178.

²²¹ Hepburn *Mining and Energy Law* 178; De Wit 2011 *SAJS* 2.

²²² See Hepburn *Mining and Energy Law* 178.

²²³ Sovacool 2014 *Renewable and Sustainable Energy Reviews* 250.

²²⁴ Sovacool 2014 *Renewable and Sustainable Energy Reviews* 250; Wang and Heftey "The Global Impact" 1; Hepburn *Mining and Energy Law* 178.

gas to move between the pores in the rock.²²⁵ Since these atypical geological locations are highly compacted in nature (low in permeability), the extraction of these natural gas reservoirs necessitates a unique set of techniques.²²⁶

2.3.2 Choices of exploitation techniques

Various exploitation techniques are available to extract unconventional natural gas. They include: hydraulic fracturing²²⁷ of a vertical well, horizontal well-drilling with or without hydraulic fracturing, hydraulic fracturing of a multi-lateral well, miscible gas injection, and methane gas-injection methods.²²⁸ Hydraulic fracturing in essence consists of forcing a high volume of water, mixed with chemicals, down a well (or multiple wells) that fractures low-permeable rock sediment which in turn enables the extraction of natural gas.²²⁹ Hydraulic fracturing is therefore a form of reservoir stimulation.²³⁰ In this sense, the reference to unconventional gas indicates the need for reservoir stimulation as opposed to conventional methods of gas-extraction where stimulation of the reservoir is not required.²³¹ While new technology focuses on waterless fracturing such as the use of liquefied petroleum gas, nitrogen foam, liquid CO₂, and cryogenics, using liquid N₂, these are yet to be proven viable and feasible.²³² A number of context-specific factors determine which exploitation techniques can or will be used.²³³ For example, two geological factors consist of primary factors that include mineralogy, grain size and sorting, lithification, provenance, depositional environment and flow regime.²³⁴ Secondary factors include the development of

²²⁵ Hepburn *Mining and Energy Law* 178-179.

²²⁶ De Wit 2011 *SAJS* 4-5; Hepburn *Mining and Energy Law* 178-179.

²²⁷ See para 2.3.3 in this chapter.

²²⁸ Muther *et al* 2021 *JPEPT* 1476-1481; Scotchman 2016 *Proceedings of the Geologists' Association* 536-538.

²²⁹ Mroue *et al* "Water-Energy Nexus" 24; Scotchman 2016 *Proceedings of the Geologists' Association* 536-538; Glazewski and Esterhuyse "Introduction" 10.

²³⁰ Warner *et al* 2014 *Environmental Science and Technology* 12552; Glazewski and Esterhuyse "Introduction" 10.

²³¹ Scotchman 2016 *Proceedings of the Geologists' Association* 536-538; Glazewski and Esterhuyse "Introduction" 10.

²³² Fu and Liu 2019 *JNGSE* 214-215; Agarwal and Kudapa 2022 *Materials Today* 2-3.

²³³ Muther *et al* 2021 *JPEPT* 1470-1471.

²³⁴ Irene *Socio-Economic and Environmental Impacts*; Muther *et al* 2021 *JPEPT* 1470-1471.

fractures, tectonics, and diagenesis including compaction, cementation, and dissolution.²³⁵

Tectonics affects the pressure and thermal gradient and therefore plays an important role in the development of unconventional resources because the pore-throat-diameter of unconventional resources, is less than one micrometre (i.e. 0.0001mm).²³⁶ Further, differences in the geological features and petro-physical characterisation between shale gas, tight gas and coal-bed methane have important input on the type of exploitation technique used (e.g. horizontal drilling with or without fracking, multilateral fracturing, waterless fracturing, miscible gas injection, and CBM gas injection methods).²³⁷ Within this criteria further differences are common depending on the geographical context of the reservoir.²³⁸ Reservoir rock properties differ from one reservoir to the next and include differences in porosity, pore size (and their distribution),²³⁹ permeability, thermal maturity of rock, total organic carbon, heterogeneity, and the absorption capacity of gas into organic and inorganic materials.²⁴⁰ In addition, the way that fluid moves through nanoporous media is not well-understood.²⁴¹ All of these factors add to the complexity of unconventional reservoirs.²⁴² It is therefore difficult to characterise and model unconventional reservoirs generally, and more specifically it makes the choice of exploitation technique dependent on a range of factors.²⁴³ Notably, exploitation techniques differ from one to the other and also within the same technique.²⁴⁴ Differences in the former are more obvious, for example, waterless fracturing versus fracturing with water.²⁴⁵ The latter has more subtle differences because adjoining wells may differ and so

²³⁵ Muther *et al* 2021 *JPEPT* 1470-1471.

²³⁶ Scotchman 2016 *Proceedings of the Geologists' Association* 538; Muther *et al* 2021 *JPEPT* 1471.

²³⁷ Wollin *et al* 2020 *Archives of Toxicology* 969; Muther *et al* 2021 *JPEPT* 1476-1480.

²³⁸ Scotchman 2016 *Proceedings of the Geologists' Association* 540.

²³⁹ Depending on the type of reservoir, pore diameter of unconventional reservoirs varies from 20 to 500 on the nano-Darcy scale. See Bera and Shah 2021 *Petroleum Geology* 1.

²⁴⁰ Scotchman 2016 *Proceedings of the Geologists' Association* 538; Bera and Shah 2021 *Petroleum Geology* 1.

²⁴¹ Bera and Shah 2021 *Petroleum Geology* 1.

²⁴² Deziel *et al* 2022 *Current Environmental Health Reports* 446; Bera and Shah 2021 *Petroleum Geology* 1.

²⁴³ Bera and Shah 2021 *Petroleum Geology* 1.

²⁴⁴ Muther *et al* 2021 *JPEPT* 1476-1483; Scotchman 2016 *Proceedings of the Geologists' Association* 543.

²⁴⁵ Muther *et al* 2021 *JPEPT* 1476-1480; Agarwal and Kudapa 2022 *Materials Today* 2.

therefore, the quantity of water and chemicals used, may differ.²⁴⁶ The impacts from exploitation techniques, are therefore not the same (between and even within the same technique).²⁴⁷

2.3.3 Principal extraction method: combination of multi-directional drilling and hydraulic fracturing

The earliest attempts to stimulate the flow of hydrocarbons, go back to the 1860s.²⁴⁸ Explosive charges were lowered down the boreholes of oil-wells in the USA and detonated to release hydrocarbons.²⁴⁹ Other early examples of horizontal drilling are those of Russia (Yarega) in 1937 and China in the 1960s.²⁵⁰ Original explorers of gas (and oil) assumed that the resource deposit tended to be elliptical in shape, with the long dimension laid down vertically.²⁵¹ Later, this assumption was discarded.²⁵² Gas and oil deposits have been found to be generally laid out in a horizontal direction and therefore it made sense to find alternative ways of accessing these resource deposits. This "new" or alternative method came to be known as horizontal or directional drilling.²⁵³ It entails a drill line (after the initial vertical drill) to follow the resource deposit along its main axis (i.e. down the length of the deposit).²⁵⁴ The drill can be turned 90 degrees at a certain depth to follow a specific trajectory.²⁵⁵

²⁴⁶ Bera and Shah 2021 *Petroleum Geology* 1.

²⁴⁷ Scotchman 2016 *Proceedings of the Geologists' Association* 540-543.

²⁴⁸ Stewart and Ingelson 2017 *JENRL* 109.

²⁴⁹ Not only applicable to oil and gas, but also to stimulate water flows from water wells, and assisting the clean-up of polluted vertical wells. This was followed by pumping water mixed with (mostly) sand down the vertical well to stimulate oil and gas. First patented in 1891 to John Smalley Campbell who used the technology of directional drilling in dental procedures. In 1929 the first horizontal oil well was dug in Texas by Robert E Lee. Newton *World Energy Crisis* 81-82.

²⁵⁰ SIWI Report 2014 "Shale gas and hydraulic fracturing" 15-16; Newton *World Energy Crisis* 81-82; Hepburn *Mining and Energy Law* 181.

²⁵¹ Newton *World Energy Crisis* 81-82.

²⁵² Newton *World Energy Crisis* 81-82.

²⁵³ Thakur "History and Methodology of Horizontal Drilling" 270.

²⁵⁴ SIWI Report 2014 "Shale gas and hydraulic fracturing" 15-16; Newton *World Energy Crisis* 81-82; Hepburn *Mining and Energy Law* 181.

²⁵⁵ SIWI Report 2014 "Shale gas and hydraulic fracturing" 15-16; Newton *World Energy Crisis* 81-82; Hepburn *Mining and Energy Law* 181.

In comparison with conventional (vertical) drilling, horizontal drilling allows for easier access to a larger fraction of the resource.²⁵⁶ It is only in 1947 that the combination of vertical drilling and horizontal drilling took place while the first commercial application thereof took place in 1949.²⁵⁷ The main method of extracting unconventional natural gas is done by a combination of multi-directional drilling on a horizontal plane (after the initial vertical drilling) and hydraulic fracturing.²⁵⁸ This combination of multi-directional drilling and hydraulic fracturing is unconventional because it differs significantly from conventional gas and oil extraction.²⁵⁹ While conventional gas and oil extraction takes place via vertical drilling, the extraction process for unconventional gas has two additional processes, namely multi-directional horizontal drilling and the multiple high-pressure pumping of a combination of water, sand and chemical additives down the drilling well to open fissures in the rock material (known as hydraulic fracturing).²⁶⁰ Multi-directional drilling follows a horizontal plane and therefore substantially extends the drilling range (compared to conventional drilling).²⁶¹ Depending on the porosity of the rock material, the process of hydraulic fracturing usually needs to be applied a number of times on the same well.²⁶² In addition, unconventional natural gas extraction by way of multi-directional drilling and hydraulic fracturing, allows for numerous well-pads in the area believed to contain unconventional hydrocarbons.²⁶³

While the fracking industry indicates that the (fracking) technology was developed and used since the 1940s, it should be noted that its application was limited to small scale

²⁵⁶ SIWI Report 2014 "Shale gas and hydraulic fracturing" 15-16; Newton *World Energy Crisis* 81-82; Hepburn *Mining and Energy Law* 181. The extraction method of hydraulic fracturing (fracking or hydrofracking) is credited to the owner and founder of Mitchell Oil & Gas Co., George Mitchell. He refined and combined earlier known methods of injecting fluids and/or gases down a well with horizontal drilling. This technology was further developed and advanced by Larry Nichols (Devon Energy) and Harold Hamm (Continental).

²⁵⁷ Hepburn *Mining and Energy Law* 181.

²⁵⁸ Sovacool and Vivoda 2014 *OGE* 17; Hepburn *Mining and Energy Law* 181.

²⁵⁹ Stewart and Ingelson 2017 *JENRL* 110; Sovacool and Vivoda 2014 *OGE* 17.

²⁶⁰ Hepburn *Mining and Energy Law* 181; Sovacool and Vivoda 2014 *OGE* 17; Corrigan and Murtazashvili 2016 *SAJIA* 2.

²⁶¹ Sovacool and Vivoda 2014 *OGE* 17; Hepburn *Mining and Energy Law* 181.

²⁶² Sovacool and Vivoda 2014 *OGE* 17; Hepburn *Mining and Energy Law* 184.

²⁶³ Hepburn *Mining and Energy Law* 184; Stewart and Ingelson 2017 *JENRL* 110; Sovacool and Vivoda 2014 *OGE* 17.

conventional oil and gas fields (no horizontal drilling was involved).²⁶⁴ Although the process of drilling and injecting a mixture of sand, water and chemicals down a wellbore to release natural gas is an established and tested technology, it is only around the 1990s that the very specific technique of horizontal drilling was combined with hydraulic fracturing.²⁶⁵ Ultimately, the combined method of injecting fluids and chemicals under pressure down a horizontal well led to the extraction of shale gas in the USA, namely in the Barnett Shale reservoir located in North Texas, Pennsylvania, West Virginia (Marcellus), Wyoming, Colorado and Texas.²⁶⁶ Notably, large scale UGD only started to take place from around the year 2000.²⁶⁷ UGD is therefore a rather relatively recent event (compared to other forms of extraction such as mining etc.).²⁶⁸

2.3.4 Multiple and interconnected activities that make up UGD

The development of unconventional natural gas does not solely rely on the single activity of hydraulic fracturing. Instead, UGD consists of a range of integrated activities within integrated phases. Numerous classification systems are used in literature to describe the multiple and interconnected activities that make up the development process of UGD. Examples of classification systems include (i) the exploration, development and production phases; (ii) drilling, stimulation, and production; (iii) seismic exploration, pad construction, vertical drilling, horizontal drilling, hydraulic fracturing, production, and waste disposal.

²⁶⁴ Stewart and Ingelson 2017 *JENRL* 110. Countries such as the United Kingdom, Poland, Spain, Germany, Sweden and Denmark used the technology of fracking over a three-decade timespan. See Tosun "Regulating hydraulic fracturing" 226; Kramer "Foreword" xv. Pastorkovich "Fracking and the Future of Fresh Water" 146. Also, see Ehrenberg 2012 *Science News* 20-25.

²⁶⁵ Tosun "Regulating hydraulic fracturing" 226-227; Pastorkovich "Fracking and the Future of Fresh Water" 146-147; Albrecht and Schneemann 2014 *Carbon & Climate Law Review* 238; and Stewart and Ingelson 2017 *JENRL* 110.

²⁶⁶ Since 2005, more than 135,000 wells have been drilled for fracking. The USA is therefore the international leader on the use of hydraulic fracturing techniques. Stewart and Ingelson 2017 *JENRL* 109-110; Muther *et al* 2021 *JPEPT* 1476-1480. See Kramer "Foreword" xv; SIWI Report 2014 "Shale gas and hydraulic fracturing" 16; Newton *World Energy Crisis* 83-84; Newton *World Energy Crisis* 80-87; Williamson and Esterhuysen 2020 *Bulletin of Engineering and the Environment* 711; Du Toit "Experiences from Other Jurisdictions" 16; 33. For another description of how fracking became a fixture of the American landscape and the global economy, see Gold *The Boom* 1-347.

²⁶⁷ May and Dernbach "Introduction" 2; Stewart and Ingelson 2017 *JENRL* 110.

²⁶⁸ Stewart and Ingelson 2017 *JENRL* 110; Lewis, McMichael and Glazewski "Fracking Fluids" 262-263.

Another method or system used to describe the numerous activities within UGD is the use of a risk model or matrix such as developed by the "Resources for the Future" think tank.²⁶⁹ Known as the "Gas Development Risk Matrix" it makes a distinction between six main categories that track activities and processes within UGD.²⁷⁰ The six categories consist of the following: site preparation, drilling activities, hydraulic fracturing and completion, well operation and production, hydraulic fracturing fluids, flow-back and produced water, storage and disposal, as well as other activities.²⁷¹

Yet another method is to make use of Campin's "List of Regulatory Rules Applied to the Control of Hydraulic Fracturing".²⁷² This regulatory list consists of 59 rules within eight main categories namely: prior approvals, pre-event information requirements, hydraulic fracturing design, well control, proximity constraints; environmental protection; hydraulic fracturing additives; and post-hydraulic fracturing event requirements.²⁷³

Another classification system is the pre-production, the production or post-production phases. The pre-production phase refers to exploration activities which typically consist of seismic surveys, vertical drilling and in some cases limited horizontal hydraulic fracturing. The production phase consists of the construction of drilling pads, vertical drilling, horizontal drilling, hydraulic fracturing, collection of gas, collection of flow-back water, and the disposal of wastewater. Post-production refers to the rehabilitation, closure and post-closure of exploration and production operations, which includes the managing of sealed and/ or abandoned wells. These phases and the activities within these phases tend to be interconnected and not always strictly separable. For example, hydraulic fracturing can be included in both the pre-production (exploration) and the production phase. A number of other associated activities such as the transporting of water, sand, waste-by-truck take place over different temporal and spatial scales. What is clear from these classification systems

²⁶⁹ It is an independent, non-profit research institution that focuses on environmental, energy and natural resources. See Krupnick, Gordon and Olmstead "Environmental Risks of Shale Gas Development" 1-78.

²⁷⁰ Krupnick, Gordon and Olmstead "Environmental Risks of Shale Gas Development" 57.

²⁷¹ Krupnick, Gordon and Olmstead "Environmental Risks of Shale Gas Development" 3.

²⁷² Campin "Regulation of Hydraulic Fracturing" 189-212.

²⁷³ See Campin "Regulation of Hydraulic Fracturing" at table 10.1.

is that UGD consists of a range of integrated activities. Hydraulic fracturing is but one of the activities that make up UGD.

2.3.5 The difference between the conventional and unconventional extraction methods

UGD usually spans large geographical areas (generally larger than the extraction of traditional resources such as coal – this includes oil and gas by way of conventional extraction methods).²⁷⁴ This is so because (i) a large number of wells are drilled that include horizontal drilling (in multiple directions), and (ii) infrastructure roll-out such as transport operations which tend to be extensive and intensive (a large network of transport is needed to service the numerous wells and associated operations).²⁷⁵ Unlike traditional mining and extraction operations, associated impacts from UGD cover a large spatial scale and are cumulative in nature.²⁷⁶ In contrast with conventional hydrocarbon extraction methods, unconventional natural gas extraction therefore has potentially a much bigger cumulative impact on the environment.²⁷⁷

2.4 A socio-ecological approach towards identifying regulatory challenges

In order to identify regulatory challenges emanating from UGD, it is necessary to follow an approach that includes both social (human) and ecological (nature) features.²⁷⁸ Past studies on UGD have either omitted or not given much recognition to social (human) features.²⁷⁹ More recent studies are pointing towards the existence of numerous direct and indirect links between ecological and social systems within

²⁷⁴ Atkinson 2018 *Extractive Industries and Society* 442; Esterhuyse *et al* 2016 *Journal of Environmental Management* 420; Stewart and Ingelson 2017 *JENRL* 110; Hepburn *Mining and Energy Law* 184.

²⁷⁵ Hepburn *Mining and Energy Law* 184. This includes the transport of drilling material, water for fracking, wastewater etc. Atkinson 2018 *Extractive Industries and Society* 442; Walton and Woocay 2013 *Journal of Green Building* 71.

²⁷⁶ Atkinson 2018 *Extractive Industries and Society* 442; Hepburn *Mining and Energy Law* 184; Walton and Woocay 2013 *Journal of Green Building* 71; Stewart and Ingelson 2017 *JENRL* 110.

²⁷⁷ Sovacool and Vivoda 2014 *OGE* 17.

²⁷⁸ Small *et al* 2014 *Environmental Science and Technology* 8289; Deziel, Shamasunder and Pejchar 2022 *BioScience* 472; Pothukuchi, Arrowsmith and Lyon 2017 *Journal of Planning Literature* 1.

²⁷⁹ Deziel, Shamasunder and Pejchar 2022 *BioScience* 472; *Environmental Science and Technology* 8289.

UGD.²⁸⁰ The identification of regulatory challenges linked to UGD therefore calls for a more holistic approach, one that includes both the social and ecological features of UGD.²⁸¹ The use of a socio-ecological approach is therefore proposed and followed here. While this approach should in theory be more holistic than those that omitted to indicate the existence of links between the ecological and the social, it is not the only approach usable, nor is it a guarantee that this approach will be able to ascertain the nature and extent of all social and ecological impacts stemming from UGD.

In simple terms, a social-ecological approach means that links between ecological and social features stemming from UGD are identified and communicated. This does not necessitate a completely new approach. In fact, other existing approaches²⁸² within either the ecological or social aspects of UGD are useful in the sense that they can be used to complement one another to get to a more holistic approach (i.e. socio-ecological approach) that try and make the links between social and ecological features clearer.

One such method is to follow a lifecycle approach.²⁸³ The development process for unconventional natural gas is mostly a wet process and heavily dependent on water and therefore it makes sense to identify possible regulatory challenges or risks by way of a water life-cycle approach. Another method is that of making a distinction between direct and indirect ecological and social risks.²⁸⁴ According to this, direct ecological risk includes water scarcity and water quality, methane leakage, air pollution, seismic

²⁸⁰ Hoffman, Walker and Henschel 2018 *AJRFs* 388-390; Meng 2017 *STE* 954.

²⁸¹ Deziel, Shamasunder and Pejchar 2022 *BioScience* 472; Hoffman, Walker and Henschel 2018 *AJRFs* 388-390; Meng 2017 *STE* 954.

²⁸² For example, a life-cycle approach, cradle to grave approach, risk approach, applied rules approach (Campkin), direct and indirect environmental approach, strategic and environmental impact assessment approaches.

²⁸³ Valder *et al* 2018 "The life cycle of unconventional oil and gas" 1-22; Tagliaferri *et al* 2017 *International Journal of Life Cycle Assessment* 919-937; Haque "The life cycle assessment of various energy technologies" 633-647; Jolliet *et al* *Life cycle impact assessment* 7-21; 105-143; and Nel and Alberts "Environmental Management and Environmental Law in South Africa: An Introduction" 5-9; Du Plessis 2015 *PELJ* 1449.

²⁸⁴ Esterhuysen *et al* 2016 *Journal of Environmental Management* 420; May and Dernbach "Introduction" 5; Albrecht and Schneemann 2014 *Carbon & Climate Law Review* 238; McBroom (ed) *The Effects of Induced Hydraulic Fracturing on the Environment* 1-331; Hepburn "Mining and Energy Law" 177; and De Witt 2011 *SAJS* 3-5.

activity, and associated health impacts.²⁸⁵ Indirect ecological and social risk includes loss of habitat, noise, odour, truck traffic, possible infrastructure degradation, and local social and economic disorder.²⁸⁶ Finally, regulatory challenges linked to UGD can also be identified by making use of strategic and environmental impact assessment approaches.²⁸⁷ As indicated, a combination of methods that straddle social and ecological aspects, is used here to identify the regulatory challenges of UGD.

2.4.1 Impacts on water – a life-cycle approach

Known hydraulic fracturing methods that could affect surface and ground water include water withdrawals at times or in locations of water scarcity, spills of hydraulic fracturing fluid and chemicals, and inadequate treatment and discharge of hydraulic fracturing wastewater.²⁸⁸ Methods impacting ground water specifically, include the movement of liquid and gas via the production well into underground water resources, and movement of liquid and gas from the fracture zone to these resources via pathways in sub-surface rock formations.²⁸⁹

Potential impacts of UGD on water resources can be mapped by way of a water project life-cycle approach. A typical water project life-cycle for UGD consists of water acquisition, chemical mixing, well-injection, flow-back and produced water, and wastewater treatment and waste disposal.²⁹⁰ Thus, what follows is a description of socio-ecological impacts from UGD from a water project life-cycle perspective. Socio-

²⁸⁵ Wollin *et al* 2020 *Archives of Toxicology* 971-1007; Meng 2017 *STE* 953-957; Steward and Ingelson 2017 *JENRL* 109-146; Arkert "Risks to Ecological Systems 1-65; Todd *et al* "Impacts of Fracking on Biodiversity" 278-301; London and Willems "Public Health Challenges" 323-344.

²⁸⁶ Avenant *et al* "Potential Impact of Unconventional Gas" 222-244; Esterhuyse *et al* 2016 *Journal of Environmental Management* 420; May and Dernbach "Introduction" 5; Albrecht and Schneemann 2014 *Carbon & Climate Law Review* 238; McBroom (ed) *The Effects of Induced Hydraulic Fracturing on the Environment* 1-331; Hepburn "Mining and Energy Law" 177; and De Witt 2011 *SAJS* 3-5.

²⁸⁷ For example, see Esterhuyse 2018 *Current Opinion in Environmental Science and Health* 1-10.

²⁸⁸ Williamson and Esterhuyse 2020 *Bulletin of Engineering and the Environment* 711-728; Pietersen *et al* 2016 *Water SA* 421-422; EPA "Hydraulic fracturing for oil and gas" 23; WWF 2015 "Shale Gas: Water Impacts" 33-49.

²⁸⁹ Pietersen *et al* 2016 *Water SA* 421-422; EPA "Hydraulic fracturing for oil and gas" 23; WWF 2015 "Shale Gas: Water Impacts" 33-49.

²⁹⁰ Williamson and Esterhuyse 2020 *Bulletin of Engineering and the Environment* 711-728; Clark, Horner, and Harto 2013 *Environmental, Science and Technology* 11829-11836.

ecological impacts that are not directly linked to a water project life-cycle are discussed later in this chapter. The water project life-cycle is illustrated in Figure 2-1.

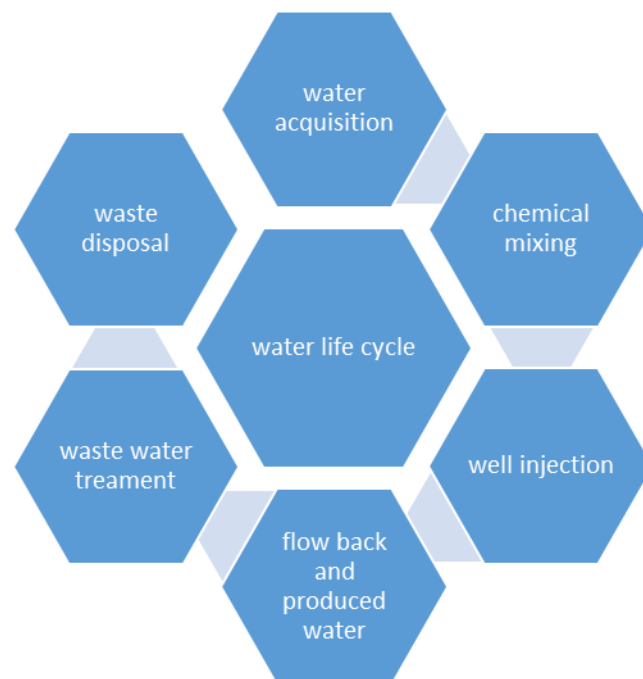


Figure 2-1: A water project life-cycle for unconventional natural gas development

This life-cycle will be discussed in the following paragraphs.

2.4.1.1 Water acquisition

Hydraulic fracturing is water intensive.²⁹¹ Typically, reserves of onshore unconventional natural gas are located in water-scarce areas.²⁹² Vast water quantities used over the life-span of a shale-well put further stress on local fresh water sources which are already needed for many other purposes.²⁹³ Fresh water needed for the hydraulic fracturing process is usually sourced from local rivers, streams, aquifers and lakes.²⁹⁴ In instances of a water supply shortage, water gets transported from other

²⁹¹ Larson, Holley and Bowman 2018 *Jurimetrics* 2-3; Scotchman 2016 *Proceedings of the Geologists' Association* 549; Mroue "Water-Energy Nexus" 22.

²⁹² Esterhuyse *et al* 2016 *Journal of Environmental Management* 420; Hitaj, Boslett and Weber 2020 *Energy Policy* 1.

²⁹³ Such as agriculture, industrial, and domestic use. Esterhuyse *et al* 2016 *Journal of Environmental Management* 420.

²⁹⁴ Esterhuyse *et al* 2016 *Journal of Environmental Management* 420.

regions via truck or pipeline.²⁹⁵ Although the amount of water used for unconventional natural gas is small compared to that of other users, (such as industry, agriculture, municipalities etc.), fracking water (wastewater) cannot be used for anything but further fracking use, unless it is treated to remove toxins.²⁹⁶ In regions of water scarcity (such as the Karoo area), water use for fracking will deplete aquifers and in effect displace water from agriculture and general community use.²⁹⁷ In this context (as in an arid area with water stress) water withdrawal for UGD represents a large share/percentage of total water withdrawals.²⁹⁸ This, in effect, creates competition for available water among different users.²⁹⁹

Water acquisition from surface and groundwater resources depends on water availability (quantity), while withdrawal also impacts water quality.³⁰⁰ Water is also needed for the drilling operation itself.³⁰¹ Total water use depends on a number of factors. This includes the variation in water use across space that in turn depends on the number of wells drilled, the type of drilling fluids used and on the depth and horizontal extent of the well, as does the variation in the cost of water acquisition and disposal of wastewater.³⁰² Studies indicate that water use can vary greatly between wells (from 8,000 to 100,000 m³ per well).³⁰³ This variability in water use is due to a number of factors such as differences in well-borehole configuration and volume, the type of hydrocarbon, the specific target of gas reservoir, and the drilling year of the well.³⁰⁴ Wells have a productive life of between 20-40 years and are re-fractured every 3-5 years to assure viable production flow.³⁰⁵ In other words, the total volume of freshwater used during the lifetime of a well is considerably more than needed for the

²⁹⁵ Esterhuyse *et al* 2016 *Journal of Environmental Management* 420.

²⁹⁶ Esterhuyse *et al* 2016 *Journal of Environmental Management* 420.

²⁹⁷ Hitaj, Boslett and Weber 2020 *Energy Policy* 1.

²⁹⁸ Hitaj, Boslett and Weber 2020 *Energy Policy* 2.

²⁹⁹ Hitaj, Boslett and Weber 2020 *Energy Policy* 1.

³⁰⁰ Typically, water for hydraulic fracturing comes from surface water, ground water, or reused hydraulic fracturing wastewater. See EPA "Hydraulic fracturing for oil and gas" 7.

³⁰¹ This accounts for less than 10% of the total water requirement. See SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 18.

³⁰² Hitaj, Boslett and Weber 2020 *Energy Policy* 2; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 18.

³⁰³ Pietersen *et al* 2016 *Water SA* 422; ASSAf (4), 44–5; Hitaj, Boslett and Weber 2020 *Energy Policy* 2.

³⁰⁴ Pietersen *et al* 2016 *Water SA* 422.

³⁰⁵ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 18.

initial fracking operation.³⁰⁶ The estimate for total water use over a well's lifetime ranges between 24,000 m³ and 500,000 m³.³⁰⁷

A possible solution to limit the impact on water resources is the use of a specific gel in the fracking operation.³⁰⁸ However, this gel requires an emulsifier that is produced from guar seed.³⁰⁹ Already, the increase in demand for guar seed has led to thousands of acres of crop land being converted for guar production.³¹⁰ This simply moves the issue of water security to another region – in other words it results in the fracking jurisdiction externalising the costs of water security to another region.³¹¹ In addition, the conversion of crop land to produce guar seed impacts negatively on food security.³¹²

In instances where groundwater withdrawals exceed natural recharge rates, water storage in aquifers decreases, thereby activating contaminants or allowing the infiltration of lower quality water from the land surface or nearby formations.³¹³ In addition, withdrawals could decrease ground water discharge to streams, thereby possibly affecting the quality of surface water.³¹⁴ Excessive water use may lead to a fall in the availability of public water supply and ecosystem degradation, and it may have adverse effects on aquatic habitats, erosion, and changes in water temperature.³¹⁵ High water use for fracking or consumption alone does not necessarily result in impacts upon water resources.³¹⁶ It is rather the combination of water use or consumption and water availability at local scale that result in impacts.³¹⁷ Areas where significant ground water pumping occurs, are most likely to experience impacts,

³⁰⁶ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 18.

³⁰⁷ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 18.

³⁰⁸ Larson, Holley and Bowman 2018 *Jurimetrics* 3.

³⁰⁹ Larson, Holley and Bowman 2018 *Jurimetrics* 3.

³¹⁰ Particularly in India and Pakistan. Larson, Holley and Bowman 2018 *Jurimetrics* 3.

³¹¹ Larson, Holley and Bowman 2018 *Jurimetrics* 3.

³¹² Larson, Holley and Bowman 2018 *Jurimetrics* 3.

³¹³ Freyman, 'Ceres Report Hydraulic Fracturing & Water Stress: Water Demand by the Numbers' February 2014; EPA "Hydraulic fracturing for oil and gas" 10.

³¹⁴ EPA "Hydraulic fracturing for oil and gas" 10. Withdrawals of surface water could also affect water quality because such withdrawals may lower water levels and change stream flow, thereby decreasing a stream's ability to dilute contaminants.

³¹⁵ Pietersen *et al* 2016 *Water SA* 422–429.

³¹⁶ EPA "Hydraulic fracturing for oil and gas" 9.

³¹⁷ EPA "Hydraulic fracturing for oil and gas" 9.

especially drought-prone regions with limited ground water recharge.³¹⁸ This is also true for the Karoo area in South Africa. The specific area earmarked for potential UGD in the Karoo area is known to be arid and it relies heavily on groundwater.³¹⁹ A study by Du Toit³²⁰ found that 31 of the 34 sizable towns, within the Karoo unconventional gas exploration concessions, rely wholly or partially on underground aquifers. Potable water resources in the Karoo are already fully allocated.³²¹ The additional water requirements for UGD would either need to use water from local non-potable sources, such as deep saline groundwater, or water imported from outside the region.³²² Because groundwater and surface water are hydraulically connected, any change in the quality and quantity of groundwater will affect surface water.³²³ The inverse is also true. The possible impact that hydraulic fracturing could have on groundwater and surface water in the Karoo area is therefore significant.³²⁴

2.4.1.2 Chemical mixing

To create the hydraulic fracturing fluid, water, chemicals and proppant are mixed.³²⁵ The purpose of the hydraulic fracturing fluids is to create and extend fractures, to transport proppant and to place proppant in the fractures.³²⁶ Fracturing fluids include the following: base fluids (water, oils and diesel, methanol, polymers, acids, potassium chloride), proppants (silica sand, resin-coated sand, man-made ceramics, radio-active mineral), foaming agents (nitrogen, CO₂, alcohols, glycol-ethers), gelling agents (guar gum, cellulose derivatives), breakers and cross linkers (enzymes, oxidizers, borate salts).³²⁷ Other additives include: biocides, bactericides, microbicides (glutaraldehyde), corrosion and scale inhibitors (ethylene glycol, methanol,

³¹⁸ EPA "Hydraulic fracturing for oil and gas" 10.

³¹⁹ Esterhuyse, de Lange and Glazewski "Impact on Karoo Aquifers" 206-207; Du Toit 2016 <https://bit.ly/3vdDoSW>.

³²⁰ Du Toit 2016 <https://bit.ly/3vdDoSW>.

³²¹ Scholes and Schreiner 2017 <https://bit.ly/3H2xrL3>.

³²² Scholes and Schreiner 2017 <https://bit.ly/3H2xrL3>.

³²³ Esterhuyse *et al* 2016 *Journal of Environmental Management* 421.

³²⁴ Esterhuyse, de Lange and Glazewski "Impact on Karoo Aquifers" 208-20212; Avenant *et al* "Impact on Surface Waters Systems" 244; Broomfield 2012 <http://bit.ly/3VmZUm4>.

³²⁵ Lewis, McMichael and Glazewski "Fracking Fluids" 249; EPA "Hydraulic fracturing for oil and gas" 10.

³²⁶ EPA "Hydraulic fracturing for oil and gas" 10; Wollin *et al* 2020 *Archives of Toxicology* 969.

³²⁷ Lewis, McMichael and Glazewski "Fracking Fluids" 247-248; Wollin *et al* 2020 *Archives of Toxicology* 970.

ammonium chloride), friction reducers (polyacrylamide, mineral oil, petroleum distillates), iron control agents (citric acid), surfactants (isopropanol, methanol), and fluid-loss agents (sands, flours, starches, clays).³²⁸

Due to the large volume of fluids required for the hydraulic fracturing operation, thousands of litres of chemicals can potentially be stored on site.³²⁹ The on-site storage, mixing and pumping of chemicals could lead to accidental releases in the form of spills or leaks.³³⁰ Estimates of the overall median per chemical per well are in the range of 2,500 litres; on the further assumption of 14 unique chemicals used per well, an estimated 34,000 litres of chemicals may be injected per well.³³¹ A report by the American Environmental Protection Agency (EPA)³³² indicates that causes of spills and leakage of fracking fluid and chemicals tend to include equipment failure, failure of container integrity, human error and to a lesser extent weather and vandalism.³³³ Vandalism and theft are frequent issues on many infrastructure and industrial development facilities.³³⁴ The same risks apply to infrastructure linked to unconventional gas development – on site but also with regard to pipe lines from drilling sites to depots.³³⁵ Corrosion and failed valves on blowout preventers seem to

³²⁸ Wollin *et al* 2020 *Archives of Toxicology* 970; EPA "Hydraulic fracturing for oil and gas" 10.

³²⁹ Lewis, McMichael and Glazewski "Fracking Fluids" 247-248; EPA "Hydraulic fracturing for oil and gas" 10. Large variabilities in the composition of hydraulic fracturing fluids result from factors such as the geology of the specific formation, availability and cost of different chemicals and service operator preference.

³³⁰ EPA "Hydraulic fracturing for oil and gas" 10; Lewis, McMichael and Glazewski "Fracking Fluids" 251. Drilling fluids and cuttings include: base fluids (water, diesel, oil, mineral oils, synthetic compounds such as esters, paraffin and olefins), weighting agents (bentonite, barite, hematite, calcium carbonate, and ilmenite), thickeners (xanthan gum, guar gum, glycol, carboxymethylcellulose, and polyanionic cellulose), thinners and deflocculant (acrylates, polyphosphates, lignosulfates, and lignite), cuttings (naturally occurring radio-active material and turbidity) and the intrusion of saline-formation water into fresh groundwater.

³³¹ EPA "Hydraulic fracturing for oil and gas" 12. These estimates have been developed from information on FracFocus (chemical registry for hydraulic fracturing – it is managed by the ground Water Protection Council and Interstate Oil and Gas Compact Commission in the USA). For FracFocus see <<http://fracfocus.org>> accessed 7 October 2019.

³³² EPA "Hydraulic fracturing for oil and gas" 11.

³³³ See Odendaal *Engineering News* 1; Khoza *Sowetan Live* 1; Simelane *Daily Maverick* 1; Groenendaal *Green Building Africa* 1; Coetzer *The Citizen* 1.

³³⁴ SAICE 2022 Infrastructure Report Card for South Africa 15; Mputing 2022 "National Assembly Debates Impact of Infrastructure Theft and Vandalism on the Economy" see <http://bit.ly/3AAxcWY>.

³³⁵ SAICE 2022 Infrastructure Report Card for South Africa 15; Odendaal *Engineering News* 1; Khoza *Sowetan Live* 1; Simelane *Daily Maverick* 1; Mputing 2022 "National Assembly Debates Impact of Infrastructure Theft and Vandalism on the Economy" see <http://bit.ly/3AAxcWY>.

be the most common cause of equipment failure.³³⁶ Mobility, solubility and volatility are all properties affecting the likelihood of a spilled chemical reaching and impacting a water resource.³³⁷ Some chemicals, such as choline chloride and tetrakis phosphonium, tend to move quickly through the environment with the flow of water, while others have the potential to stay in the environment as long-term contaminants.³³⁸ Not many of the chemicals volatilize and consequently a large portion of most hydraulic fracturing fluids tends to stay in water.³³⁹

There are a number of ways in which a spill can potentially contaminate water resources. They include overland flow to nearby surface water, soil contamination, and infiltration and contamination of underlying ground water.³⁴⁰ Impacts of such spills could occur quickly, be delayed for short or long periods of time, or have a continual effect over time.³⁴¹ The lack of full disclosure of chemicals used in unconventional gas operations (hydraulic fracturing) is highly problematic. For example, the EPA in a 2016 report identified more than 1,600 chemicals used in drilling and fracking and fracking wastewater.³⁴² Near 200 of these chemicals are deemed carcinogenic or toxic to human health.³⁴³ This includes reports of the use of per- and polyfluoroalkyl substances (PFAS) or substances that can degrade (precursors) into PFAS.³⁴⁴ PFAS have properties that make them useful in hydraulic fracturing operations, such as being oil and water repellent, being slippery, and possibly used as dispersant or

³³⁶ EPA "Hydraulic fracturing for oil and gas" 11.

³³⁷ EPA "Hydraulic fracturing for oil and gas" 12.

³³⁸ Ferrer and Thurman 2015 *Trends in Environmental Analytical Chemistry* 20-22; Thomas *et al* 2019 *Journal of Petroleum Science and Engineering* 798-799.

³³⁹ Stroebel, Thiart and De Wit "Towards defining a baseline status" 130; Ferrer and Thurman 2015 *Trends in Environmental Analytical Chemistry* 20-22; Thomas *et al* 2019 *Journal of Petroleum Science and Engineering* 798-799.

³⁴⁰ EPA "Hydraulic fracturing for oil and gas" 13.

³⁴¹ EPA "Hydraulic fracturing for oil and gas" 13.

³⁴² EPA "Hydraulic fracturing for oil and gas" 16-22. Also, see Tabuchi 2021 <https://nyti.ms/3r06Rge>.

³⁴³ Tabuchi 2021 <https://nyti.ms/3r06Rge>.

³⁴⁴ Tabuchi 2021 <https://nyti.ms/3r06Rge>; Bond 2021 <https://nyti.ms/3r06Rge>; Physicians for Responsible Society "Fracking with forever chemicals" 5.

foaming agents.³⁴⁵ These substances (PFAS) are toxic in minuscule concentrations and do not easily break down in the environment.³⁴⁶

2.4.1.3 Well injection

Fracking wells tend to pass through aquifers and therefore the possibility of subsurface migration of fracturing fluids or hydrocarbons into groundwater aquifers exists.³⁴⁷ Foremost ways of possible contamination of water resources by the injection of hydraulic fluids include the unintended movement of liquids or gases from the well or along the outside of the well via deficiencies in the well's casing or cement into a water resource, and movement of fluids from the production zone through subsurface geological formations into a water resource.³⁴⁸ A particularly important well construction feature is cemented surface-casing to keep water resources isolated from liquids and gases that may move through the subsurface.³⁴⁹ Inadequate design or construction issues of casing and/or cement could lead to possible contamination of water resources and is of critical importance. Construction issues, sustained pressure on casings and the presence of natural faults and fractures could work together to create pathways for fluids and gases to move into water resources.³⁵⁰ The possibility of the likelihood of subsurface migration of liquids and gases to water resources could also depend on the vertical distance between the base of the water resources and the top of the shale formation. Less vertical distance or separation between the two creates a proportionately greater risk of liquids or gas migrating to water resources. In some instances, gas resources and water resources could also co-exist in the same formation. In these instances, the injection of hydraulic fracturing fluids will affect the water resource, because some of the fluid will likely stay in the formation after completion of the hydraulic fracturing.³⁵¹

³⁴⁵ Murphy and Hewat 2008 *The Petroleum Engineering Journal* 61. Also known as "forever chemicals" due to it being extremely resistant to breaking down in the environment. See Physicians for Responsible Society "Fracking with forever chemicals" 5.

³⁴⁶ Physicians for Responsible Society "Fracking with forever chemicals" 5.

³⁴⁷ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 217; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁴⁸ A combination of the two is also possible. See EPA "Hydraulic fracturing for oil and gas" 13.

³⁴⁹ EPA "Hydraulic fracturing for oil and gas" 14.

³⁵⁰ EPA "Hydraulic fracturing for oil and gas" 15.

³⁵¹ EPA "Hydraulic fracturing for oil and gas" 15.

A number of possible migration pathways exist.³⁵² A lot depends on the integrity of the casing and cement of the well.³⁵³ Any issue with the integrity of a well may well lead to leakage and contamination of fracturing fluids into groundwater aquifers.³⁵⁴ Poor cement casing around the well-bore could result in natural gas (methane) reaching the water zone.³⁵⁵ The drilling of the shallow section of a well could temporarily open up natural gas (methane) located in shallow areas and result in it reaching water aquifers.³⁵⁶ Another possible pathway is where the cement casing of abandoned wellbores has deteriorated which could lead to the linking with other deeper pressure gas formations. In other words, the gas links up with the abandoned wellbore and travels to another aquifer.³⁵⁷ This intersection (generally known as "frack hits" or "well communications") can result in the flow of liquids and gases into nearby wells (connected to the same well-pad) and other fracture networks.³⁵⁸ Older or inactive wells may pose significant risks as they are more likely to be negatively affected by stresses caused by nearby hydraulic fracturing operations that have not been plugged properly (i.e. without cement).³⁵⁹ The greatest risk is that the fracking fluid leaks into the surface water and shallow aquifers used by people, livestock and the ecosystem, due to inadequate sealing of the upper parts of the borehole, or following a spill on the surface.³⁶⁰

2.4.1.4 Flow-back and produced water

Flow-back water refers to the water that is initially produced after the hydraulic fracturing operation.³⁶¹ Flow-back water usually contains brine, heavy metals and

³⁵² SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁵³ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁵⁴ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 217.

³⁵⁵ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁵⁶ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 217; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁵⁷ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 217.

³⁵⁸ EPA "Hydraulic fracturing for oil and gas" 16.

³⁵⁹ EPA "Hydraulic fracturing for oil and gas" 16.

³⁶⁰ Scholes and Schreiner "Unpacking the issues around fracking in South Africa" *The Conversation* (13 July 2017) <https://theconversation.com/explainer-unpacking-the-issues-around-fracking-in-south-africa-80513>.

³⁶¹ Williamson and Esterhuyse 2020 *Bulletin of Engineering and the Environment* 712; EPA "Hydraulic fracturing for oil and gas" 29-33.

radioactive contaminants (this is in addition to methane that gets released and fracking chemicals).³⁶² If treated in a proper manner, flow-back water can be reused in other fracking operations.³⁶³ However, the degree of difficulty, and therefore the cost of treatment depends on a number of factors. This includes the salinity, the chemical composition of the fluid, and the tolerance level of the ecological system into which the treated water is supposed to be discharged.³⁶⁴ The nature of saline fluids is such that it cannot be treated in the usual municipal treatment plants.³⁶⁵ Other harmful components found in flow-back water is also an issue when looking to employ typical municipal treatment plants. These components can either be absorbed by the sludge or simply flow through the treatment plant.³⁶⁶ Other, more costly options include reverse osmosis and thermal distillation and crystallisation.³⁶⁷ The treatment of flow-back water into drinking water quality is therefore not easily done.³⁶⁸ Treatment of fracking wastewater depends on operational infrastructure and economic cost.³⁶⁹ It requires specialist treatment infrastructure at considerable costs.³⁷⁰

Produced water refers to hydraulic fracturing fluids and any formation water that returns to the surface. This water is initially similar to the fracturing fluid, but with time the composition is affected by the characteristics of the specific formation and possible reactions between the formulation and the fracturing fluid.³⁷¹ From the water that is initial pumped under pressure down the wellbore, a certain volume comes back up.³⁷² The volume of flow-back water depends on the geological formation. It can be

³⁶² SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

³⁶³ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁶⁴ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 94.

³⁶⁵ It has a toxic effect on microbes in the sludge process. See the EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 94.

³⁶⁶ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 94.

³⁶⁷ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 94.

³⁶⁸ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

³⁶⁹ Williamson and Esterhuyse 2020 *Bulletin of Engineering and the Environment* 718. Most municipalities in South Africa are already struggling to maintain normal water treatment. Many lack both operational infrastructure and finances to maintain water treatment infrastructure. See SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 19.

³⁷⁰ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁷¹ Factors that influence the composition of produced water include the type of formation fractured, the composition of the injected fracturing fluids, subsurface processes and residence time (duration). EPA "Hydraulic fracturing for oil and gas" 16.

³⁷² EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

as low as 15 per cent and as high as 300 per cent.³⁷³ However, in some instances the total volume of produced water can be equal or exceed the injected volume of the fracturing fluid.³⁷⁴ The volume, timing and composition of produced water are all factors that define the level of impact on water resources.³⁷⁵ Returned water is pumped into storage tanks or pits before it gets hauled to other destinations (such as deep well injection).

The flow-back water could spill and lead to contamination.³⁷⁶ Examples include tankers that leak, faulty valves and traffic accidents.³⁷⁷ Potential accidents could lead to spillage of fracking fluids or wastewater and the contamination of ground and surface waters.³⁷⁸ Overflow of on-site waste ponds, could spill or leak into groundwater and streams.³⁷⁹ If produced water is spilled, it has the potential to impact water resources.³⁸⁰ Spills could also occur away from the well, such as during truck and pipeline transport. The EPA³⁸¹ estimates that the median volume per produced water-spills is more than double that for spills of hydraulic fracturing fluids and chemicals; the cause of most of the produced water-spills is failure of container integrity.³⁸² As is the case with chemicals in hydraulic fracturing fluid, mobility, solubility and volatility are all properties affecting the likelihood of a spilled chemical reaching and impacting a water resource.³⁸³ Produced water that is disposed of in unlined pits or impoundments can lead to chronic releases and have long-term impacts.³⁸⁴ Constituents of flow-back and produced water include: total dissolved solids (chlorides e.g. sodium, potassium, bromides, carbonates, sulphates, nitrates), total suspended solids (iron solids, sand, silt and clay), metals (calcium, magnesium, barium,

³⁷³ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁷⁴ EPA "Hydraulic fracturing for oil and gas" 16. Also, see "Andrews-Speed Shale Gas in the United States" 115.

³⁷⁵ EPA "Hydraulic fracturing for oil and gas" 19.

³⁷⁶ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

³⁷⁷ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁷⁸ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

³⁷⁹ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 22.

³⁸⁰ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction".

³⁸¹ EPA "Hydraulic fracturing for oil and gas" 17.

³⁸² EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 93.

³⁸³ EPA "Hydraulic fracturing for oil and gas" 18.

³⁸⁴ EPA "Hydraulic fracturing for oil and gas" 19.

strontium, lead, mercury, manganese, molybdenum, zinc, arsenic, aluminium, and lithium), naturally occurring radioactive material (radium-226, radium-228, uranium, thorium), acid gases (CO₂, hydrogen sulphate), oil and grease, aromatic hydrocarbons, bacteria, condenser, and dehydration additives (triethylene glycol). All of these may impact on soil, water and food quality as well as on human health.

2.4.1.5 Wastewater treatment and waste disposal

After the injection pressure is released following a hydraulic fracturing operation, water flows back from the well and is collected in tanks.³⁸⁵ Water generated from the hydraulic fracturing process requires management and disposal.³⁸⁶ Wastewater contains high concentrations of totally dissolved solids, with these dissolved solids ranging from 5,000 to more than 10,000 mg/L.³⁸⁷ There are a number of options available to the managing of contaminated wastewater from UGD. These options include: the minimisation of produced water generation, recycling and re-use within future operations, treatment, disposal (via sewage systems) and beneficial re-use outside the operations.³⁸⁸ From a practical point of view, the management of wastewater translates into the following choices: management via evaporation ponds, by disposal in underground disposal wells, treatment at waste treatment facilities followed by re-use or discharge to surface waters or treatment works, re-use with minimal or no treatment, and land application or road spreading.³⁸⁹ The disposal and management of wastewater could impact water resources in a number of ways, including: inadequate treatment of wastewater prior to discharge to a receiving water source, accidental releases during transport or leakage from wastewater storage pits, unpermitted discharge, migration of constituents in wastewater following land application, inappropriate management of residual materials from treatment, and accumulation of wastewater constituents in sediments near outfalls of waste treatment

³⁸⁵ Sovacool and Vivoda 2013 *OGE* 5; Oelofse, Schoonraad, and Baldwin "Impacts on Waste Planning and Management" 8.

³⁸⁶ There are numerous other possible waste streams from UGD, for example, construction and demolition waste, drill cuttings and drilling muds. Oelofse, Schoonraad, and Baldwin "Impacts on Waste Planning and Management" 9-16.

³⁸⁷ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 22; Oelofse, Schoonraad, and Baldwin "Impacts on Waste Planning and Management" 6-7.

³⁸⁸ Oelofse, Schoonraad and Baldwin "Impacts on Waste Planning and Management 9-16.

³⁸⁹ EPA "Hydraulic fracturing for oil and gas" 19–20.

facilities.³⁹⁰ Another possible impact on water resources could be by disposal of wastewater into underground injection control wells where leakage could occur.³⁹¹ Local municipalities in the Karoo area are already struggling to provide access to water (being a water-scarce area). They most likely do not have the human capacity and financial resources to undertake any additional wastewater treatment and disposal management.³⁹²

2.4.1.6 Summary of potential risks for water resources

The previous paragraphs focused on potential risks for water resources by using a water project life-cycle for unconventional natural gas development.³⁹³ This consisted of water acquisition, chemical mixing, well injection, flow-back and produced water, and wastewater treatment and waste disposal.³⁹⁴ The main risks to water resources include: aquifer contamination from stray gas-contamination (in the form of hydrocarbon gases); salination of groundwater due to leaking wells and subsurface flow; surface and groundwater contamination due to leaks, spills and the disposal of untreated or inadequately treated wastewater; toxic and radioactive elements settling in stream and soil sediments (near disposal or spill sites); and overextraction of fresh water resources (particularly in water-stressed areas).³⁹⁵

2.4.2 Air quality – gaseous emissions and climate change

Gaseous emissions that have an impact on air quality include greenhouse emissions released during the production process of UGD.³⁹⁶ These harmful emissions include methane, (escapes from valves and compressor blowout) and non-methane volatile organic compounds (VOCs such as Benzene, Toluene, Ethylbenzene, and Xylenes) that

³⁹⁰ EPA "Hydraulic fracturing for oil and gas" 19.

³⁹¹ EPA "Hydraulic fracturing for oil and gas" 20.

³⁹² See Kirsten and Schöffman 15 December 2020 Daily Maverick; Jordan 11 January 2021 Sunday Times; Felix 29 July 2020 News24.

³⁹³ Paragraphs 2.4.1.1 - 2.4.1.5.

³⁹⁴ Paragraphs 2.4.1.1 - 2.4.1.5.

³⁹⁵ Paragraphs 2.4.1.1 - 2.4.1.5. Also, see Vengosh *et al* 2014 *Environmental Science and Technology* 8334-8348.

³⁹⁶ Typical air pollutants associated with shale gas development include: conventional air pollutants and carbon dioxide (CO₂); volatile organic compounds (VOCs); methane; hydrogen sulphide; and silica. Krupnik, Gordon, and Olmstead "Environmental Risks of Shale Gas Development" (RFF Report 2013).

are released from condensation tanks.³⁹⁷ Engine-exhaust and dust from diesel-powered pumps and truck-traffic include ozone precursors such as NO_x and non-methane volatile organic compounds (VOC) and particulates.³⁹⁸ Non-combustion particles include silica dust from proppant-usage during hydraulic fracturing and dust from the construction of gravel roads for access to drill pads.³⁹⁹ Silica dust can lodge in human lungs and causes silicosis.⁴⁰⁰ Methane emissions take place during the well completion process and include the flaring (the burn-off of excess natural gas).⁴⁰¹ Another risk is that of fire caused by well-blowout that could lead to the release of methane into the atmosphere.⁴⁰²

Compared to other traditional fossil fuels, natural gas produces lower greenhouse gas emissions and therefore it is frequently described as a bridge fuel that forms the bridge for the transition from fossil fuels to renewable energy.⁴⁰³ Natural gas, which consists of approximately 90 percent methane, releases close to 30% less carbon dioxide than oil and close to 50% less than coal.⁴⁰⁴ However, the argument that natural gas has a much lower carbon footprint than coal or oil is only partly true because much depends on the amount of greenhouse gases released in the burning of these fuels (gas, coal and oil).⁴⁰⁵ This is so because the drilling and extraction process of unconventional natural gas (horizontal drilling and fracking) releases 40-60 percent more methane than conventional natural gas drilling.⁴⁰⁶ Numerous studies indicate that methane leakage is common during UGD (includes leakage from well-casings, tanks and vents).⁴⁰⁷ Methane is a potent greenhouse gas because it has a global warming potential of 28 over a 100-year time.⁴⁰⁸ In other words, compared to carbon dioxide,

³⁹⁷ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 22.

³⁹⁸ Includes carbon dioxide. SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 22.

³⁹⁹ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 22.

⁴⁰⁰ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 22.

⁴⁰¹ When the well is flowed back and or tested. SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 22.

⁴⁰² SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20.

⁴⁰³ Wang and Heftey "The Global Impact" 1.

⁴⁰⁴ Pastorkovich "Drilling in the Marcellus Shale" 140.

⁴⁰⁵ Pastorkovich "Drilling in the Marcellus Shale" 140.

⁴⁰⁶ Pastorkovich "Drilling in the Marcellus Shale" 140; Tollefson 2013 *Nature* 415-416; Howarth 2019 *Biogeosciences* 3041; Howarth, Santoro and Ingraffea 2011 *Climate Change* 688. Sovacool and Vivoda 2013 *OGE* 23.

⁴⁰⁷ Tollefson 2013 *Nature* 415-416; Howarth 2019 *Biogeosciences* 3041; Howarth, Santoro and Ingraffea 2011 *Climate Change* 688. Sovacool and Vivoda 2013 *OGE* 23.

⁴⁰⁸ Hmiel *et al* 2020 *Nature* 409, 411.

methane absorbs 28 times more thermal energy.⁴⁰⁹ This is also the case when comparing the instantaneous impact of methane and carbon dioxide on the climate.⁴¹⁰ Methane's impact is therefore much larger than that of carbon dioxide.⁴¹¹ The development of unconventional natural gas will, over a period of 10-20 years, likely have a greater greenhouse effect than that of conventional oil and gas.⁴¹² In addition, more recent studies indicate that methane leakage takes place across the life-cycle of UGD and therefore the impact is even greater.⁴¹³

The argument that the use of natural gas from UGD increases the ability of the power generation system to use intermittent renewable energy sources in a way which slow-to-respond power sources like coal and nuclear, cannot, is a contested one.⁴¹⁴ This is so because the production of natural gas has led to increased competition within the fossil fuel market.⁴¹⁵ This relates to lower coal export prices and therefore a continuation of fossil fuels use.⁴¹⁶ In this way natural gas has the potential to crowd-out renewables⁴¹⁷ and delay the sustainable energy transition.⁴¹⁸

The impact of UGD on climate change (such as higher temperatures, drought, less water and less food) contradicts the idea that natural gas should be viewed as a transition or bridging fuel, namely, a temporary solution to mitigate GHG emissions while renewables come online.⁴¹⁹

⁴⁰⁹ Alvarez *et al* 2018 *Science* 186-188; Pastorkovich "Drilling in the Marcellus Shale" 140. This measurement reflects how much heat is trapped in the atmosphere (per ton of GHG).

⁴¹⁰ Methane's half-life measurement is 12 years. Sovacool and Vivoda 2013 *OGE* 28.

⁴¹¹ Howarth 2019 *Biogeosciences* 3041; Howarth, Santoro and Ingraffea 2011 *Climate Change* 688.

⁴¹² Sovacool and Vivoda 2013 *OGE* 28; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 94.

⁴¹³ Wakeford "South African Energy Context" 158.

⁴¹⁴ Scholes and Schreiner 2017 <https://bit.ly/3H2xrL3>.

⁴¹⁵ Gürsan and de Gooyert 2021 *RSE* 15.

⁴¹⁶ Gürsan and de Gooyert 2021 *RSE* 15.

⁴¹⁷ While the use of renewables is progressing, a number of constraints limits its application. These relate to issues of storage and negative weather implications (absence of wind and sunshine for windfarms and solar panels). See Irene *Socio-Economic and Environmental Implications* 1; Clark *et al* 2022 *JESA* 23.

⁴¹⁸ Gürsan and de Gooyert 2021 *RSE* 15; Wakeford "South African Energy Context" 162.

⁴¹⁹ Such as technologies used for renewables. Gürsan and de Gooyert 2021 *RSE* 12.

2.4.3 Seismicity and earthquakes

It is known that pumping fluids into or out of the Earth can cause seismicity of different magnitudes, and in some instances cause earthquakes.⁴²⁰ In terms of UGD two main activities are associated with an increase in seismicity and earthquakes.⁴²¹ A distinction is generally made between the injection and withdrawal of fracking fluids, and the disposing of fracking wastewater by injecting or pumping it in deep wells.⁴²² A number of factors may exert control on induced seismicity.⁴²³ These factors include the rate of injection, total injected volume, the temperature of the fluid, injection depth, presence of fault-lines and their orientation and existing stress state.⁴²⁴ While both of these activities consist of injecting fluids into the earth at high pressure, their impacts are different in magnitude.⁴²⁵ In the former activity (injection and withdrawal of fracking fluids) the pressurised water caused rocks to fracture and inevitably caused many micro seismic events.⁴²⁶ Although these seismic events are small and are generally not detectable on the surface, current studies are exploring possible linkages between micro-seismic events and earthquakes.⁴²⁷ In contrast, evidence of a clear link between wastewater disposal (deep well) and increased seismicity does exist.⁴²⁸ The latter activity (deep well disposing of fracking wastewater) takes place at a deeper level where the lubricated effect of pressurised water could expose fault lines within the underground geological area which in turn can lead to earthquakes.⁴²⁹ Geographical

⁴²⁰ Best known scale used to measure the magnitude and potential damage of an earthquake is the Richter scale. Stewart and Ingelson 2017 *JENRL* 112-113; Kijko *et al* "Hydraulic fracturing and seismicity" 264.

⁴²¹ Stewart and Ingelson 2017 *JENRL* 113; Kijko *et al* "Hydraulic fracturing and seismicity" 265; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20; ASSAf "Science Action Plan" 18.

⁴²² Habib, Hinojosa, and Hinojosa "Societal Implications" 172; Kijko *et al* "Hydraulic fracturing and seismicity" 265; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 20; Stewart and Ingelson 2017 *JENRL* 115.

⁴²³ Kijko *et al* "Hydraulic fracturing and seismicity" 267.

⁴²⁴ Stewart and Ingelson 2017 *JENRL* 114; Kijko *et al* "Hydraulic fracturing and seismicity" 267.

⁴²⁵ The pressure changes are controlled by the volumes of fluid and the rate of injection. ASSAf 2022 "Science Action Plan" 18; Stewart and Ingelson 2016 *JENRL* 113; Kijko *et al* "Hydraulic fracturing and seismicity" 265.

⁴²⁶ ASSAf 2022 "Science Action Plan" 18; Kijko *et al* "Hydraulic fracturing and seismicity" 265.

⁴²⁷ Habib, Hinojosa and Hinojosa "Societal Implications" 172; Stewart and Ingelson 2016 *JENRL* 113; Kijko *et al* "Hydraulic fracturing and seismicity" 265.

⁴²⁸ Stewart and Ingelson 2017 *JENRL* 114-115; Kijko *et al* "Hydraulic fracturing and seismicity" 267.

⁴²⁹ Kijko *et al* "Hydraulic fracturing and seismicity" 265; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218; SIWI Report 2014 "Shale Gas and Hydraulic Fracturing"

locations respond to seismic activities in different ways and therefore efforts are needed to gather information on the composition and fault sensitivities of those target areas.⁴³⁰ It is, however, a challenge to identify pre-existing faults at depth across large geographical areas.⁴³¹ Deep-well disposal of fracking wastewater therefore could trigger bigger seismic events that could cause an earthquake.⁴³²

2.4.4 Socio-ecological impacts

The previous paragraphs focused on the specific impacts of UGD related to water, air quality (gaseous emissions and climate change) and seismicity and earthquakes. This paragraph identifies the social and ecological impacts of UGD. In other words, it identifies UGD impacts that create and exhibit links between the social and the ecological as a system. While numerous studies focus on the environmental impacts of UGD, and while some make obvious links between the impacts of UGD to human health (usually in terms of water pollution), not many studies make explicit connections regarding possible links to and within a wider socio-ecological system. While the water and air-related impacts from UGD are common features of studies that link those impacts to human health, not many studies aim to examine and identify further possible links to ecological systems. This includes possible links to other land uses such as agriculture which speaks to food security, and also to energy security. The impacts of UGD discussed above⁴³³ relating to water, air quality (gaseous emissions and climate change), seismicity and earthquakes are used to further the identification of links to social and ecological systems.

Local communities' access to water and sanitation may be negatively impacted upon as a result of UGD.⁴³⁴ As stated above, hydraulic fracturing impacts on water quantity

20. A number of studies in the USA and the Netherlands linked deep well injection with earthquakes. Sovacool and Vivoda 2013 *OGE* 20; Stewart and Ingelson 2017 *JENRL* 115.
⁴³⁰ Habib, Hinojosa and Hinojosa "Societal Implications" 172.
⁴³¹ Kijko *et al* "Hydraulic fracturing and seismicity" 265.
⁴³² Stewart and Ingelson 2017 *JENRL* 114-115; Kijko *et al* "Hydraulic fracturing and seismicity" 267. The South African National Seismograph Network (operated by the Council for Geoscience) has conducted a seismic hazard assessment for South Africa (includes the Karoo region). Papers on the seismic hazard assessment is currently in review (October 2022). See ASSAf 2022 "Science Action Plan" 18.
⁴³³ See chapter 2.4.1 (including sub-paras) – 2.4.3.
⁴³⁴ Esterhuysen *et al* 2016 *Journal of Environmental Management* 420.

and quality due to extraction of fresh water for its operations and its possible pollution of the underground and subsurface water resources.⁴³⁵ The chemicals used in the hydraulic fracturing process (e.g. PFAS) are toxic and are linked to health issues and risks such as cancer, birth defects, and pre-eclampsia.⁴³⁶ Contamination of surface water, ground water, and soil contamination from spills and or leaks of these chemicals will be disastrous for the Karoo natural area, in other words, there will be an increase in not only physical water needs but also an increase in health risks.⁴³⁷ Medical sociologists view health more and more as a social construct rather than merely as a biomedical reality.⁴³⁸ Health (both in the physical and psychological sense) is a key element within socio-ecological systems.

Todd *et al* identify and comprehensively describe numerous potential impacts from UGD on ecosystems within the broader Karoo area.⁴³⁹ Using a hydraulic fracturing life-cycle approach based on a single well pad, the study identified the following sources of impact: noise pollution, light pollution, increase of human presence and activity, vehicle impacts, dust, vegetation-clearing leading to direct habitat-loss, chemical spills, erosion and saltation, alien plant invasion, waste water impacts, amongst others. The study was done in terms of the ecological characteristics and features of the Karoo environment.⁴⁴⁰ It includes biomes and vegetation types, and the distribution of key animal data such as critically endangered and endangered category species in the areas where UGD are likely to take place on the Karoo area.⁴⁴¹ UGD may impact on wildlife and livestock in terms of habitat loss, impacts on fertility and possible pollution of their water resources. The consumption of contaminated wildlife and livestock may impact on people's health. Contaminated livestock may also have an economic impact, in that they cannot be sold or exported.⁴⁴²

⁴³⁵ Esterhuyse, De Lange and Glazewski "Impact on Karoo Aquifers" 222-244; Sovacool and Vivoda 2013 *OGE* 23.

⁴³⁶ Physicians for Responsible Society "Fracking with forever chemicals" 3.

⁴³⁷ Esterhuyse *et al* 2016 *Journal of Environmental Management* 420.

⁴³⁸ Redelinghuys "Effects on Communities" 359.

⁴³⁹ Todd *et al* "Potential Impacts of Fracking" 278-301.

⁴⁴⁰ Todd *et al* "Potential Impacts of Fracking" 278.

⁴⁴¹ Category species in the study include mammals, frogs, reptiles, birds and butterflies. See Todd *et al* "Potential Impacts of Fracking" 279-282 and 284-286 respectively.

⁴⁴² London and Willems "Hydraulic Fracturing in Shale Gas Extraction" 334.

Activities associated with UGD will likely have negative effects on the quality of life and well-being in communities.⁴⁴³ UGD may increase the number of people living in the area, lead to new construction and roads, change the area's character, social fabric and psyche of the existing society.⁴⁴⁴ UGD may lead to loss of rural serenity, the visual landscape and may disturb people's sense of place.⁴⁴⁵ People may experience unease about the unknown impacts of hydraulic fracturing.⁴⁴⁶ UGD may further result in an increase in noise and traffic (trucks delivering water and general mechanical activities). Intensified heavy vehicle use during UGD creates dust pollution at ground level.⁴⁴⁷ Dust pollution could severely impact upon people, livestock and crops alike.⁴⁴⁸ Diesel-powered pumps, drills, and compressors may "release ... volatile hydrocarbons⁴⁴⁹ (such as benzene, toluene, and formaldehyde)" that will increase air pollution (dust and possible methane emission due to leakage, flaring and venting)⁴⁵⁰ and odours. If the activities continue at night it may result in light pollution that impacts not only on people's well-being, but may affect astronomic areas.⁴⁵¹ In South Africa the Karoo is

⁴⁴³ Redelinghuys "Effects on the Communities" 345-365. The level of impacts depend on local social and ecological conditions. EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218; Todd *et al* "Potential Impacts of Fracking" 282-283; McBroom *The Effects of Hydraulic Fracturing on the Environment* xix; London and Willems "Hydraulic Fracturing in Shale Gas Extraction" 323-344; Speigh *Deep Shale Oil and Gas* 410-422; Walton and Woocay 2013 *Journal of Green Building* 70.

⁴⁴⁴ Hepburn *Mining and Energy Law* 184; Speigh *Deep Shale Oil and Gas* 410-422; Obeng-Darko and Crossley 2018 *OGE* 2-3; Glowacki and Henkel 2014 *Indiana International and Comparative Law Journal* 7-12.

⁴⁴⁵ Feris "Making Legal Sense of a 'Sense of Place' in the Karoo" 395-408; Redelinghuys "Effect on Communities" 345-365.

⁴⁴⁶ May and Dernbach "Introduction" 5; Hepburn "Mining and Energy Law" 177; Esterhuysen *et al* 2016 *Journal of Environmental Management* 420; Sovacool and Vivoda 2013 *OGE* 8. Risk from accidents during routine operations in typical shale gas development environments include: truck/transport, casing failure, cement failure, surface blowout, underground blowout, surface valve failure, hose burst, impoundment failure, storage tank spill, pipeline rupture, underground well communication, accidents resulting in spill, and accidents resulting in fire or explosion. See Krupnik, Gordon, and Olmstead "Environmental Risks of Shale Gas Development" (RFF Report 2013) 4. EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

⁴⁴⁷ Scholes and Schreiner *The Conversation* (13 July 2017). Weideman "Hydraulic fracturing in the Karoo" 16-17.

⁴⁴⁸ Scholes and Schreiner *The Conversation* (13 July 2017); Weideman "Hydraulic fracturing in the Karoo" 16-17.

⁴⁴⁹ Sovacool and Vivoda 2013 *OGE* 27.

⁴⁵⁰ Sovacool and Vivoda 2013 *OGE* 27.

⁴⁵¹ Department of Mineral Resources "Investigation of Hydraulic Fracturing in The Karoo Basin of South Africa" 5, 7 and 9. Also see the *Astronomy Geographic Advantage Act* 21 of 2007 and some of its regulations: Declaration of astronomy advantage and core advantage areas, GN 115 in GG 32951 of 19 February 2010; GN 723 in GG 33462 of 20 August 2010; declaration of the Sutherland Central Astronomy Advantage Area – General Notice 199 in GG 37434 of 12 March 2014; Regulations on the Protection of the Karoo Central Astronomy Advantage Areas –

known as one of the best locations for astronomy.⁴⁵² This may negatively affect tourism.

The boomtown effect that goes with rapid industrialisation will likely place additional stress on municipal and community services such as policing, health, and emergency services.⁴⁵³ The rapid population increase due to workers moving into the area will result in an increase in housing rental prices.⁴⁵⁴ This will have an impact on local inhabitants who with their smaller incomes, will struggle to compete.⁴⁵⁵ In this sense rapid industrialisation could either force local owners to sell their properties (below the market value before planned industrialisation) or lead to a decrease in property value (location of properties in relation to industrial and shale gas development activities). New production and industrial activities, such as those associated with UGD, are intrusive and change the qualities associated with quiet rural towns and areas.⁴⁵⁶ Community disruption and heightened stress levels negatively impact on quality of life.⁴⁵⁷

Seismicity (earthquakes) can cause considerable harm to socio-ecological systems. This includes, among others, loss of human and animal life (live-stock, domesticated animals and wildlife), field crops, soil fertility, stored seeds, agriculture equipment, and their supply systems (in the form of infrastructure).⁴⁵⁸ Consequently this could trigger human and nature induced landslides, land degradation, flooding, drying- up of water resources and disease epidemics.⁴⁵⁹ The nature of crops and live-stock within agriculture is such that the impact from an earthquake will likely not be limited to the

GN 1411 in GG 41321 of 15 December 2017; Declaration to Prohibit Certain Mining Activities within the Sutherland Central Astronomy Advantage Area - GN 806 in GG 42492 of 29 May 2019. GN 806 specifically mentions hydraulic fracturing.

⁴⁵² See the South African Astronomical Observatory <https://www.sao.ac.za/>; Glazewski and Esterhuyse "Introduction" 5.

⁴⁵³ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 219.

⁴⁵⁴ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 24.

⁴⁵⁵ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 24.

⁴⁵⁶ SIWI Report 2014 "Shale Gas and Hydraulic Fracturing" 30.

⁴⁵⁷ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

⁴⁵⁸ Kijko *et al* "Hydraulic Fracturing, Wastewater Pumping and Seismicity" 264-277; Chapagain and Raizada 2017 *Agri & Food Security* 1; FAO 2015 <https://bit.ly/3WlqdKP>; EPA 2022 <https://bit.ly/3Ui6Ssg>.

⁴⁵⁹ Kijko *et al* "Hydraulic Fracturing, Wastewater Pumping and Seismicity" 264-277; EPA 2022 <https://bit.ly/3Ui6Ssg>; Gauchan *et al* 2017 <https://bit.ly/3DOUiuW>.

immediate growing season but also negatively impact upon future growing seasons.⁴⁶⁰ In rural areas, such as the Karoo in South Africa, farmers and residents strongly rely on natural resources.⁴⁶¹ They do not necessarily have alternative sources of income or employment and are therefore particularly vulnerable to negative impacts resulting from earthquakes.⁴⁶² Earthquake impacts from UGD could therefore be severe for food security both generally (within a national and regional context) and within a local context, such as the agriculture sector in the Karoo area.⁴⁶³

Many of the named socio-ecological impacts associated with UGD are expected to be long-term.⁴⁶⁴ Changes to land and land use remain until the end of the life of the well (between 20-40 years). Uncertainty remains regarding the degree of successful land reclamation after the end-of-well life.

2.4.5 Agriculture (food security)

UGD impacts on and creates specific challenges for existing land use, such as agriculture.⁴⁶⁵ These challenges are particularly pertinent to water resources (water use and water pollution)⁴⁶⁶ and climate change impacts (the release of methane).⁴⁶⁷ The withdrawal of large amounts of groundwater may lead to the depletion of aquifers, and hydraulic fracturing fluids, known as flow-back water, which may pose risks to water quality.⁴⁶⁸ Water that is meant for agriculture can be reallocated for UGD and its associated activities.⁴⁶⁹ This will likely have an impact on food production and can

⁴⁶⁰ Chapagain and Raizada 2017 *Agri & Food Security* 1; EPA 2022 <https://bit.ly/3Ui6Ssg>.

⁴⁶¹ Redelinghuys "Effects on Communities" 356-357; ASSAf "Science Action Plan" 4.

⁴⁶² Chapagain and Raizada 2017 *Agri & Food Security* 2.

⁴⁶³ Kijko *et al* "Hydraulic fracturing and seismicity" 276-277.

⁴⁶⁴ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

⁴⁶⁵ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218; Esterhuysen *et al* 2016 *Journal of Environmental Management* 420.

⁴⁶⁶ UNEP, in its Global Alert report warned that development of unconventional gas carries many uncertainties, one being the depletion and pollution of water resources (UNEP Global Environmental Alert Service 2012). Concern for water resources due to the envisaged impact of unconventional gas extraction has been raised by both the UN's Special Rapporteur on the human right to safe drinking water and sanitation and by the UN Special Rapporteur on the human rights obligations related to environmentally sound management and disposal of hazardous substances and waste (Report of the Special Rapporteur 2012).

⁴⁶⁷ Reins 2011 *Review of the European Community and International Environmental Law* 300. Other challenges or impacts relate to air pollution, competing land use and food security.

⁴⁶⁸ Freyman 2014 "Hydraulic Fracturing & Water Stress" 1-85.

⁴⁶⁹ Esterhuysen *et al* 2016 *Journal of Environmental Management* 420.

negatively affect food security at different levels (local, regional and national).⁴⁷⁰ UGD negatively impacts on agriculture and farming in general.⁴⁷¹ Reasons include changes in land use associated with UGD, and the effect of pollution on crops and livestock.⁴⁷² Issues of water security relating to water quality, quantity and availability are therefore at stake – it is of particular concern in areas or regions already subject to water stress, such as the Karoo.⁴⁷³ The water-scarce, borehole-dependent farms of the Karoo would be heavily affected if contamination of their groundwater were to occur.⁴⁷⁴ Furthermore, UGD has a substantial greenhouse gas footprint.⁴⁷⁵ This is due to methane gas that escapes from the well (during and after drilling and hydraulic fracturing activities).⁴⁷⁶ This in turn creates even more pressure on water resources (climate change) that are needed for agriculture.⁴⁷⁷

Sulphur dioxide (SO₂) and nitrogen oxides (NO_x) react with water, oxygen and other chemicals to form sulphuric and nitric acids.⁴⁷⁸ Most sulphur dioxide and nitrogen oxides originate from the burning of fossil fuels, from vehicles and heavy equipment, manufacturing, etc.⁴⁷⁹ There are two forms of acid deposition. Wet deposition takes place when the sulphuric and nitric acids formed in the atmosphere mix with rain, snow, fog or hail. Hence generally known as acid rain.⁴⁸⁰ Dry deposition refers to acidic particles of gases that deposit on surfaces such as water bodies, vegetation, buildings, vehicles, equipment, etc.⁴⁸¹ These accumulated acids are washed off those surfaces by the next rain and move through the ground and can harm plants, wildlife and

⁴⁷⁰ Esterhuysen *et al* 2016 *Journal of Environmental Management* 420.

⁴⁷¹ Redelinghuys "Effects on Communities" 357.

⁴⁷² Redelinghuys "Effects on Communities" 357.

⁴⁷³ Martin and Fisher 2012 "The Energy-Water Nexus" 1-33 <http://groundwork.org.za/archives/2013/ClimateHealthRoundtables/water-energy-nexus.pdf>; Williams and Pittock 2012 "Unconventional Gas Production" 1-53.

⁴⁷⁴ Weideman "Hydraulic fracturing in the Karoo" 16-17.

⁴⁷⁵ Howarth, Santoro and Ingraffea 2011 *Climatic Change* 679-690.

⁴⁷⁶ Howarth, Santoro and Ingraffea 2011 *Climatic Change* 679-690.

⁴⁷⁷ Water for livestock and the irrigation of crops. Howarth, Santoro and Ingraffea 2011 *Climatic Change* 679-690.

⁴⁷⁸ EPA 2022 <https://bit.ly/3WoIfMk>; Nunez 2019 <https://on.natgeo.com/3sQW0ps>.

⁴⁷⁹ EPA 2022 <https://bit.ly/3WoIfMk>; Nunez 2019 <https://on.natgeo.com/3sQW0ps>.

⁴⁸⁰ EPA 2022 <https://bit.ly/3WoIfMk>.

⁴⁸¹ Nunez 2019 <https://on.natgeo.com/3sQW0ps>; EPA 2022 <https://bit.ly/3WoIfMk>.

livestock.⁴⁸² Acid deposition therefore has a negative impact on agriculture and by association, on food systems too.⁴⁸³

The combined and linked effects of water use, water pollution and climate change (methane escaping into atmosphere and dust pollution) within UGD, are therefore likely to have major implications for agriculture and food security.⁴⁸⁴ They are over and above the socio-ecological impacts mentioned above.

2.4.6 Energy

It was indicated earlier in this chapter that the development of UGD comprises a number of integrated activities set within a number of integrated phases.⁴⁸⁵ While some of these activities, such as drilling, tend to be driven by a number of diesel generators, other activities, such as the sourcing of water (pumping) and treatment of wastewater may well require additional energy use in the form of electricity. Local municipalities may well find themselves in the position of having to treat wastewater from fracking operations. Local municipalities may well agree to these additional services based on the promise of financial compensation from fracking companies.⁴⁸⁶ Within the current context of energy insecurity in the country (load shedding) these activities will put additional pressure on the access to energy of the local municipalities and communities. This may very well lead to competition between the different users. Local communities (in the form of its residents, local businesses, farmers, etc.) will likely be competing with "fracking" companies for access to energy. While the scenario described above may play out differently in that fracking companies may (at least theoretically) be able to source/generate their own electricity, it remains an energy insecurity reality.

⁴⁸² EPA 2022 <https://bit.ly/3WoIfMk>.

⁴⁸³ Nunez 2019 <https://on.natgeo.com/3sQW0ps>; EPA 2022 <https://bit.ly/3WoIfMk>.

⁴⁸⁴ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 218.

⁴⁸⁵ See chapter 2.3.4.

⁴⁸⁶ Particularly in geographical areas, where poverty is rife and where local municipalities' revenue is minimal. Political pressure may also play a role in that certain powerful actors supporting the development of unconventional gas in the Karoo area.

2.4.7 Regulatory issues due to lack of environmental base-line data

From a regulatory point of view the importance of verified scientific data on social-ecological impacts from UGD is a given. It is important to know when and where possible impacts (groundwater and surface water extraction and pollution and air pollution) from UGD will occur, to what extent, and the duration of the contamination.⁴⁸⁷ Current data-sets on groundwater and surface water resources across regions and local areas tend to be lacking in this regard.⁴⁸⁸ Reliable data is also limited on water flows and abstraction (from rivers and aquifers) between the different water users and stakeholders.⁴⁸⁹ This makes it difficult for regulators to get to and set a limit on water abstraction between stakeholders.⁴⁹⁰ UGD contaminants (methane gas and hydraulic fracturing chemicals) are found within groundwater and therefore the absorption capacities of the specific groundwater zone needs to be understood.⁴⁹¹ This may vary depending on the hydrological environment and therefore it needs to be studied over certain time-periods and distances.⁴⁹² Because ecological impacts are gradual, it is difficult to predict impacts on groundwater quality using current scientific and engineering analysis.⁴⁹³ The lack of baseline hydro-geological and hydro-chemical data on groundwater systems results in a lack of understanding on the behaviour of chemical additives (in fracturing groundwater) and their interactions with local fluids and geological formations.⁴⁹⁴

The issue of methane leaks from poor cement-casing in drilling wells is another example of scientific uncertainty due to a lack of baseline data. A lack of information on the nature and rate of cement deterioration leads to a lack of understanding of potential environmental impacts on water and air quality.⁴⁹⁵ Methods for detection and

⁴⁸⁷ Stroebel, Thiart and De Wit "Towards defining a baseline status" 129-130; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96; Todd *et al* "Potential Impacts of Fracking on Biodiversity" 279, 286.

⁴⁸⁸ Ahamed *et al* 2019 *Case Studies in Environment 2*; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁴⁸⁹ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁴⁹⁰ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁴⁹¹ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁴⁹² EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁴⁹³ Hepburn *Mining and Energy Law* 185. EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvi. EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁴⁹⁴ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁴⁹⁵ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvii.

measuring methane leaks from wells consist of surface casing vent-flows and noise logs and are not sophisticated enough to provide consistent and reliable data on leakage pathways and rates.⁴⁹⁶ In addition, information is lacking on potential hazardous chemicals that are produced down the well due to chemical interactions under pressure and high temperature.⁴⁹⁷ This relates to information on each chemical on its own, and as a combination, of concentration, mobility, resolution in ground and surface water, and bio-accumulation properties.⁴⁹⁸

The lack of environmental baseline data (and where data is available - the validation thereof) on, for example, water quality and quantity, habitat, ecosystems, air quality and methane leaks, - hinders the identification and categorisation of environmental impacts that may be associated with UGD.⁴⁹⁹ In other words, a lot of scientific gaps exist on the environmental impacts of UGD.⁵⁰⁰ This in turn leads to a lack of understanding of the many interlinked socio-ecological impacts of UGD.⁵⁰¹ The lack of scientific data and understanding thereof makes it difficult to assess the extent of the risk that UGD poses to socio-ecological aspects.⁵⁰² More critically, the lack of ecological/environmental baseline data on UGD erodes the understanding of the many interlinked impacts between specific socio-ecological aspects (for example water and air quality, linked to human health). Potential socio-ecological risks to UGD are not understood well.⁵⁰³ A comprehensive understanding of possible interlinked socio-ecological impacts associated with UGD, may take decades.⁵⁰⁴

The study by Todd *et al* on the potential ecological impacts from UGD in the Karoo specifically, indicates that while research on this topic is increasing, not merely enough

⁴⁹⁶ Saul and Malik May 2022 Bloomberg <https://bit.ly/3CumPoJ>; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvii.

⁴⁹⁷ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvii.

⁴⁹⁸ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvii.

⁴⁹⁹ Stroebel, Thiart and De Wit "Towards defining a baseline status" 129; EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvi.

⁵⁰⁰ On geological and environmental conditions in areas where shale gas exists see EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvi.

⁵⁰¹ EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvii.

⁵⁰² EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" 96.

⁵⁰³ Rasch and Köhne 2016 *Energy Research & Social Science* 115; Krupnik, Gordon, and Olmstead "Environmental Risks of Shale Gas Development" (RFF Report 2013) 52.

⁵⁰⁴ Hepburn *Mining and Energy Law* 185. EPHST Report 2014 "Environmental Impacts of Shale Gas Extraction" xvi.

studies exist to get a good understanding of actual impacts generally and more specifically over those on temporal and spatial scales.⁵⁰⁵ Most studies on potential impacts of UGD on ecological systems are based on modelling of better-studied similar industries such as conventional oil and gas development projects.⁵⁰⁶ In short, research is still playing catch-up to the rapid growth of the UGD industry, including the many potential socio-ecological impacts stemming from it. This implies that current governance approaches to manage potential impacts of UGD will likely not be effective to the goal of sustainability.

2.5 Conclusion

This chapter set out to identify regulatory challenges that emanate from UGD, generally and locally in South Africa. The specific aim was to identify and describe possible regulatory challenges to water, energy and food resource systems. In order to attain this aim the chapter started by stating the rationale for UGD (in the form of drivers and benefits), generally, and in the South African context. In order to get an understanding of the unique features of UGD, a particular effort was made to describe the historic development of exploitation techniques to get to a contemporary understanding of "fracking" namely the combination of multi-directional drilling and hydraulic fracturing. The chapter then focused on identifying and linking impacts from UGD to social and ecological systems. What follows are some notable findings.

The extraction and production processes of UGD (particularly that of horizontal drilling combined with hydraulic fracturing) are unique, complex, context-specific and different from conventional extraction methods. While hydraulic fracturing is certainly one of the main activities (due to its many associated impacts on other critical social and ecological aspects), it is not the only activity of significance. A further finding is that the use of multi-directional drilling in combination with hydraulic fracturing is a rather more recent exploitation technique. This debunks the perception that impacts from "fracking" on social and ecological systems are well-understood. In short, science is still playing catch-up with this new technology and its associated impacts on social

⁵⁰⁵ Todd *et al*/"Potential Impacts of Fracking" 286.

⁵⁰⁶ Todd *et al*/"Potential Impacts of Fracking" 286.

and ecological systems. Further, the idea that "fracking" is and should be viewed as a single activity has been shown to be problematic. A case was presented that stresses the interlinked nature of UGD in that it consists of a range of integrated activities within integrated phases (UGD consists of numerous mechanical and chemical activities and processes).

The technique of hydraulic fracturing within UGD impacted the energy transition paradigm because it led to increased competition in the fossil fuel market and lower coal prices. Increased investment in unconventional natural gas development inevitably leads to more exploration and production and in this way it delays the sustainability transition to renewables. In this sense the role of UGD is problematic because it has the potential to further a lock-in with fossil fuels and crowd-out renewables.

UGD is a fairly new technological development and there is a general lack of environmental baseline data which in turn makes it difficult to get a comprehensive understanding of possible socio-ecological impacts, both within specific geographical contexts, over time (temporal) and the severity of these impacts. These two aspects (it being a new technology and the lack of environmental data) were further explored to stress that numerous social and ecological impacts are either not well understood or not accounted for within UGD.

It was found that the impacts from UGD straddle and are interlinked with water, food and energy resource systems. A complex interlinked system creates feedback loops in that water impacts from UGD, also has impacts for agriculture (food) and even energy. Numerous socio-ecological impacts emanate from UGD and these can occur at any of the multiple points of the development process. This creates an integrated system where impacts from UGD cut across social and ecological systems at different levels. These impacts include amongst others, the impact on ground and surface water (water extraction and pollution due to possible spills below and above the surface), competing land and energy use (other users such as agriculture), air and noise pollution, health-related impacts and climate change (possible methane emission due to leakage, flaring and venting, and also dust due to mechanical and transport operations).

The socio-ecological impacts emanating from UGD are interconnected and interdependent particularly within and between water, energy and food systems. This integrated nature of the socio-ecological impacts emanating from UGD, particularly in so far as these impacts straddle water, energy and food resources, poses new challenges to regulatory and decision-making frameworks. There is, therefore, a need for a regulatory and decision-making approach that acknowledges the integrated nature of water, energy and food resource systems within UGD, generally, and in South Africa specifically.

Of particular relevance is the issue of how regulatory and decision-making frameworks will be able to implement a more integrated or holistic approach in managing the various interlinkages that exist between water, energy and food resource systems. In this vein, an integrative approach that acknowledges that water, energy and food resource systems are intricately linked, is needed. Following from previous integrative management approaches in natural resource management, (such as IWRM), the WEF nexus approach is the latest such attempt. The WEF nexus approach, due to its specific integrative characteristics, may be a solution to address the regulatory challenges posed by UGD. In the following chapter the WEF nexus approach as a specific form of an integrative approach, is discussed.

CHAPTER 3: THEORETICAL FOUNDATIONS, HISTORY, RATIONALE AND DEVELOPMENT OF A NEXUS APPROACH TO REGULATING WATER, ENERGY AND FOOD

3.1 Introduction

The previous chapter showed that UGD consists of a number of industrial and chemical activities that include, amongst others, a combination of multi-directional drilling combined with hydraulic fracturing.⁵⁰⁷ The development process is complex and linked to numerous socio-ecological impacts that are interconnected and interdependent within water- energy- and food resource systems.⁵⁰⁸ The nature and extent of regulatory challenges posed by UGD are unique (a fairly novel development process which differs substantially from conventional mining operations), and complex (in the sense of the non-linear nature of social and ecological impacts across spatial and temporal scales with a fair degree of uncertainty due to a lack of environmental baseline data).

This creates a number of unique governance challenges for regulatory and decision-making frameworks, specifically on sustainability aspects.⁵⁰⁹ Regulatory and decision-making frameworks that do not take account of the interlinked impacts between the water, energy and food resource systems will likely have negative consequences for sustainability in these resource sectors.⁵¹⁰ A governance action or a governance gap that has a negative impact on the environment (such as pollution, over extraction of water resources etcetera) could lead to worse environmental quality which may be unsustainable in a socio-ecological sense. Unsustainable outcomes in turn lead to resource insecurity. Regulatory and decision-making frameworks need to know how best to integrate separate sector-specific systems to achieve more sustainable outcomes for water, energy and food security.⁵¹¹ A possible solution for the regulatory and decision-making challenges stemming from UGD, is the use of the WEF nexus

⁵⁰⁷ See Chapter 2.3.

⁵⁰⁸ See Chapters 2.4 and 2.5.

⁵⁰⁹ On general sustainability and environmental governance in South Africa, see Soyapi 2023 *Potchefstroom Electronic Law Journal* 1-28.

⁵¹⁰ Peel "Regulation of the nexus" 198.

⁵¹¹ Holley and Kennedy 2019 *Jurimetrics* 9.

approach. As stated before, the WEF nexus approach is a relatively novel approach to integrated resource management. While integrated resource management is not new (for example IWRM), the novelty of a WEF nexus approach lies in its approach to view the different sectors (water, energy and food) as being multi-centric. It therefore departs from previous integrated natural resource approaches such as IWRM that continues to follow a sector centric approach (e.g. water centric in the case of IWRM). Due to its integrative nature, the WEF nexus approach could be a valuable tool within regulatory and decision-making frameworks to govern socio ecological impacts from UGD that are interlinked and interconnected across water, energy and food resource systems.

The aim of this chapter is to identify and describe the main elements that are indicative of the WEF nexus approach. In order to attain this aim, it is necessary to discuss the following:

- The international roots of the WEF nexus, also in relation to the Sustainable Development Goals (SDGs);
- The drivers of the nexus approach to water, energy and food resource systems to provide a description of the rationale and development of the nexus approach;
- The value of following a nexus approach to water, energy and food resource systems with specific reference to examples of water, energy and food security issues in South Africa;
- Defining the WEF nexus and WEF nexus governance using a socio-ecological systems approach; and
- Distilling the main governance elements of the WEF nexus.

This chapter starts by briefly referring to the existence of an international legal basis for "integration" on water, energy and food, also exploring the links between the nexus and sustainable development, and the SDGs in particular. This is followed by a discussion of the drivers and general development of the nexus approach that includes reference to (i) its origin and roots from other integrated resource management approaches, such as IWRM, (ii) an explanation of the components and/ or nodes that

make up the nexus approach and (iii) securitisation aspects embedded within the green and circular economy. Following the discussion on securitisation, this chapter then turns to examining the water, energy and food security issues in South Africa. This discussion continues to provide examples of interlinkages between water, energy and food resource systems in South Africa, particularly regarding the issue of how insecurity in the energy sector has a number of impacts on water and food security.

This is followed by defining governance of the WEF nexus. This includes aspects of anthropocentrism as well as social and ecological systems. The chapter then defines the nexus and the WEF nexus specifically, concluding with identifying elements that are indicative of a WEF nexus approach within a governance framework. Critical elements of the WEF governance are identified that will be used in Chapter 4 to test the level of integration between the water, energy and food resource systems within the South African regulatory framework applicable to UGD.

3.2 *An international legal basis for integration of WEF Nexus*

Article 31(3)(c) of the Vienna Convention on the Law of Treaties of 1969⁵¹² confirms the importance of interpreting and applying international law instruments in mutually supportive ways. Several international obligations on the access to water, energy and food are reflected in treaties such as the United Nations Framework Convention on Climate Change⁵¹³ (UNFCCC, 1992), International Covenant on Civil and Political Rights⁵¹⁴ (ICCPR, 1966), and the International Covenant on Economic, Social and Cultural Rights, 1966.⁵¹⁵ Non-binding declarations and action plans include the

⁵¹² Adopted at Vienna on 23 May 1969. It entered into force on 27 January 1980. United Nations, Treaty Series vol. 1155 331. See also Olawuyi 2020 *Environmental Science and Policy* 3. South Africa is not signature to the Convention. The Convention may however be binding on South Africa, see Burt "The Vienna Convention on the Law of Treaties and the OECD Commentaries".

⁵¹³ Adopted in New York on May 1992 and entered into force on 21 March 1994 - FCCC/INFORMAL/84 GE.05-62220 (E) 200705. South Africa signed the UNFCCC on 22 April 2016 and ratified it on 1 November 2016. It ratified the Kyoto Protocol on 31 July 2002.

⁵¹⁴ Adopted on 16 December 1966 – entered into force on 23 March 1976 - General Assembly resolution 2200A (XXI). South Africa signed the Covenant on 3 October 1994 and ratified it on 10 December 1998.

⁵¹⁵ General Assembly resolution 2200A (XXI) of 16 December 1966, entered into force on 3 January 1976. South Africa ratified the Covenant on 12 January 2015.

Sustainable Development Goals (SDGs),⁵¹⁶ and the Universal Declaration of Human Rights (UDHR, 1948).⁵¹⁷ This discussion will focus on the concept of sustainable development and then specifically on the SDGs.

The concept of sustainable development is "well-established in international, regional, and national law and policy".⁵¹⁸ The Brundtland Report,⁵¹⁹ describes sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Formulated as a universal agreed moral principle, sustainable development is a broad concept that includes multiple interpretations and possibilities, and therefore, agreement on the precise meaning thereof, is still debated.⁵²⁰ Two main concepts of sustainable development include: the concept of "needs", specifically the needs of the poor; and the concept of limitations, particularly the ability of the environment to meet present and future needs (e.g. for resources, socio-ecological services).⁵²¹ While the concept of a "whole system view" has been associated with sustainable development from early on, it has proven difficult to implement and attain sustainable outcomes.⁵²² Hussey, Pittock and Dovers⁵²³ make the argument that there simply is not enough human capacity to compute the many variables and imperatives within a "whole system" approach that straddles the economic, social and environmental domains. In

⁵¹⁶ Resolution adopted by the General Assembly on 25 September 2015 - A/70/L.1. 2030. South Africa adopted the Agenda for Sustainable Development at the Sustainable Development Summit. It was signed by 192 countries.

⁵¹⁷ Adopted 10 December 1948. South Africa did not sign the Declaration but subsequently adopted the *Constitution of the Republic of South Africa*, 1997 that embodies the rights of the Declaration.

⁵¹⁸ Coetzee *Sustainability-Environmental Risks and Legal Liabilities* 5.

⁵¹⁹ The Brundtland Report: Our Common Future by the World Commission on Environment and Development, 1987.

⁵²⁰ Whitehead "Sustainable Development" 113; Das Gupta "WEF Nexus and Sustainable Development" 224; Kotzé "Environmental Governance" 103-104.

⁵²¹ Das Gupta "Water-Energy-food Nexus and Sustainable Development" 224.

⁵²² Hussey, Pittock and Dovers "Applying Nexus Thinking in the Quest for Sustainable Development" 3; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 2.

⁵²³ Hussey, Pittock and Dovers "Applying Nexus Thinking in the Quest for Sustainable Development" 3.

addition, Pahl-Wostl⁵²⁴ states that sustainable development cannot be achieved from following a single silo sector approach.⁵²⁵

These arguments are levelled at many an example of poor sustainable outcomes, both at the individual development project level and at institutional level.⁵²⁶ For example, the Millennium Development Goals (MDGs)⁵²⁷ is criticised for not considering the possible interactions that exist between sectors (such as energy, water and food) and how action in one sector can have an impact (externalities) in another sector and vice versa.⁵²⁸ While the MDGs focused mainly on the promotion of development and the easing of poverty by identifying sectoral goals, the new development agenda in the form of the SDGs follows a more integrated approach.⁵²⁹ The SDGs acknowledge a number of interlinkages between natural resource sectors by linking 17 goals with most of the 169 targets.⁵³⁰ While the SDGs as a system links goals with targets, there

⁵²⁴ Pahl-Wostl 2019 *Environmental Science & Policy* 360.

⁵²⁵ Schneider, Avellan and Le Hung "Water-Energy-Food Nexus and Sustainability" 7. Ultimately, the management of impacts and interconnections between natural resource sectors (such as water, energy and food) should be set within the wider goal of sustainable development. Sustainability in the areas of water, energy and food was originally based on an equilibrium thinking between these aspects as summarised by the idea of balancing. (See in this regard, *Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture Conservation and Environment, Mpumalanga Province* 2007 (6) SA 4(CC), Bosselmann *The Principle of Sustainability: Transforming Law and Governance*; Du Plessis and Du Plessis "Striking the sustainability balance in South Africa" 413-458). More recent understandings of ecological systems have "shifted from seeing nature in balance with other considerations, to recognising that ecological systems are dynamic, non-equilibrium with nonlinear responses and multiple stable states".

⁵²⁶ Das Gupta "WEF Nexus and Sustainable Development" 224; Hussey, Pittock and Dovers "Applying Nexus Thinking in the Quest for Sustainable Development" 3.

⁵²⁷ "In September 2000, building upon a decade of major United Nations conferences and summits, world leaders came together at United Nations Headquarters in New York to adopt the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets - with a deadline of 2015 - that have become known as the Millennium Development Goals." United Nations <https://www.un.org/millenniumgoals/bkgd.shtml>.

⁵²⁸ Das Gupta "WEF Nexus and Sustainable Development" 226. The MDGs lack of integration across resource sectors shows to an inadequate understanding and accounting of trade-offs and synergies across resource sectors (so much for proper reflection of complexity between natural resource sectors). For example, environmental protection (relating to MDG7) has not been achieved under the MDGs and in many cases have been negatively impacted by the setting of other sectoral goals. See Le Blanc "Towards Integration at Last?" 140.

⁵²⁹ Das Gupta "WEF Nexus and Sustainable Development" 226. Also see French and Kotzé (eds) *Sustainable Development Goals: Law, Theory and Implementation*; Ebbesson and Hey (eds) *The Cambridge Handbook of the Sustainable Development Goals and International Law*.

⁵³⁰ Le Blanc "Towards Integration at Last? 177-178. Targets within the SDGs have been set for a number of sectors that are linked namely: SDG 2 (zero hunger); SDG 6 (clean water and sanitation); SDG 7 (affordable and clean energy); SDG 12 (more sustainable production and consumption patterns); SDG 13 (tackle climate change); SDG 13 (ensuring a balance in

are various degrees of linkages, varying from weak to strong.⁵³¹ In this sense the SDGs are arguably not a deliberate attempt at embracing the nexus approach, but it is rather implied.⁵³²

The setting of the SDGs and its linked targets and outcomes indicate a departure from the hierarchical-specialised silo sectoral mentality followed with the MDGs.⁵³³ SDG 6 determines that states should "[e]nsure availability and sustainable management of water",⁵³⁴ while SDG 7 indicates that states should "ensure access to affordable, reliable, sustainable and modern energy for all".⁵³⁵ SDG 2 strives to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture".⁵³⁶ None of the SDGs, however, should be read in isolation. Other SDGs may also impact on the water, energy and food, for example, SDG 1 that strives to end poverty in all its forms,⁵³⁷ which could include energy, water and food poverty⁵³⁸ and SDG 3 that deals with the promotion of health and well-being.⁵³⁹ The targets link the SDGs. For example, Target 2.1 strives to end hunger and ensures that everyone has access to "safe, nutritious and sufficient food all year round" and Target 2.4 states that "[b]y

ecosystems on land); and SDG 15 (ensuring a balance in ecosystems in water). Salam *et al* "The Need for the Nexus Approach" 4.

⁵³¹ Weitz et al "Approaching Interaction in the SDGs" 2-5, 7; Le Blanc "Towards Integration at Last? 184.

⁵³² Van Zanten and Van Tulder 2021 *IJSDWE* 222; Le Blanc "Towards Integration at Last? 184-186; Liu *et al* 2018 *Nature Sustainability* 471-472.

⁵³³ Das Gupta "WEF Nexus and Sustainable Development" 232-233; The SDG Report 2022 at 3. The underlying rationale being that action to meet one target could have unintended consequences on others if they are pursued separately. See Le Blanc "Towards Integration at Last? 140.

⁵³⁴ Also read Gupta and Bosch "SDG 6: Ensure Availability and Sustainable Management of Water and Sanitation for All" 163-184.

⁵³⁵ Also see Bruce and Viñuales "SDG 7: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All" 185-207.

⁵³⁶ Also see Gonzalez "SDG 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture" 72-89.

⁵³⁷ See e.g., Target 1.4 that deals with access to natural resources, land and new technology, Target 1.5 that stresses that people should be protected against "economic, social and environmental shocks and disasters". Target 1.a reiterates that poverty should be eradicated in all its forms and dimensions. Also read Tladi "SDG 1: End Poverty in All Its Forms Everywhere" 50-71.

⁵³⁸ See e.g., Feitelson and Chenoweth 2022 *Water Policy* 263-281; Sy and Mokaddem 2022 *Energy Research & Social Science* 102562; Caraher and Coveney *Food Poverty and Insecurity: International Food Inequalities*.

⁵³⁹ Target 3.1 refers to the elimination of waterborne diseases, while target 3.9 specifically states that "the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination" should be reduced".

2030, [states should] ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality". SDG 6's targets link back to poverty, water and energy.⁵⁴⁰

Despite the interlinkages and states' commitment to the SDGs there is still much to be done.⁵⁴¹ The *Sustainable Development Goals Report 2022* (hereafter the SDGs 2022 Report) indicates that multiple and intersecting crises such as climate change, COVID-19 and political conflicts (wars) are putting enormous strain and pressure on all of the Goals.⁵⁴² This is due to complex interactions that exist between natural resources systems and hence it results in numerous spin-off crises in water, energy and food (among others).⁵⁴³ The SDGs 2022 Report indicates that these cascading intersecting crises are putting the 2030 Agenda for Sustainable Development in "grave jeopardy".⁵⁴⁴ The lack of progress is supported by an article published in *Nature* that explored several publications on SDGs. Bierman *et al* indicate that the impact of the SDGs on governance (at global, national and local level), in general, is limited.⁵⁴⁵ The study confirms that main governance principles that underlie the SDGs, such as integration, universality and coherence, have not led to any significant adjustments in

⁵⁴⁰ Target 6.3: "By 2030, improve water quality by reducing pollution, ... and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater". Target 6.4 addresses water scarcity. Water scarcity is a major problem in the Karoo and introducing UGD will impact even more severely on water scarcity and food production. Target 6.6 deals with the restoration of wetlands and ecosystems, amongst others. Target 6.a implies the use of technology, which will have implications on energy use and the type of energy that has to be used.

⁵⁴¹ Bierman, Hickman, Sénit and Grob "The Sustainable Development Goals as a Transformative Force?" 220. United Nations "The Sustainable Development Goals Report 2022".

⁵⁴² The SDG Report 2022 at 3, 4, 6, and 39. Conflict, such as that between Ukraine and Russia has major energy security impacts. Also see para 2.2.5 in Chapter 2.

⁵⁴³ The SDG Report 2022 at 3. Other spin-off crises include health, education, peace and security. Le Blanc "SDGs and integration in the nexus" 51-55 argue that because the SDGs is primarily a political construction it is not geared to address all relevant links among the goals. The many links and the relevance of the links across location and scale also differ, hence targets linking the nexus of water, energy and food are rather weakly captured.

⁵⁴⁴ The SDG Report 2022 at 3.

⁵⁴⁵ Biermann *et al* 2022 *Nature Sustainability* 795-796. In this regard, Venghaus and Dieken point to inconsistency between comparative analysis of nexus indicators. See Venghaus and Dieken 2019 *Sustainable Production and Consumption* 342-355.

legislative and regulatory frameworks and policies.⁵⁴⁶ This is true at the global, national and local governance levels.⁵⁴⁷ There is little evidence of institutional change or realignment in the sense that new or adjusted cross-sectoral and integrated policies and programmes that cohere with one another, came to be/to exist.⁵⁴⁸

Sustainable development⁵⁴⁹ remains central to the current global development vision.⁵⁵⁰ The nexus is linked to "development" thinking which acknowledges that development has often failed to meet the needs of the current generation and at the same time meet the basic ecological/environmental issues of using those resources.⁵⁵¹ The nexus approach is restating the fundamental tenant of sustainable development, namely policy integration and co-ordination across sectors to attend to linkages and interdependencies.⁵⁵² The "nexus" approach arguably goes wider than sustainable development thinking as one can embrace the relationship between two, three or four sectors in a way that is impossible within the broader concept of sustainable development.⁵⁵³ For example, in striving to achieve collective goals, such as reducing

⁵⁴⁶ While the impacts from the SDGs are mainly to be found at a discursive level, it has fostered mutual learning among governments on some of the main governance principles such as integration and coherence. See Biermann *et al* 2022 *Nature Sustainability* 798.

⁵⁴⁷ Biermann *et al* 2022 *Nature Sustainability* 795-796.

⁵⁴⁸ The study indicates that two countries, namely, the Netherlands and Germany are leading other countries in aligning their institutions by way of establishing coordination bodies within central agencies and the promotion of inter-ministerial coordination. See Biermann *et al* 2022 *Nature Sustainability* 795-798.

⁵⁴⁹ Sustainable development consists of both an analytical and a normative (ethical) arrangement. The analytical arrangement provides a window or "framework in and through which we can study how the world operates. The normative arrangement of sustainable development suggests an outline for how the world should be". See Sachs *The Age of Sustainable Development* 3.

As a science of complex systems, SD aims to reflect sustainable yields and thresholds in the context of different forms of interaction between economic, social and environmental systems. Therefore, it is based on the principles of sustainable yield and thresholds. SD is also influenced by economic principles. SD demands integrated or whole system research and policy approach that may well extend beyond our capacities, including too many variables and imperatives. See Whitehead "Sustainable Development" 113 and Bernstein *The Compromise of Liberal Environmentalism*.

⁵⁵⁰ Kotzé and Adelman 2022 *Law and Critique* 1.

⁵⁵¹ Hussey, Pittock and Dovers "Justifying, extending and applying 'nexus' thinking in the quest for sustainable development" 3.

⁵⁵² The identification of interdependencies, linkages and trade-offs between sectors to lead to better-informed decision-making process.

⁵⁵³ Hussey, Pittock and Dovers "Justifying, extending and applying "nexus" thinking in the quest for sustainable development" 1-5.

global greenhouse gases (as agreed by countries via the Paris agreement⁵⁵⁴) there should be collaboration and coordination between parties (countries). In this manner, as is the case with many other SDGs, integration (and a systems-based approach⁵⁵⁵) is inherently part of international law. In this sense the principle of systemic integration and coherent interpretation of international law obligations provide a legal basis for harmonising and coordinating international law obligations on water, energy and food (climate change, and human rights obligations) and the introduction of a nexus approach.⁵⁵⁶ To understand the nexus approach its origins need to be explored.

3.3 Nexus: old roots

The assessment of interlinkages of resource systems is useful in understanding a world that strives towards more sustainable outcomes. Haas and Stevens⁵⁵⁷ indicate that an effort to couple the governance of environmental issues to the governance of casually-connected issues already started in 1972. Nexus terminology, with specific reference to interlinked natural resource-use practices, first appeared in the 1980s. For example, the 1983 United Nations University's (UNU) "Food-Energy Nexus Programme" focused on technical and policy solutions to food and energy challenges in developing countries.⁵⁵⁸ At least two international conferences flowing from the UNU's programme took place to further demonstrate the interlinkages between food, energy and ecosystems.⁵⁵⁹ In parallel to the UNU-led initiatives, there was increasing recognition in the USA of the inherent water aspect of the nexus between energy and

⁵⁵⁴ Adopted on 12 December 2015 and entered into force 4 November 2016. South Africa signed the Agreement 22 April 2016 and ratified it on 1 November 2016.

⁵⁵⁵ See Chapter 3.8.2 for a discussion on the system-based approach.

⁵⁵⁶ Olawuyi 2020 *Environmental Science and Policy* 3.

⁵⁵⁷ Haas and Stevens "Lessons from Food, Water, and Energy Policies" 138.

⁵⁵⁸ Scott, Kurian and Wescoat "The water-energy-food nexus" 17. Also see Sachs and Silk "Food and energy: Strategies for sustainable development" 83.

⁵⁵⁹ Specifically in western parts of the USA. These two conferences seemed to include deliberation on the wider environmental aspects of the importance of food and energy as elements of development. See Batliwala 1982 *Economic and Political Weekly* 329–333. One conference took place in Brasilia, Brazil in 1984. See Parikh 1986 *Energy Policy* 363–372 and another in New Delhi, India in 1986 (12–14 February). See Alam "Energy requirements of food production". The UNU was also involved in the developing and publishing of 'modelling approaches' to address the food-energy nexus. See Pimentel "Energy and agriculture: Their interacting futures".

agriculture.⁵⁶⁰ While the former was concerned with the nexus phenomenon within developing countries, the latter focused on the geographical area of the Western USA.⁵⁶¹

Integrative approaches to natural resource management are therefore not new. Ecological systems thinking moved from viewing nature as "in balance" to recognising it as being a dynamic process. This dynamic nature of ecological systems implies non-equilibrium, non-linear impacts⁵⁶² and the need to move to a dynamic approach that includes an adaptive, reflexive approach which accommodates and responds to change (uncertainty).⁵⁶³ IWRM is an example of an approach that recognised the need for understanding and managing mutual influences between resource systems.⁵⁶⁴ IWRM already challenged conventional, partial water development and management systems and called for an integrated approach with greater coordinated decision-making across resource sectors and scales.⁵⁶⁵ The IWRM approach indicated that a sector-based approach to water management would lead to negative economic, social and environmental impacts.⁵⁶⁶ The IWRM approach, however, remains a water-centric approach and therefore it does not recognise other natural resource systems such as energy and food as equal parts of the system.⁵⁶⁷ Previous integrative approaches to natural resources management such as IWRM, make up some of the roots of the latest

⁵⁶⁰ Scott, Kurian and Wescoat "The water-energy-food nexus 17. See for example (i) the identification of water and land constraints to the generation of electrical power Mckell *et al* "Paradoxes of western energy development" (ii) the general impact of energy and environmental needs on water management (Durant and Holmes 1985 *Public Administration Review* 821–831) and (iii) the energy and water overview as institutional elements of water and resource management in the Western United States (Gleick 1994 *Annual Review of Energy and the Environment* 267–299.

⁵⁶¹ Scott, Kurian and Wescoat "The water-energy-food nexus" 17.

⁵⁶² Allouche, Middleton and Gyawali "Water-Food-Energy Nexus" 34.

⁵⁶³ Allouche, Middleton and Gyawali "Water-Food-Energy Nexus" 35.

⁵⁶⁴ Schneider, Avellan and Le Hung "Water–Energy-Food Nexus and Sustainability" 2. See INRM – Lovell, Mandondo and Moriarty 2002 *Conservation Ecology* 25; Makamuri, Manjengwa and Anstey *Beyond Proprietorship: Murphree's Laws on Community-based Natural Resource Management in Southern Africa*; Fabricius *et al* *Rights Resources and Rural Development: Community-based Natural Resource Management in Southern Africa*; Campbell and Sayer *Integrated natural resource management: linking productivity, the environment, and development*; Fabricius C *et al* *Rights Resources and Rural Development: Community-based Natural Resource Management in Southern Africa*.

⁵⁶⁵ Schneider, Avellan and Le Hung "Water–Energy-Food Nexus and Sustainability" 3.

⁵⁶⁶ Schneider, Avellan and Le Hung "Water–Energy-Food Nexus and Sustainability" 3.

⁵⁶⁷ Seeliget *et al* 2018 *SAJS* 2; Schneider, Avellan and Le Hung "Water–Energy-Food Nexus and Sustainability" 3.

integrative approach, namely the nexus approach. A main claim of the nexus approach is that it considers multiple resource sectors equally important.⁵⁶⁸ In other words, it does not, for example, follow a water-centric approach. The nexus approach considers multiple sectors as being inter-linked and therefore equally important.⁵⁶⁹ The nexus approach relates to a systems theory in that it relies on contemplating the whole social and environment (ecological) system, including the numerous interactions between parts of the system.⁵⁷⁰ It follows a systems theory in recognising that any specific constituent part of the whole system should not be viewed in isolation from the rest of the system.⁵⁷¹

Different knowledge communities view the nexus differently and hence the number of components (also known as nexus nodes) differ in number and in name. The nexus literature confirms the use of many different order variations of nexus resource components.⁵⁷² Popular two set components (nodes), for example, include water and energy, water and food, etc. Other nexus approaches, include the water-energy-food (WEF), water-energy-land (WEL),⁵⁷³ and the land-energy-food-water-minerals nexus (LEFWM),⁵⁷⁴ (identified by Andrews-Speed *et al*⁵⁷⁵). While climate change is not strictly a "resource" like water, energy and food, some studies include it due to its capability to simultaneously impact and be impacted by water, energy and food (agriculture) resources. Climate change is directly part of the water node and arguably applicable and connected to all other nodes. Because the "nexus is used in different contexts to describe a set of interrelated activities and their linkages", it can theoretically include any number of resource components.⁵⁷⁶ This depends on a number of factors, among others, the identification of linkages that are perceived (real or not) as critical within

⁵⁶⁸ Stein, Barron and Moss "Governance of the Nexus" 7.

⁵⁶⁹ Stein, Barron and Moss "Governance of the Nexus" 7; Holley and Kennedy 2019 *Jurimetrics* 235. This is in contrast with for example the notion of IWRM where a water centric approach is followed. Stein, Barron and Moss "Governance of the Nexus" 7; Scott *et al* "The Water-Energy-Food Nexus" 15.

⁵⁷⁰ Von Braun and Mirzabev "Nexus scientific research" 58.

⁵⁷¹ Von Braun and Mirzabev "Nexus scientific research" 58.

⁵⁷² See Andrews-Speed *et al* "Understanding the Resource Nexus" 9; Pittock, Hussey and Dovers "Climate, Energy and Water" 1-337; Kurian and Ardakanian (eds) *Governing the Nexus* 1-60.

⁵⁷³ Brandi, Richerzhagen and Stepping "Post 2015" 2.

⁵⁷⁴ Andrews-Speed *et al* "Want, Waste or War" 4.

⁵⁷⁵ Andrews-Speed *et al* "Understanding the Resource Nexus" 9.

⁵⁷⁶ Pandey and Shrestha "Evolution of the Nexus" 13.

a certain context (whether geographical or otherwise).⁵⁷⁷ Because the nexus approach aims to be multi-centric, the placing and/ or naming of components applicable, should (at least in theory) not imply any sort of component superiority. However, it should be noted that any systems or holistic approach face the issue of the impact of human value systems such as its living and working environment. For example, energy analysts tend to refer to either energy-food-water (EFW) or climate-land-energy-water (CLEW), while water analysts use the water-energy-food (WEF) component make up.⁵⁷⁸ The nexus, due to its popularity as a research concept and because it can be linked to almost anything, is relating to numerous other links (such as, environment, ocean, etcetera). This study will focus on the water, energy and food nexus specifically.

The following paragraphs examine the further development of the nexus concept. It does this by examining general and specific drivers that shaped the more recent understandings of the nexus.

3.4 Drivers for the development of the WEF nexus approach

The ever-increasing demand for water, energy and food resources is driven by the needs of a growing population, an increase in mobility (people and goods), changing consumption trends (such as changing dietary needs, e.g. an increase in red meat consumption), cultural changes (cultural groups adopting Western life-styles and concomitant consumerism trends), economic growth (require more resources and increased consumerism), technological changes (for example, hydraulic fracturing techniques), environmental degradation (pollution), and climate change (global warming has numerous environmental impacts – less water availability impacts most aspects of social and ecological systems including agriculture).⁵⁷⁹

⁵⁷⁷ Pandey and Shrestha "Evolution of the Nexus" 13.

⁵⁷⁸ Pandey and Shrestha "Evolution of the Nexus" 13.

⁵⁷⁹ Salam *et al*/"The Need for the Nexus Approach" 4; Mabhaudhi *et al*/"Emerging Water-Energy-Food Nexus Lessons" 143; Das Gupta "WEF Nexus and Sustainable Development" 223; Von Braun and Mirzabaev "Nexus scientific research" 59-60; Schneider, Avellan and Le Hung "Water–Energy-Food Nexus and Sustainability" 2.

While knowledge of the increasing demand for water, energy and food resources is not new, the impacts of the 2008 financial crisis led to the realisation that water, energy and food resource sectors should be viewed from a more holistic or a systems approach.⁵⁸⁰ This change in view came about due to sharp increases in energy prices in 2008 resulting in increases in food prices because food production, manufacturing, distribution, amongst others, rely on high energy input, including that of water use.⁵⁸¹ The 2008 financial crisis confirmed a clear link between water, energy and food interactions and showed that single sectoral or compartmentalised approaches in managing these resources, were unsustainable.⁵⁸² Following this incident (the 2008 financial crises) the World Economic Forum indicated its concern about water, energy and food security and referred to the 2008 crisis as "the world in crises".⁵⁸³ The Forum cited the importance of interlinkages between water, energy and food systems.⁵⁸⁴ Notably, acknowledgement of the links between water, energy and food resources started to be described as a nexus (i.e. "a connection or series of connections linking two or more things").⁵⁸⁵

The concept of the nexus emerged under the influence of the World Economic Forum when business leaders in 2008 identified "nexus issues between economic growth and water, energy and food resource systems".⁵⁸⁶ Global multi-national companies and actors such as Coca-Cola Company, Barilla Group, PepsiCo, Standard Chartered Bank, SABMiller, Nestlé, New Holland Agriculture, the World Wildlife Fund for Nature, the World Economic Forum, the Global Green Growth Institute, and the Global Water Partnership came together under the 2030 Water Resources Group to discuss issues of economic growth linked to water security and political security challenges.⁵⁸⁷ This

⁵⁸⁰ The average price of energy for period 2000-2012 was 183 percent higher than the period during 1990-1999. The World Bank's global food price index showed an increase of 104 percent for the same period. (Dodds and Bertam "Water, Food, Energy and Climate Nexus" 22.

⁵⁸¹ Dodds and Bertam "Water, Food, Energy and Climate Nexus" 22; Grafton "Global risks and opportunities in food, energy, environment and water" 73-74.

⁵⁸² Pandey and Shrestha "Evolution of the Nexus" 12; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 4; Dodds and Bertam "Water, Food, Energy and Climate Nexus" 22.

⁵⁸³ Scott *et al* "The Water-Energy-Food Nexus" 15; Waughray *The water-food-energy-climate nexus* 1-16.

⁵⁸⁴ Scott *et al* "The Water-Energy-Food Nexus" 15; Waughray *Water Security: the water-food-energy-climate nexus* 1-16.

⁵⁸⁵ Pandey and Shrestha "Evolution of the Nexus" 12.

⁵⁸⁶ Brouwer "The water-energy-food nexus" 2.

⁵⁸⁷ Leese and Meisch 2015 *Water Alternatives* 696-697.

2030 Water Resources Group had a distinct business profile and it received funding from multi-lateral development banks such as the World Bank, the International Finance Corporation, and the Inter-American Development Bank.⁵⁸⁸ Funding was also received from official development agencies including the Swedish International Development Corporation Agency, the Swiss Agency for Development and Cooperation, and the United States Agency for International Development.⁵⁸⁹ The group published a report in 2009 with the title "Charting Our Water Future: Economic frameworks to inform decision-making".⁵⁹⁰ The report focused on water resource economics and called for stakeholder-involvement, including the private sector and to some extent, organised civil society.⁵⁹¹

This was followed by a report on water security in 2011 by the World Economic Forum titled "Water Security: the water-food-energy-climate nexus".⁵⁹² This report was influential in that it was taken up by many stakeholders, actors and agencies that straddled political and academic agendas.⁵⁹³ Flowing from this report other conferences such as the Bonn2011 Conference "The Water, Energy and Food-Security Nexus – Solutions for the Green Economy" followed.⁵⁹⁴ The Bonn2011 Conference made use of a background paper "Understanding the Nexus". This paper was developed and coordinated by the Stockholm Environment Institute and further contributions were made by the Food and Agriculture Organisation of the United Nations, the Stockholm International Water Institute, the Energy and Resources Institute, the World Business Council for Sustainable Development and the World Wildlife Fund for Nature.⁵⁹⁵ The results of the Bonn2011 Conference were discussed at the "Water, Energy and Food-Security Nexus in Practice – Make it Happen!" conference. "The Bonn2011 Conference specifically aimed to explore how a nexus approach can enhance water, energy and food security by increasing efficiency,

⁵⁸⁸ Dodds and Bartram "History of the nexus" 30; Leese and Meisch 2015 *Water Alternatives* 696.

⁵⁸⁹ Leese and Meisch 2015 *Water Alternatives* 697.

⁵⁹⁰ Leese and Meisch 2015 *Water Alternatives* 697.

⁵⁹¹ Leese and Meisch 2015 *Water Alternatives* 697.

⁵⁹² Brouwer "The water-energy-food nexus" 2.

⁵⁹³ Leese and Meisch 2015 *Water Alternatives* 697.

⁵⁹⁴ Leese and Meisch 2015 *Water Alternatives* 697.

⁵⁹⁵ Leese and Meisch 2015 *Water Alternatives* 697.

reducing trade-offs, building synergies and improving governance across sectors".⁵⁹⁶ Since then, a plethora of conferences, events, workshops, academic articles, case studies, policy briefs, etcetera, have continued to explore the nexus concept.⁵⁹⁷

Linked to resource scarcity and a general sense of insecurity, the 2008 crisis forced stakeholders (such as governments and multi-national companies) to reflect on complexities that exist between systems, namely that socio-ecological systems are interlinked and interconnected and that action in one system will have an impact on another dimension of the system.⁵⁹⁸ Risk, in the sense of a resource scarcity framing, easily leads to a business opportunity.⁵⁹⁹ In other words, a nexus approach, through the appropriation of security, can be turned into a business opportunity.⁶⁰⁰

The Bonn2011 recommendations turned to and focused on the economy, specifically the circular and green economy, which is envisioned to operate under a resource security paradigm.⁶⁰¹ It based its focus on the economy as a valuable (only) tool to move away from a linear economy to one that keeps materials in circles, maintains utility and produces public value (i.e. as per a holistic nexus concept).⁶⁰² The Bonn2011 recommendations stated that there is a need to "establish monitoring systems to comprehensively track and monitor water, energy, food security, and carbon movements and nexus indicators so policy development is based on sound evidence".⁶⁰³ This implies that water, energy and food are to be commodified in order to provide a manageable basis for the green and/or circular economy.⁶⁰⁴ It is questionable whether this is the correct strategy, especially in light of the securitisation of water, energy and food resources and especially the lack of water, energy and food

⁵⁹⁶ Hoff 2011 "Understanding the nexus" 4.

⁵⁹⁷ As described by Dodd and Bartram "History of the nexus" 30.

⁵⁹⁸ Initially, transnational corporations (such as Nestlé) and the Organisation for Economic Co-operation and Development (OECD) country governments lead the call for rethink of complexities within socio-ecological system. Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 4-5.

⁵⁹⁹ Leese and Meisch 2015 *Water Alternatives* 703.

⁶⁰⁰ Leese and Meisch 2015 *Water Alternatives* 703.

⁶⁰¹ Leese and Meisch 2015 *Water Alternatives* 703.

⁶⁰² Leese and Meisch 2015 *Water Alternatives* 697-698; Schneider, Avellan and Le Hung "Water-Energy-Food Nexus and Sustainability" 1.

⁶⁰³ Bonn 2011 Conference 19.

⁶⁰⁴ Leese and Meisch 2015 *Water Alternatives* 703.

security in South Africa. The next paragraph will first explain what is meant by securitisation and will then focus on each of the resources specifically.

3.5 Securitisation

3.5.1 Resource securitisation

As indicated earlier, the recognition of the concept of resource securitisation⁶⁰⁵ is principally due to the 2008 global crises in water, energy and food (prices) and global finance. The 2008 crises confirmed as a principle that water-use is inter-dependent and inter-connected with energy and food production.⁶⁰⁶ The link between energy and food became stronger due to rising energy intensity in agriculture and increasing land use competition between the two.⁶⁰⁷ Rising energy intensity and an increase in land use competition made for a general increase in food prices.⁶⁰⁸ Many actors (such as governments and multinational corporations) realised that a shock or risk in one natural resource sector can have the same effect in another sector or sectors.⁶⁰⁹ In addition, new uncertainties brought about by climate change, led to fears of limited natural resources (scarcity and limits to growth) and fears of an unpredictable future.⁶¹⁰ It was realised that scarcity in one natural resource could lead to scarcity in another and ultimately lead to conflicts (competition for resources).⁶¹¹ Accordingly, natural resource security and political security are related and therefore energy, water or food insecurity has the potential to (either independently or combined) destabilise

⁶⁰⁵ Also see Srivastave and Mehta "Nexus and Security: Not another nexus" 1. "Security" before and after 1990 were associated with the political and military dimensions of national security. The Post-Cold War era changed the landscape of international relations as a number of "non-traditional security challenges" came to the fore. For example, one can see change in the interpretation of security by looking at the 1994 UNDP report on "human security". The scope of the concept greatly expanded (departed from state-centric orthodoxy). Allouche *et al*/indicate there is no longer any clear difference between the notions of human security and human development. Also see Srivastave and Mehta "Nexus and Security: Not another nexus" 2; and Allouche *et al* 2011 *The Whitehead Journal of Diplomacy and International Relations* 153 – 171.

⁶⁰⁶ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 1.

⁶⁰⁷ Direct energy use for crop management and indirect energy use for machinery production, fertilizers and pesticides. See Carbonnier and Brugger "The Development Nexus" 69.

⁶⁰⁸ Carbonnier and Brugger "The Development Nexus" 69.

⁶⁰⁹ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 5-6.

⁶¹⁰ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 5.

⁶¹¹ Carbonnier and Brugger posit that energy security is directly linked to security in other domains such as food (agriculture) and water. See Carbonnier and Brugger "The Development Nexus" 69. Conflicts could be between governments, regions, or local communities.

political stability in any applicable region.⁶¹² Thus, fears of a resource "scarcity crisis" and general "uncertainty" led to a narrative of resource "security" and "risk management".⁶¹³ This narrative of resource (in)security and risk management led to a renewed focus to identify and understand the interlinked and interdependent processes between water, energy and food sectors.⁶¹⁴ One specific aim of this focus is to guard against possible unintended consequences resulting from the interlinked and interdependent processes between the different resource sectors.⁶¹⁵

The theory of securitisation as developed by the Copenhagen School of Security Studies focuses on understanding who securitises, on what issues (threats, etc.), for whom (referent objects), why (motivation), with what result, and, under what conditions (which explains when it is successful).⁶¹⁶ In other words, the concept of securitisation refers to efforts at interpreting a security discourse, usually referring to that issue that is redefined as extraordinary which therefore poses an existential threat.⁶¹⁷ This redefining to a specific threat, in turn, demands extraordinary forms of decision-making, creating a political opportunity to bypass ordinary political processes.⁶¹⁸

However, securitisation has also been used in alternative ways, notably to describe alarmist discourse in general.⁶¹⁹ For example, securitisation has been used in studies of water security and water discourse.⁶²⁰ Securitisation is not always explicit, but is masked implicitly in the way issues (such as water issues) are framed as potential sources of conflict or security challenges.⁶²¹ Notably, securitisation (water, energy, food and environment) in this way can be understood as a theoretical approach that

⁶¹² The concept of scarcity is "itself highly political and relates as much to socially-produced scarcity emerging principles, processes and politics of distribution, as it does to absolute scarcity". See Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 6. The issue of a hegemonic understanding of "scarcity" within resource politics within an integrative or nexus approach is discussed in Chapter 3.5. Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 5.

⁶¹³ This narrative of resource security is reflected in international organisations, institutions and government policies. Allouche *et al*, "Water and the Nexus: nexus Nirvana or Nexus Nullity?".

⁶¹⁴ Butare "From Bonn 2011 Nexus" xix.

⁶¹⁵ Butare "From Bonn 2011 Nexus" xix.

⁶¹⁶ Staupe-Delgado 2020 *EDS* 6141.

⁶¹⁷ Staupe-Delgado 2020 *EDS* 6141.

⁶¹⁸ Staupe-Delgado 2020 *EDS* 6141.

⁶¹⁹ Staupe-Delgado 2020 *EDS* 6141.

⁶²⁰ Staupe-Delgado 2020 *EDS* 6141.

⁶²¹ Staupe-Delgado 2020 *EDS* 6141.

is not necessarily "tested" formally in research, and therefore scholars could consciously or unconsciously engage in alarmist discourses in an effort to create a *raison d' être*.⁶²² It can also be understood as a form of risk discourse, referring not to existential framings *per se*, but to a discourse surrounding potentialities that in turn require long-term precautionary measures.⁶²³ Securitisation and its associated discourses are about efforts to either point out actual or perceived areas of resource conflicts, or alternatively discourses may use an alarmist tone in general.⁶²⁴ It is further driven by narratives of scarcity and uncertainty.⁶²⁵

It is not possible to measure "uncertainty" or "scarcity" in an objective way.⁶²⁶ People and organisations are not likely to agree on why, how, whether and when any particular resource is scarce or when there is uncertainty.⁶²⁷ Scarcity consists of, or is made up of, multiple dimensions, such as those which are political, economic, physical, and environmental and equitable (dimensions).⁶²⁸ In order to capture the complexity around resources, the different dimensions, although related to one another, tend to be articulated separately.⁶²⁹ Two general sets of views exist on whether the most critically important resources are or will ever be "geophysically" scarce. One view subscribes to the findings of the Club of Rome's *Limits to Growth*-report (hereafter referred to as the LTG report).⁶³⁰ The LTG report was modelled on the five variables of world population, industrialisation, food production, pollution and resource depletion.⁶³¹ In essence the LTG report predicted that a business-as-usual approach, namely continuing the unbridled extraction and use of resources, is unsustainable and will likely lead to catastrophe and the possible implosion of the human race on earth.⁶³²

⁶²² Staupe-Delgado 2020 EDS 6141. This could also apply to scholars and their research on nexus issues.

⁶²³ Staupe-Delgado 2020 EDS 6141.

⁶²⁴ Staupe-Delgado 2020 EDS 6141.

⁶²⁵ Allouche *et al* "Water and the Nexus" STEPS Working Paper 63.

⁶²⁶ Andrews-Speed, Bleischwitz, Boersma *et al* "Want, Waste or War? 16.

⁶²⁷ Andrews-Speed, Bleischwitz, Boersma *et al* "Want, Waste or War? 16.

⁶²⁸ Andrews-Speed, Bleischwitz, Boersma *et al* "Want, Waste or War? 16.

⁶²⁹ Andrews-Speed, Bleischwitz, Boersma *et al* "Want, Waste or War? 16.

⁶³⁰ Meadows *et al* *The Limits of Growth A Report for the Club of Rome's Project on the Predicament of Mankind*.

⁶³¹ Meadows *et al* *The Limits of Growth A Report for the Club of Rome's Project on the Predicament of Mankind* 23.

⁶³² Meadows *et al* *The Limits of Growth A Report for the Club of Rome's Project on the Predicament of Mankind* 189-197.

Uncertainty features in any future prediction and it is not possible to predict all outcomes.⁶³³ A lack of data, limited data inter-operability, and data-incompatibility make prediction even more complex.⁶³⁴ Jakeman *et al* on the context of groundwater management state as follows:⁶³⁵

Effective IGM recognizes the source, nature and level of uncertainties associated with problem definition, social/political context, communication, and models and tools used in the assessment process. Due to the inherent and often large uncertainties associated with managing groundwater systems, there is a need to communicate decision-making in the context of uncertainty and, when possible, develop robust management strategies that perform well under a range of plausible conditions.

At end of the Cold War the environmental security agenda focused on the links between resource scarcity, climate change and conflict.⁶³⁶ It developed alongside a reappearance of conventional security agendas linked to the global war on terror.⁶³⁷ Added to this, is the relatively "new" notion of the nexus between water, energy, and food security. This led to further discursive shifts of the term "security" and changed to concepts such as water, energy and food security and general nexus security.⁶³⁸

The previous paragraphs focused on the "security" aspect of the nexus. Before moving to other aspects (such as sustainable development, the SDGs and socio-ecological systems) the following paragraphs examine water, energy and food security issues in South Africa. This is relevant in so far as it provides context to the South African reality and examines how impacts from the energy system are impacting water and energy systems. This directly relates to WEF nexus examples as it plays out within South Africa.

Recent issues of access to water, energy and food in South Africa can still be traced to the legacy of apartheid whereby the apartheid government entrenched a system of

⁶³³ This is true in environmental impact assessments as well as in integrated groundwater management to mention just two examples where uncertainty occurs. See in this regard, Tenney, Kværner and Gierstad 2006 *Impact Assessment and Project Appraisal* 45-56; Guillaume *et al* "Methods for Exploring Uncertainty in Groundwater Management Predictions" 711-737.

⁶³⁴ Allouche, Middleton and Gyawali "Water-Food-Energy Nexus" 63.

⁶³⁵ Jakeman *et al* (eds) *Integrated Groundwater Management* 12.

⁶³⁶ Srivastave and Mehta "Nexus and Security: Not another nexus" 2.

⁶³⁷ Srivastave and Mehta "Nexus and Security: Not another nexus" 2.

⁶³⁸ Srivastave and Mehta "Nexus and Security: Not another nexus" 2.

unequal access to water, energy and food resources.⁶³⁹ While post-apartheid saw a drive for equal access to water, energy and food resources, rapid industrialisation and urbanisation of the population resulted in an increase in the demand for not only energy, but also for water and food resources.⁶⁴⁰ This was exacerbated by climate change. In the lead-up to the SDGs, a number of research papers, conferences and think-tanks already made reference to the need and possible implications of an integrated approach to the SDGs.⁶⁴¹ A further driver of scarcity and insecurity followed the 2008 crisis, namely climate change.⁶⁴² The impacts of climate change became more visible and this fuelled or amplified general uncertainties, and more specifically

⁶³⁹ The "apartheid government" discriminated against Black South Africans on all levels including access to natural resources. One particular impact resulting from this is the lack of infrastructure to enable access to water, energy and food for all. Obeng-Darko and Crossley 2018 *OGE* 4; Patel 2000 *The International Journal of Justice and Sustainability* 383-399; Hoogeveen and Özler 2005 *The William Davidson Institute Working Paper* 1-41; Kidd *Environmental Law* 292-307; Goodall "Indigenous Peoples, Colonialism, and Memories of Environmental Injustice" 73-98; Aston Philander, Makunga and Platten 2011 *Human Ecology* 203-216; Stull, Bell and Ncwadi 2016 *Journal of Rural Studies* 369-380; and Bhattacharya and Lowenberg 2010 *Comparative Economic Studies* 38-61.

⁶⁴⁰ Obeng-Darko and Crossley 2018 *OGE* 4; Patel 2000 *The International Journal of Justice and Sustainability* 383-399; Hoogeveen and Özler 2005 *The William Davidson Institute Working Paper* 1-41; Kidd *Environmental Law* 292-307; Goodall "Indigenous Peoples, Colonialism, and Memories of Environmental Injustice" 73-98; Aston Philander, Makunga and Platten 2011 *Human Ecology* 203-216; Stull, Bell and Ncwadi 2016 *Journal of Rural Studies* 369-380; and Bhattacharya and Lowenberg 2010 *Comparative Economic Studies* 38-61.

⁶⁴¹ The conference "Jump Starting the SDGs in Germany: Natural Resources and Sustainable Consumption and Production" focused on addressing the challenges and opportunities of implementing the SDGs in Germany and worldwide. International Institute for Sustainable Development (IISD) SDGs Bulletin "A Summary of the Conference Jump-starting the SDGs in Germany: Natural resources and Sustainable Consumption and Production" 7 May 2016 <http://www.iisd.ca/sdgs/jump-starting-germany/>.

A number of participants made reference to the concepts of integration" (or an integrated approach) and the nexus approach". For example, the following: Måns Nilsson (SEI, presenting the work of the Independent Research Forum, IRF); Jes Weigelt, Thando Tilmann, Tim Beringer, Falk Schmidt, Sybille Röhrkasten, Ivonne Lobos Alva (Institute for Advanced Sustainability Issues, IASS); and Klement Tockner (Leibniz-Institute of Freshwater Ecology and Inland Fisheries, IGB).

The United Nations indicated the possible value of using an integrated or nexus approach to achieve its SDGs. It referred to the nexus' ability to reduce negative environmental, economic and social externalities and its ability to increase resource use efficiency. Olusola, Esterhuise, and Levine "The Water-Energy-Food Nexus" 137. For example, see Brandi, Richerzhagen and Stepping "Post 2015: Why is the Water-Energy-Land nexus Important for the Future Development Agenda?"; Weitz *et al* "Cross-sectoral integration in the Sustainable Development Goals: a nexus approach" 1-8; Yumkella and Yillia 2015 *Aquatic Procedia* 8-12.

⁶⁴² Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 5.

uncertainties about the risk that climate change may hold for water, energy and food security.⁶⁴³

3.5.2 Water security - general

The Global Water Partnership⁶⁴⁴ indicates that the main elements of water security are: (i) water access, (ii) water safety and (iii) water availability. In 2013 the Bonn Declaration on Global Water Security stated:⁶⁴⁵

After years of observations and a decade of integrative research convened under the Earth System Science Partnership (ESSP) and other initiatives, water scientists are more than ever convinced that fresh water systems across the planet are in a precarious state.

The United Nations-Water Task Force on Water Security⁶⁴⁶ defines water security as:

The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

The World Economic Forum⁶⁴⁷ in turn defines water security:

...the gossamer that links together the web of food, energy, climate, economic growth and human security challenges that the world economy faces over the next two decades.

Another widely used definition of water security is that by Grey and Sadoff:⁶⁴⁸

The availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies.

From the above definitions, it is clear that water security deals with (a) access to water; (b) the quality and quantity of the available water; (c) the link to livelihoods, human health and well-being, healthy ecosystems, socio-economic development, and

⁶⁴³ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 5.

⁶⁴⁴ Global Water Partnership 2000 "Towards Water Security" 12.

⁶⁴⁵ Bonn 2013 Declaration on Global Water Security 1.

⁶⁴⁶ United Nations University UNU-INWEH 2013.

⁶⁴⁷ World Economic Forum 2011.

⁶⁴⁸ Grey and Sadoff 2007 *Water Policy* 547-548.

(d) the reduction of the risks associated with pollution. Other factors contributing to water security range from political, social, environmental, institutional, infrastructural and biophysical issues; accordingly consequently water security is at the centre of many other security areas.⁶⁴⁹

3.5.3 Water security – South Africa

Known to be a water-scarce country, South Africa has a mean annual rainfall of 465mm. This is half of the world-average annual rainfall.⁶⁵⁰ Not only is the rain unevenly distributed across the country, but it is also impacted by high evaporation rates⁶⁵¹ so much so that less than nine percent of rainfall in South Africa ends up in its rivers. A rather small area of land (20 percent) delivers around 60% of surface runoff.⁶⁵² Numerous droughts in recent years, combined with deteriorating infrastructure (including failing pumps and non-operational wastewater works), depleted water supplies in South Africa.⁶⁵³ Sporadic water curtailment is common in some parts of the country.⁶⁵⁴

Most of the available water has already been allocated and the country will have a water demand and supply deficit of 17 percent by 2030.⁶⁵⁵ This is set against the goal of the NDP for an increase in land to be irrigated for agricultural purposes.⁶⁵⁶ Aside from the water deficits,⁶⁵⁷ South Africa also has water quality issues.⁶⁵⁸ Main contributors to water-quality challenges are mining, including coal mining (acidity and increased metals content), urban development (salinity, nutrients, microbiological pollution), industry (chemicals, toxins), agriculture (sediment, nutrients,

⁶⁴⁹ UN-Water 2013 "Analytical Brief on Water Security and the Global Water Agenda". See also Soyapi 2017 *Potchefstroom Electronic Law Journal* 1-26.

⁶⁵⁰ NWRS (3) 43.

⁶⁵¹ NWRS (3) 102.

⁶⁵² NWRS (3) 43.

⁶⁵³ NWRS (3) 94.

⁶⁵⁴ Also, see para 3.5.9 in this chapter.

⁶⁵⁵ National Water and Sanitation Master Plan at 1, 2 and 5.

⁶⁵⁶ NDP at 219 states that currently 1.5 million hectares under irrigation.

⁶⁵⁷ NWRS (3) 193.

⁶⁵⁸ NWRS (3) 120-122.

agrochemicals, salinity through irrigation return flows) and untreated or poorly-treated wastewater.⁶⁵⁹

To illustrate the plight of poor households in terms of access to water, the empirical research in the WEF nexus project illustrates water security issues in that the majority of the respondents in the Greater Taung Local Municipality indicated that they are water-secure to moderately water-secure, but approximately 20 percent of the respondents still indicated that they were severely water-insecure. 68 percent of respondents in the Matatiele Local Municipality area had access to sufficient water.⁶⁶⁰ It must also be noted that access to water in this regard means that the community has access to a communal tap rather than direct access to water in their own yard or within the household.⁶⁶¹ In addition, water quality is a major issue. 59 percent of households in the Matatiele Local Municipality, for example, indicated their water to be of poor quality.⁶⁶² StatsSA conducted a household survey in 2019 and found that "An estimated 44,9% of households had access to piped water in their dwellings in 2019. A further 28,5% accessed water on site while 12,2% relied on communal taps and 2,5% relied on neighbours' taps. Although generally households' access to water improved, 3,1% of households still had to fetch water from rivers, streams, stagnant water pools, dams, wells and springs in 2019".⁶⁶³ These statistics indicated that although it seems that there is some improvement, the statistics may differ from one area to another and even more so in the rural areas.

The physical scarcity of resources in South Africa means that there should be significant trade-offs between water, energy and food. Water is the most significant resource constraint, since South Africa is a water-scarce country that experiences huge variations in temporal and spatial distribution of rainfall.⁶⁶⁴ At the same time, there is limited irrigable land and the electricity-generation sector is largely coal-fired and thus water-intensive. The energy sector is facing constraints due to water availability and

⁶⁵⁹ NWRS (3) 121.

⁶⁶⁰ Moyo A situational analysis in Alfred Nzo District Municipality 71.

⁶⁶¹ Moyo A situational analysis in Alfred Nzo District Municipality 71.

⁶⁶² Moyo A situational analysis in Alfred Nzo District Municipality 72.

⁶⁶³ StatsSA "P0318 - General Household Survey (GHS), 2019".

⁶⁶⁴ Adom, Simatele and Reid 2022 *JWCC* 2765.

international pressure regarding greenhouse gas emissions.⁶⁶⁵ South Africa's main source of electricity, namely, coal-fired power-plants, has a significant impact on water, both through the use of significant amounts for cooling and through water pollution arising from coal mining.⁶⁶⁶ It is estimated that Eskom uses 270 million m³ of water per year for power generation, which is about two percent of the country's total water consumption.⁶⁶⁷ The following paragraph focuses on energy security.

3.5.4 Energy security - general

The World Energy Council's definition of energy security focuses on aspects of accessibility, availability and acceptability. It defines energy security as:⁶⁶⁸

The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand.

The International Energy Agency in turn defines energy security as "the uninterrupted availability of energy sources at an affordable price".⁶⁶⁹

More recent understanding of energy security consists of four general criteria namely, availability, affordability, efficiency (including reliability) and stewardship.⁶⁷⁰ Each criterium is underpinned by certain values and includes the following: independence and diversification (availability), equity (affordability), innovation and consumer education (efficiency and reliability), and social and environmental sustainability (stewardship).⁶⁷¹ Energy independence is about diversifying (i) the different types of fuels used to provide energy services and (ii) the location of energy facilities.⁶⁷² The aim of energy independence is to have energy systems that are resilient to disruptions (such as attacks), that operate in a reliable fashion, and that do not depend on foreign energy supplies.⁶⁷³ The elements of energy security are (i) continuity of energy

⁶⁶⁵ Adom, Simatele and Reid 2022 *JWCC* 2762.

⁶⁶⁶ Goga and Pegram "Understanding the Food Energy Water Nexus" 9.

⁶⁶⁷ Goga and Pegram "Understanding the Food Energy Water Nexus" 9.

⁶⁶⁸ World Energy Trilemma Report 2013 (World Energy Council) <http://www.worldenergy.org/work-programme>.

⁶⁶⁹ The International Energy Agency (IEA).

⁶⁷⁰ Sovacool and Vivoda 2014 *OGE* 10.

⁶⁷¹ Sovacool and Vivoda 2014 *OGE* 10.

⁶⁷² Sovacool and Vivoda 2014 *OGE* 10.

⁶⁷³ Sovacool and Vivoda 2014 *OGE* 10.

supplies relative to demand, (ii) physical availability of supplies, and (iii) sufficient supply to satisfy demand at a given price;⁶⁷⁴ in other words, the uninterrupted availability of energy sources at an affordable price.⁶⁷⁵ There is certainly a case to include renewable energy into modern definitions of energy security. This is due to climate change pressure (greenhouse gas emissions from fossil fuels) that has major impacts on social and ecological systems.⁶⁷⁶ The concept of energy security has evolved to be much broader and more dynamic. This is based on countries' need to address several challenges such as climate change, geopolitical realities, and new energy peak needs.⁶⁷⁷ The IEA refers to a "clean energy transition".⁶⁷⁸ In South Africa, the Just Transition Framework supports a transition to a low carbon climate resilient economy and society.⁶⁷⁹ This links to goal seven of the SDGs, namely to ensure "access to clean and affordable energy".⁶⁸⁰

3.5.5 Energy security – South Africa

While South Africa's ever increasing demand of access to water and food resources is known, it is the lack of energy security that is putting significant pressure on South Africa's ability to provide basic services, and general socio-economic development.⁶⁸¹ South Africa's current energy mix is dominated by the use of fossil fuels, particularly that of coal.⁶⁸² Coal accounts for about 70 percent of South Africa's primary energy consumption while more than 86-90 percent of electricity generation is attributed to the use of coal.⁶⁸³ During the last couple of decades the lack of maintenance to South

⁶⁷⁴ Sovacool and Vivoda 2014 *OGE* 10.

⁶⁷⁵ Sovacool and Vivoda 2014 *OGE* 10.

⁶⁷⁶ Such as drought and floods and other extreme weather events. Notably, the frequency and intensity of these weather events are increasing. See IPCC 2022 *Climate Change: Summary for policy makers* 9. See the SDGs where the goals and targets confirm explicit links between the impacts of climate change (due to fossil fuels use) and numerous social and ecological aspects, such as health etcetera. See para 2 in this chapter.

⁶⁷⁷ Hepburn "What is energy security and how has it changed?" 12 September *The Conversation*.

⁶⁷⁸ IEA "A major structural change in the electricity generation around the world".

⁶⁷⁹ "A Framework for a Just Transition in South Africa" (September 2022) 2.

⁶⁸⁰ SDGs 2022 Report.

⁶⁸¹ Obeng-Darko and Crossley 2018 *OGE* 5; Orthofer, Huppmann and Krey 2019 *Frontiers in Energy Research* 1-2; Heinberg *Blackout: Coal, Climate and the Last Energy Crisis* 95-98.

⁶⁸² NDP 2030 *Our Future - Make It Work* 164; Wakeford "The South African Energy Context" 142-165.

⁶⁸³ U.S. Energy Information Administration "South Africa – International Analysis" (October 2017) Von Bormann and Gulati "The Food Energy Water Nexus" 5; NDP 2030 *Our Future - Make It Work* 164.

Africa's ageing state-owned coal-fired based electricity supply system (Eskom) put additional stress on its ability to generate electricity, as was also the inability to transition to renewable energy.⁶⁸⁴ This led to a situation where energy demand is presently outstripping supply in South Africa.⁶⁸⁵ The underlying reasons for this are well-documented and include among others: (i) a culture of non-payment of electricity bills by users⁶⁸⁶ which simply means that the utility (Eskom) is working out-of-pocket and can therefore not do the necessary maintenance on its infrastructure; (ii) a lack of technical know-how at the power utility is another contributing factor;⁶⁸⁷ and (iii) numerous incidents of corruption (and state capture) linked to Eskom have been confirmed by the Zondo Commission of Inquiry.⁶⁸⁸ A number of generation units, namely Grootvlei, Komati and Hendrina were shut down early because of their inability to perform.⁶⁸⁹ In addition, the Koeberg power facility is expected to reach its 40 year end of design life around 2024 and its shutdown will put additional stress on the energy supply.⁶⁹⁰ Even though two new coal-fired based power stations (Medupi and Kusile) have been constructed, a number of design flaws have been identified at both power stations.⁶⁹¹ Neither the Medupi nor the Kusile plants are performing at optimal

⁶⁸⁴ Eskom (The Electricity Supply Commission) is a South African state-owned electricity utility that provides around 90 percent of all electricity in the country. It consists of some 30 power stations with a total nominal capacity of 44,172 MW. Nuclear power accounts for 1,860 MW while the remaining 36,479 MW is coal-fired. See Burkhardt and Cohen "How Medupi and Kusile are sinking South Africa" *Bloomberg News*; Brandt *Eyewitness News* 29 October 2019. Also, see the IRP2019 at 40 and the Just Transition Framework at 10, 15. Also see para 4.2.

⁶⁸⁵ Obeng-Darko and Crossley 2018 *OGE* 4. See Donnelly 2019 *Mail and Guardian*; Burkhardt and Cohen 2019 *Bloomberg News*; Brandt 2019 *Eyewitness News*.

⁶⁸⁶ Includes both public and private electricity users. See De Villiers 2019 *SAJL* 605; Grootes 2022 *Daily Maverick*; Ntsaluba 2019 *The Citizen*; Nkanjeni 2022 *TimesLive*; Brink 2022 *Daily Maverick*; Mahlokwane 2022 *IOL*; Katzenellenbogen 2022 *BizNews*.

⁶⁸⁷ Lack of skilled and experienced workers due to large numbers of former employees leaving the utility. This has resulted in a serious brain drain within Eskom. See Ndenze 2022 *Eyewitness News*; Ismail 2020 *TimesLive*.

⁶⁸⁸ A number of Eskom executives are implicated in awarding the Gupta owned Tegeta mining company a multi-billion Rand coal supply tender for a period of 10 years, despite the mine having failed coal quality standard multiple times. See the National Treasury Fundudzi Report 2018 at 14-36. Eskom's debt stands at around R488 billion. See Merten 2020 *Daily Maverick*. The Judicial Commission of Inquiry into allegations of State Capture, Corruption and Fraud in the Public Sector including organs of State was chaired by deputy chief justice Raymond Zondo. See IRP2019 at 40.

⁶⁹⁰ IRP 2019 at 40.

⁶⁹¹ Obeng-Darko and Crossley 2018 *OGE* 4; Donnelly "2019 *Mail and Guardian*"; Burkhardt and Cohen 2019 *Bloomberg News*; Brandt 2019 *Eyewitness News*.

performance levels.⁶⁹² Both Medupi and Kusile have been de-rated at below name-plate rating.⁶⁹³ In addition, Eskom also faces emission regulatory issues in the sense that a number of its power generation units do not meet the minimum regulatory emission standards.⁶⁹⁴ In March 2022 the High Court in *Trustees for the time being of Groundwork Trust v Minister of Environmental Affairs*⁶⁹⁵ (hereafter the *Groundwork* case) indicated that air pollution in parts of the country is so severe that it is a breach of human rights. Pressure from civil society organisations and government departments is mounting on Eskom to either install the necessary technology to ensure the meeting of regulatory emission requirements or to do away with almost half (16 000 MW) of its power-generating capacity.⁶⁹⁶ The former seems highly unlikely because the country's economic woes simply mean that there are not financial resources to install the necessary technology.⁶⁹⁷ The latter, at least in the short term, is also unlikely because of the economic, social and likely political impact this will have.

The state-owned entity Eskom is therefore not able to consistently generate sufficient electricity output to meet current energy demand in South Africa. Because of this undependable nature of electricity generation and supply, the country has experienced periodic energy "black-outs" in the form of rolling electricity load-shedding since 2008.⁶⁹⁸ Electricity supply allocations are made to ensure that main economic activity

⁶⁹² Donnelly 2019 *Mail and Guardian*; Burkhardt and Cohen 2019 *Bloomberg News*. Also, see CSIR "The Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa".

⁶⁹³ Medupi and Kusile "are unable to provide the full complement of energy for their rating". See the IRP2019 at 40.

⁶⁹⁴ The minimum emission standards (MES) have been set and published in 2010. Eskom has applied for and received concessions on the MES. The motivation for concession on MES is that the consequences of attempting to meet MES will be too severe – in short the national electricity grid will likely collapse. See Isaacs 2021 Cape Times.

⁶⁹⁵ *Trustees for the time being of Groundwork Trust v Minister of Environmental Affairs* (39724/2019) [2022] ZAGPPHC 208 (18 March 2022) para 12.1; 12.2; 70; 71; 73; 75; and 153. Some 2 200 people are estimated to annually pass away due to air pollution impacts of these 12 coal power generating units. Thousands more suffer from asthma and bronchitis. Specifically in the Gauteng and Mpumalanga are where some 12 Eskom power generating units operate. See Holland "Health impacts of coal fired power plants in South Africa" 1-19.

⁶⁹⁶ Eskom has some 38 000 MW power generating capacity (on or around October 2022).

⁶⁹⁷ Bega 2022 *Mail & Guardian*.

⁶⁹⁸ Obeng-Darko and Crossley 2018 *OGE* 5; Orthofer, Huppmann and Krey 2019 *Frontiers in Energy Research* 1-2; Heinberg *Blackout: Coal, Climate and the Last Energy Crisis* 95-98; Bayliss "Lessons from the South African Electricity Crisis" June 2008 International Poverty Centre 1; Ateba, Prinsloo and Gawlik 2019 *Energy Reports* 1324–1325; Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 133.

can continue (such as the industrial and manufacturing sector) without causing the electric grid to crash. Parts of the country are therefore temporarily delinked from the electric grid on a rolling basis.⁶⁹⁹ Indications are that this situation will continue in the short to medium term.⁷⁰⁰ The government is (at the time of writing) considering declaring a national state of disaster on the energy crises.⁷⁰¹ While some progress has been made in boosting renewable energy in South Africa, specifically via the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) it has been slow-going (started in 2011).⁷⁰² A total of 56 wind and solar projects for an allocation of 4,200 megawatt has been submitted under the latest REIPPPP.⁷⁰³ Backup systems in South Africa are mostly in the form of diesel generators or battery systems.⁷⁰⁴ However, only a small number of households and businesses can afford such alternative systems.⁷⁰⁵ Households that can afford to install either inverter battery systems (small inverters in the region of 1440W/2,400VA UPS), generators (expensive due to diesel costs) or solar panels are starting to find ways of being less dependent on the national energy supplier (Eskom). While the government has

⁶⁹⁹ Obeng-Darko and Crossley 2018 *OGE* 5; Orthofer, Huppmann and Krey 2019 *Frontiers in Energy Research* 1-2; Heinberg *Blackout: Coal, Climate and the Last Energy Crisis* 95-98; Bayliss "Lessons from the South African Electricity Crisis" June 2008 International Poverty Centre 1; Ateba, Prinsloo and Gawlik 2019 *Energy Reports* 1324-1325.

⁷⁰⁰ Burkhardt 2020 <https://bloom.bg/3sHywm1>. On 31 January 2020 Eskom CEO Mr de Ruyter already indicated that load-shedding will continue for the next 18 months (while maintenance on the system takes place). See Zama 2020 <https://bit.ly/3rOpVip>. The South African Government seems to be looking at independent power producers (IPPs) to alleviate the energy short supply. However, this process (the regulation thereof etc.) is a work in progress and therefore will take some time to implement. While any additional power to the network is certainly welcome, it remains to be seen what the impact in real terms will be.

⁷⁰¹ End January 2023, the President (under pressure of its ruling party) announced that he might declare a state of disaster in order to expedite energy reform. See in this regard, Brandt <https://ewn.co.za/2023/01/31/ramaphosa-mulls-national-state-of-disaster-over-energy-crisis>. See also, Cele *SA considers national state of disaster for energy crisis* 2023 Bloomberg.

⁷⁰² Creamer Media's Engineering News 2022 "56 wind and solar projects bid into South Africa's enlarged renewables round".

⁷⁰³ Creamer Media's Engineering News 2022 "56 wind and solar projects bid into South Africa's enlarged renewables round".

⁷⁰⁴ People turn to private safe deposit vaults due to load shedding | Witness (citizen.co.za) 31 January 2023; Ngcoya Alternative solutions to load shedding crisis gain traction 22 January 2023 Alternative solutions to load shedding crisis gain traction (msn.com); Zondi "South Africans advised to make alternative plans since load shedding is staying" 23 January 2023 South Africans advised to make alternative plans since load shedding is staying – DFA.

⁷⁰⁵ People turn to private safe deposit vaults due to load shedding | Witness (citizen.co.za) 31 January 2023; Ngcoya Alternative solutions to load shedding crisis gain traction 22 January 2023 Alternative solutions to load shedding crisis gain traction (msn.com); Zondi "South Africans advised to make alternative plans since load shedding is staying" 23 January 2023 South Africans advised to make alternative plans since load shedding is staying – DFA.

changed regulations on the need for a licence on small scale household energy generation, there is no mechanism nor political will that enables the reselling of excess energy back into the grid (i.e. back to Eskom). Government seems not wanting to lose future revenue (i.e. current monopoly on energy generating and supply). The result of this will likely be less revenue for government (at national and local municipal level) and even lead to a further worsening of general services such as water and sanitation. Civil society that includes numerous organisations and businesses are challenging government's stand on this.⁷⁰⁶ Indications are (due to the sheer magnitude of energy insecurity and pressure by civil society) that municipalities are starting to mull around the possibility of allowing private persons, companies and groups to generate energy and sell excess energy back to Eskom.⁷⁰⁷ The outcome remains to be seen.

The impacts associated with COVID-19 (such as the rise in unemployment) is particularly severe upon the millions of poor households in South Africa. This impacts on households' ability to access energy.⁷⁰⁸ They simply cannot afford electricity and the indigent policies that provide 50 Kwh electricity to certain households is not enough. Accordingly, community members revert back to using wood and paraffin as sources of energy. For example, in the WEF nexus project, only 45 percent of the respondents in the Matatiele area indicated that they had access to electricity.

While South Africa has experienced energy insecurity in the form of "load shedding" since 2008, the frequency and duration of load shedding increased significantly during 2022.⁷⁰⁹ Current predictions point to even more load shedding in 2023.⁷¹⁰ A notable impact from increased load shedding is that of frequent interruptions of water supply and general water services across the country.⁷¹¹ Water supply systems rely on the

⁷⁰⁶ Ferreira <https://mg.co.za/news/2023-01-24-eskom-government-face-constitutional-challenge-on-load-shedding/>.

⁷⁰⁷ Some municipalities indicated that they would buy excess energy. This will only be possible, should the energy system allow for it. At this stage it will only be possible in some metropolitan areas. See in this regard Daniel <https://www.businessinsider.co.za/you-can-sell-excess-solar-power-back-to-govt-but-it-can-take-around-7-years-to-break-even-2021-1>.

⁷⁰⁸ Graff and Carley 2020 *Nature Energy* 352.

⁷⁰⁹ CSIR Report <https://bit.ly/3wck5DZ> 107.

⁷¹⁰ See Eskom Presentation "System Status and Outlook" to the Joint Portfolio Committee on Public Enterprises and Mineral Resources and Energy for period September 2022 – August 2023 <https://bit.ly/3D0Fad7>; Lilley <https://bit.ly/3CYzdgG>; Dlodla <https://bit.ly/3XolR5B>.

⁷¹¹ Ebrahim <https://bit.ly/3XK11h5>; Anon 2023 <https://bit.ly/3HhIFhK>; Van der Walt 2022 <http://bit.ly/3ADG0LS>; Patel 2022 <http://bit.ly/3tRt2pW>; De Jager 2022 <http://bit.ly/3tTL5f7>;

availability of electricity to run pumps and pumping stations as a continuous process to move water and fill reservoirs.⁷¹² The frequency and duration of electricity interruption is directly impacting the ability of public and private water services providers to supply water.⁷¹³ Due to load shedding there simply is not enough electricity available to keep the pumps running at a minimum required rate to ensure basic water services.⁷¹⁴ Energy insecurity also has impacts on food and food production.⁷¹⁵ In the following paragraph food security is addressed.

3.5.6 Food security - general

Concepts of food security evolved from around the 1970s when the World Food Conference defined food security in terms of food supply and guaranteeing availability and price stability of basic foodstuffs.⁷¹⁶ Later definitions addressed demand and access issues, resulting in a definition based on the balance of the demand and supply side of food security.⁷¹⁷ In 1996 the concept of food security moved from a mainly economic view to a more social understanding of food security.⁷¹⁸ The social view recognised the negative effect of lack of food on the physical, social and emotional and cognitive development of humans.⁷¹⁹ In this vein the 1996 World Summit on Food

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- Tau 2022 <http://bit.ly/3i8yLVN>; Patel <https://bit.ly/3GRvgM7>; Schrieber <https://bit.ly/3HfFdEB>; Coetzer <https://bit.ly/3GYTEvw>.
- ⁷¹² Anon 2023 <https://bit.ly/3HhIFhK>; Van der Walt 2022 <http://bit.ly/3ADG0LS>; Patel 2022 <http://bit.ly/3tRt2pW>; De Jager 2022 <http://bit.ly/3tTL5f7>; Tau 2022 <http://bit.ly/3i8yLVN>.
- ⁷¹³ Coetzer <https://bit.ly/3GYTEvw>; De Jager 2022 <http://bit.ly/3tTL5f7>; Schrieber <https://bit.ly/3HfFdEB>; Patel <https://bit.ly/3GRvgM7>; Ebrahim <https://bit.ly/3XK11h5>; Anon 2023 <https://bit.ly/3HhIFhK>. This includes sanitation services because it is directly linked to the ability of pumping water.
- ⁷¹⁴ Coetzer <https://bit.ly/3GYTEvw>; Van der Walt 2022 <http://bit.ly/3ADG0LS>.
- ⁷¹⁵ Ginindza <https://www.iol.co.za/business-report/companies/farmers-warn-of-food-security-threat-due-to-load-shedding-43f00b48-2ddf-41a8-b132-470bd683b444#:~:text=Farmers%20warn%20of%20food%20security%20threat%20due%20to,stop%20production%20because%20of%20their%20inability%20to%20irrigate>. Ginindza B "Farmers warn of food security threat due to load shedding" *IOL* 16 January 2023.
- ⁷¹⁶ Schneider, Avellan and Le Hung "Water-Energy-Food Nexus and Sustainability" 5. Also see Terblanche and Pienaar 2012 *Potchefstroom Electronic Law Journal* 228-286.
- ⁷¹⁷ Terblanche *Voedselsekerheid as ontwikkelingsdoelwit* 19-23; Schneider, Avellan and Le Hung "Water-Energy-Food Nexus and Sustainability" 5.
- ⁷¹⁸ Schneider, Avellan and Le Hung "Water-Energy-Food Nexus and Sustainability" 5.
- ⁷¹⁹ Schneider, Avellan and Le Hung "Water-Energy-Food Nexus and Sustainability" 5.

security indicated that "food should not be used as an instrument for political and economic pressure".⁷²⁰ The FAO World Food Summit in 1997 defined food security as:

A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.⁷²¹

The elements of food security therefore are (i) food availability, (ii) access to food (economic and physical), (iii) utilisation (nutrition value, choice, social value and food safety), and (iv) food stability (over time).⁷²² "Food security depends on an adequate availability of good quality soil, water and nutrients."⁷²³

3.5.7 Food security – South Africa

While the practise of agriculture is generally concerned with the production of useful plants, fungi or animals for the production of food, fibre fuel or other products, a distinction is made between conventional and organic/regenerative farming methods.⁷²⁴ Conventional farming is characterised by a number of techniques such as

Rapid technological innovation, large capital investments to enable production and management technology, large-scale farms, single crops grown continuously over many seasons, uniform high-yield hybrid crops, extensive use of pesticides, fertilisers, and external energy inputs, and high labour efficiency.⁷²⁵

The overuse of nitrogenous fertiliser contributes to soil, water pollution and air pollution.⁷²⁶ In addition it is a source of greenhouse gas emissions.⁷²⁷ The conversion of pastures, grasslands and forests to crop and stock production land has resulted in

⁷²⁰ Terblanche *Voedselsekerheid as ontwikkelingsdoelwit* 19-23; Schneider, Avellan and Le Hung "Water-Energy-Food Nexus and Sustainability" 5.

⁷²¹ FAO 2017 "The state of food security" 107.

⁷²² IISD 2013 "The Water-Energy-Food Security Nexus" 5; and FAO 2017 "The state of food security" 107. Also, see Snyman and Gildenhuys 2015 *Potchefstroom Electronic Law Journal* 1691–1724.

⁷²³ Lal "The nexus approach" 47.

⁷²⁴ Mwongera, Lamanna, Kamau and Girvetz "Scaling climate-smart agriculture for agricultural transformation in Southern Africa" 88-90; Meyer *et al* "Soil, land and agriculture" 316.

⁷²⁵ Meyer *et al* "Soil, land and agriculture" 316.

⁷²⁶ Cheteni and Umejesi 2022 *EMS* 78.

⁷²⁷ A number of practices and strategies have been suggested to limit the amount of GHG that is released into the atmosphere. These include proper application and use of agrochemicals, improving ruminant nutrients and the intermittent irrigation of agriculture land. Additional measures include the reduction and substitutes for nitrogenous fertilisers. See Cheteni and Umejesi 2022 *EMS* 78.

overgrazing and land degradation in South Africa.⁷²⁸ As agricultural production intensifies, expansion of agricultural and habitat fragmentation becomes common.⁷²⁹

In contrast to conventional farming, organic or regenerative farming avoids the use of synthetic fertilisers, irradiation, sewage sludge, and genetic engineering.⁷³⁰ It instead focuses on the use of practices that promote the cycling of resources, conserve biodiversity and promote ecological balance.⁷³¹ This is achieved by using bacteria to increase the effectiveness of the denitrification process in the nitrogen cycle.⁷³² Cover crops are used to enrich the soil via nitrogen fixation and phosphorous mobilisation.⁷³³ The result of this is that organically tended soils contain a higher organic matter, higher denitrification potential and greater microbial activity than conventionally tended soil.⁷³⁴

Commercial agriculture in South Africa faces serious challenges.⁷³⁵ In terms of environmental aspects farming takes place on a degraded resource base together with impending climatic changes due to global warming.⁷³⁶ In an effort to make a change from conventional farming to organic or regenerative farming practices the government has launched a number of initiatives such as the national Land Care Programme, the establishment of conservation stewardship programmes in a couple of provinces and the establishment of biodiversity corridors (linking areas of biodiversity value with other sustainable agricultural uses).⁷³⁷ The biggest drive for change to organic or regenerative farming in South Africa is farming entities wanting to export its products to the global market, who in turn have certain product quality requirements. Most success in this regard is found within the fruit and wine sector.

⁷²⁸ Cheteni and Umejesi 2022 *EMS* 77.

⁷²⁹ Wakefield "South African Energy Context" 357; Cheteni and Umejesi 2022 *EMS* 78.

⁷³⁰ Meyer *et al* "Soil, land and agriculture" 316.

⁷³¹ Mwongera, Lamanna, Kamau and Girvetz "Scaling climate-smart agriculture for agricultural transformation in Southern Africa" 88-91; Meyer *et al* "Soil, land and agriculture" 316.

⁷³² Meyer *et al* "Soil, land and agriculture" 316.

⁷³³ Meyer *et al* "Soil, land and agriculture" 316.

⁷³⁴ Sage "Agro-food systems" 486-489; Meyer *et al* "Soil, land and agriculture" 316.

⁷³⁵ Meyer *et al* "Soil, land and agriculture" 331. Other challenges include issues of redistribution of land and tenure of farm workers.

⁷³⁶ Mwongera, Lamanna, Kamau and Girvetz "Scaling climate-smart agriculture for agricultural transformation in Southern Africa" 88-91; Meyer *et al* "Soil, land and agriculture" 331.

⁷³⁷ Meyer *et al* "Soil, land and agriculture" 330-331.

The agricultural sector in South Africa is for the most part still based on conventional and therefore unsustainable farming practices.

Agriculture in South Africa can be described in terms of commercial, smallholder and subsistence farming. Commercial agriculture consists of less than 40 000 farming units but is responsible for 99% of the country's formal agricultural output.⁷³⁸ Smallholder agriculture is estimated to consist of 1.3 million farming households that are mainly based in areas of poor productive land, little water resources and little to no infrastructure.⁷³⁹ These areas are located in the former homeland regions of the country (i.e. areas created during the apartheid regime). Smallholder farmers in these areas face serious challenges in terms of access to transport, general support infrastructure, technical support, and financial services support.⁷⁴⁰ Smallholder farmers participate in agriculture to supplement their household food requirements.⁷⁴¹ Surplus goods are sold at local markets.⁷⁴² While subsistence farmers engage in agriculture mainly for household consumption, recent studies indicate an increase in the use of local markets for food purchases.⁷⁴³ This uptake in the use of local food markets is seen as an important measure in improving livelihoods for rural food-insecure households.⁷⁴⁴

Due to the combination of climate and soil type in South Africa, only about 12% of the country is suitable for growing rain-fed crops, while only about 3% of the land surface is considered truly fertile.⁷⁴⁵ As a result, most of the land is used for grazing and livestock farming, which is by far the largest agricultural sector in the country.⁷⁴⁶

⁷³⁸ Meyer *et al* "Soil, land and agriculture" 314.

⁷³⁹ Meyer *et al* "Soil, land and agriculture" 314; Ngqangweni, Tempia and Lubinga "Importance of small rural markets in the transformation of Southern African agriculture" 251-252.

⁷⁴⁰ Siphesihle and Lelethu 2020 *SAJAE* 99; Meyer *et al* "Soil, land and agriculture" 314.

⁷⁴¹ Ngqangweni, Tempia and Lubinga "Importance of small rural markets in the transformation of Southern African agriculture" 251-252.

⁷⁴² Meyer *et al* "Soil, land and agriculture" 314; Siphesihle and Lelethu 2020 *SAJAE* 98.

⁷⁴³ Ngqangweni, Tempia and Lubinga "Importance of small rural markets in the transformation of Southern African agriculture" 251-252; Siphesihle and Lelethu 2020 *SAJAE* 98-99; Meyer *et al* "Soil, land and agriculture" 315.

⁷⁴⁴ Siphesihle and Lelethu 2020 *SAJAE* 98-99; Ngqangweni, Tempia and Lubinga "Importance of small rural markets in the transformation of Southern African agriculture" 255.

⁷⁴⁵ Mabhaudhi *et al* "Assessing the state of the WEF nexus in SA" 1.

⁷⁴⁶ Redelinghuys "Effects on communities" 357; the 2021 report by DALRRD "Trends in the agriculture sector" 1.

Most of South Africa's irrigable land (just over one percent of land surface) is already cultivated with some irrigation taking place in marginal lands/fields. About one and a half percent of land is under irrigation, and this area produces 30 percent of the crops.⁷⁴⁷ Irrigation can reduce soil fertility by contributing to salinisation, particularly in arid areas.⁷⁴⁸ It is estimated that about 26 000 ha of irrigated land in South Africa is affected by this problem.⁷⁴⁹ Production of maize and wheat has remained relatively constant, even though the area being farmed has decreased significantly in the last 20 years.⁷⁵⁰ This indicates that the intensity of production has increased significantly.⁷⁵¹ Increasingly intensive farming has a range of impacts on the natural environment, including a reduction in long-term soil fertility, soil erosion, pollution of water supplies and climate change.⁷⁵²

Irrigated agriculture is the biggest water user in South Africa, accounting for about 61 percent of national water use, as stated in the draft of the second edition of the National Water Resources Strategy (NWRS2).⁷⁵³ Climate change predictions for South Africa point to a change in the variability of rainfall, with rainfall expected to be more infrequent but also more intense.⁷⁵⁴ This is expected to lead to the shrinking of arable land as well as an increase in uncertainty and unpredictability, meaning that farming conditions will be challenging.⁷⁵⁵ With a movement towards more intensive farming as well as the farming and irrigation of marginal areas, there has been pollution of ground and surface water, loss of biodiversity, loss of soil fertility, and erosion.⁷⁵⁶

South Africa used to be a net food-exporter for the period 1985-2008.⁷⁵⁷ However, since then the country became a net food importer. Reasons for this include: a rapid growth in population, a decrease in agricultural yield (droughts), and a general

⁷⁴⁷ Mabhaudhi *et al* "Assessing the state of the WEF nexus in SA" 1.

⁷⁴⁸ Meyer *et al* "Soil, land and agriculture" 320.

⁷⁴⁹ Meyer *et al* "Soil, land and agriculture" 320.

⁷⁵⁰ Meyer *et al* "Soil, land and agriculture" 314-316.

⁷⁵¹ Meyer *et al* "Soil, land and agriculture" 316.

⁷⁵² Cheteni and Umejese 2022 *EMS* 77-78; Meyer *et al* "Soil, land and agriculture" 317-324.

⁷⁵³ GN 2327 in GG 47133 of 29 July 2022.

⁷⁵⁴ Mabhaudhi *et al* "Assessing the state of the WEF nexus in SA" 23; NDP 33.

⁷⁵⁴ Mabhaudhi *et al* "Assessing the state of the WEF nexus in SA" 23; NDP 33.

⁷⁵⁵ Mabhaudhi *et al* "Assessing the state of the WEF nexus in SA" 23; NDP 33.

⁷⁵⁶ Meyer *et al* "Soil, land and agriculture" 283-350.

⁷⁵⁷ Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 133.

shortfall in food.⁷⁵⁸ Over 60 percent of South African households are considered to be food insecure.⁷⁵⁹ That number is expected to increase due to the socio-economic impacts of the Covid-19 Coronavirus.⁷⁶⁰ Water scarcity and shortages could impact the ability of the agricultural sector to provide food security for the country's population.⁷⁶¹ In addition, irrigation in the agricultural sector is also dependent on energy (pumping of water).⁷⁶²

The WEF nexus project also addressed food security. An illustration of the food insecurity of households in South Africa is clear from the fact that 16 percent of households in the Greater Taung Local Municipality indicated that they were food insecure and 5.76 percent that they were extremely food insecure.⁷⁶³ In the combined study areas (Matatiele, Majeng and Greater Taung) 32.35 percent of the respondents indicated that they were somehow food secure, while 26.69 percent indicated they were moderately food secure and only 23.56 percent indicated they were food secure; 12.50 percent were food insecure and 4.9 percent extremely food insecure.⁷⁶⁴ Most of these households rely on social grants as their only household income and in the Majeng area a soup-kitchen provides at least one meal per day. Very few of the households partake in agricultural activities, despite being rural communities. The reliance on social security grants and the lack of small-scale agriculture or even household gardens in these areas is an indication of how food insecure households are/have become (if then in these areas only). StatSA published a report indicating that in 2020 "almost 23,6 per cent of South Africans in 2020 were affected by moderate to severe food insecurity, while almost 14,9% experienced severe food

⁷⁵⁸ Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 133.

⁷⁵⁹ Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 134.

⁷⁶⁰ The United Nations World Food Programme (WFP) indicates that COVID-19 will double the number of people suffering from a food crisis (particular severe impacts for poor countries). The rise in unemployment is a major issue that hampers poor household's ability to afford food. See the Global Network against Food Crises 2020 "Global Report on Food Crisis" 1-233; Barbiroglio *Forbes* 1; Witten *Argus* 1; Singh *The Mercury* 1.

⁷⁶¹ Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 134.

⁷⁶² Olusola, Esterhuyse and Levine "Nexus from a South African Perspective" 134.

⁷⁶³ Chapter 4.8.2-4.8.3.

⁷⁶⁴ Chapter 4.8.2-4.8.3.

insecurity."⁷⁶⁵ This correlates with the data found in the Matatiele, Majeng and Greater Taung studies.⁷⁶⁶

Climate change may exacerbate water, energy and food insecurity in South Africa and cannot be ignored in the discussion on water, energy and food security. The cross-cutting effect of climate change is discussed in the following paragraph.

3.5.8 Climate change impacts on water, energy and food security

Global warming will adversely affect the water, energy and food sectors.⁷⁶⁷ Mitigation of and adaptation to climate change will then continue to interact and impact on water, energy and food.⁷⁶⁸ These impacts of climate change have serious consequences for water, energy and food security.⁷⁶⁹ An increase in aridity, will increase the pressure on water demand for agriculture, water provision and energy production.⁷⁷⁰ The issue of water scarcity is expected to be exacerbated with the threat of climate change.⁷⁷¹ Water is the most vulnerable element of the nexus that is affected by climate change, yet there is a definite knock-on effect to the other sectors.⁷⁷² It is projected that climate change will alter rainfall patterns and increase the frequency of extreme weather events such as droughts and floods.⁷⁷³ South Africa's rainfall variability, coupled with projected climate change impacts, is expected to lead to shrinking areas suitable for crop production and a rise in the unpredictability of farming conditions.⁷⁷⁴

⁷⁶⁵ StatsSA "Report-03-00-19 - Measuring Food Security in South Africa: Applying the Food Insecurity Experience Scale, 2020".

⁷⁶⁶ Chapter 4.8.2-4.8.3.

⁷⁶⁷ Leese and Meisch 2015 *Water Alternatives* 699.

⁷⁶⁸ Leese and Meisch 2015 *Water Alternatives* 699.

⁷⁶⁹ Mabhaudhi "Assessing the state of the Water-Energy-Food (WEF) Nexus in South Africa" 2018 Report to the Water Research Commission 23.

⁷⁷⁰ Mabhaudhi "Assessing the state of the Water-Energy-Food (WEF) Nexus in South Africa" 2018 Report to the Water Research Commission 23.

⁷⁷¹ Mabhaudhi "Assessing the state of the Water-Energy-Food (WEF) Nexus in South Africa" 2018 Report to the Water Research Commission 23.

⁷⁷² Mabhaudhi "Assessing the state of the Water-Energy-Food (WEF) Nexus in South Africa" 2018 Report to the Water Research Commission 23.

⁷⁷³ Mabhaudhi "Assessing the state of the Water-Energy-Food (WEF) Nexus in South Africa" 2018 Report to the Water Research Commission 23.

⁷⁷⁴ Adom, Simatele and Reid 2022 *JWCC* 2765; Mabhaudhi "Assessing the state of the Water-Energy-Food (WEF) Nexus in South Africa" 2018 Report to the Water Research Commission 23.

South African specific concerns include: the risk of negative impacts on water sources (both the extraction and possible pollution due to chemicals and methane emissions) and the linked impact on food production (competing resource use and change in land use). South Africa, being the 30th driest country in the world (and the Karoo is particularly arid), faces the specific challenge of water scarcity.⁷⁷⁵ This is made worse by the impacts of climate change.⁷⁷⁶

3.5.9 Example of interlinked impacts between water, energy and food systems in South Africa

The result of increasing load shedding (both in terms of duration and frequency) is having an impact on the supply of drinking water.⁷⁷⁷ In short, water supply mechanisms, both in the bulk and reticulation networks, are negatively affected by load shedding.⁷⁷⁸ The impacts take on a number of forms in the sense that the water infrastructure scheme in South Africa consists of numerous inter-pumping operations to move water from one reservoir to the next and for onward supply to residents within cities, towns and local regions such as rural areas.⁷⁷⁹ The provision of water services is not a straightforward process. It consists of a complex series of processes, events and entities that ensure water is captured, treated, transmitted and distributed to users.⁷⁸⁰ It is not only an issue of intermittent supply of potable water but includes

⁷⁷⁵ As per the WWF Report "South Africa's Water Source Areas" only 8 percent of land area provides 50 percent of South Africa's surface water; South Africa's rainfall (490 millimetre per annum) is half the global average and most of available reliable water (98 percent) has already been allocated. South Africa face high to extremely high water stress where its shale gas is located (e.g. the Karoo) – see Reig *et al* "Global Shale Gas Development – Water Availability and Business Risks" *World Resources Institute* 34-37. South Africa could face significant water shortages in the future – due to expected increase of water usage needs and the impacts of climate change. See WWF Report "South Africa's Water Source Areas" 23.

⁷⁷⁶ The impacts of climate change are particular severe in sub-Sahara Africa and drier areas such as the Karoo. See Van Dijk "Water resources, climate change and energy" 11. Also, see the IPCC report and the *Climate Change Bill*, B9-2022 before National Assembly as of 24 October 2023 – Parliament of the Republic of South Africa. <https://www.parliament.gov.za/bill/2300> 773.

⁷⁷⁷ Singh 11 December 2022 *The Mercury* <http://bit.ly/3YeN2Rn>; Blignaut J and van Heerden J Working Paper 141 University of Pretoria "Is Water Shedding Next?"; Beukes 22 September 2022 East Coast Radio <http://bit.ly/3uIKgGE>; Dayimani December 2022 News24 <http://bit.ly/3W6zwgI>; Barnard December 2022 Netwerk24 <http://bit.ly/3j7WtSA>.

⁷⁷⁸ Kruger December 2022 Netwerk24 <https://bit.ly/3Q4NduS>; Van der Walt 2022 Engineering News <http://bit.ly/3VREWMP>; Blignaut and van Heerden Working Paper 141 University of Pretoria "Is Water Shedding Next?".

⁷⁷⁹ Ismael February 2015 News24 <http://bit.ly/3FMchDy>.

⁷⁸⁰ Van der Walt *Engineering News* 2022. <http://bit.ly/3VREWMP>.

the issue of intermittent treatment effluent produced by users.⁷⁸¹ Untreated effluent from the upper reaches of a water catchment area will have an impact on all downstream users.⁷⁸² While some main water treatment works are exempted from load shedding (usually linked to bigger metros and cities), numerous others are not.⁷⁸³ Metros and or municipalities either have to sit out the water supply issue for a number of hours a day (this can range from four to six hours) before power is restored.⁷⁸⁴ When power is restored there is a lag in the refill of reservoirs. In short, the pumping of water is a power intensive operation (numerous pumps) and is time consuming.⁷⁸⁵ The pumping via generators is slow and involves a long process (the water yields are less than what is required). This is worse when power interruption (load shedding) occurs. The refilling of reservoirs by pumping therefore experiences serious lagging effects. It is an issue of playing catch-up until the next set of load shedding occurs.⁷⁸⁶ While some Water Services Authorities (over 150 mostly in the form of local municipalities) have installed generators to assist with the pumping of water, it is a rather slow process and runs at considerable cost.⁷⁸⁷ Many municipalities cannot afford the acquisition and running costs associated with back-up generators and therefore suffer even more from the lack of water supply.⁷⁸⁸ Urban users of water are dependent on a centralised water supply system and therefore extended water supply shedding will eventually deplete water stored in tanks.⁷⁸⁹ The impact of load shedding on water services coupled with under-maintained and worsening water infrastructure is cumulating in more and more examples of extended water supply interruptions across the country.⁷⁹⁰

⁷⁸¹ Van der Walt *Engineering News* 2022. <http://bit.ly/3VREWMP>.

⁷⁸² Van der Walt *Engineering News* 2022. <http://bit.ly/3VREWMP>.

⁷⁸³ Van der Walt *Engineering News* 2022. <http://bit.ly/3VREWMP>.

⁷⁸⁴ Ismael *News24* 2015 <http://bit.ly/3FMchDy>; Singh 2022 *The Mercury* <http://bit.ly/3YeN2Rn>.

⁷⁸⁵ Van der Walt *Engineering News* 2022 <http://bit.ly/3VREWMP>.

⁷⁸⁶ Van der Walt 2022 *Engineering News* <http://bit.ly/3VREWMP>.

⁷⁸⁷ Van der Walt 2022 *Engineering News* <http://bit.ly/3VREWMP>.

⁷⁸⁸ Van der Walt 2022 *Engineering News* <http://bit.ly/3VREWMP>.

⁷⁸⁹ Van der Walt 2022 *Engineering News* <http://bit.ly/3VREWMP>.

⁷⁹⁰ Some towns and areas are without normal water supply ranging from days and even weeks. Limited water is usually trucked in to provide communities with some drinking water. In many instances the community by way of the private sector assist with the pumping of borehole water etc. The impact of load shedding on the country's economy is staggering. The spill over affects thereof are impacting society at all levels (individuals, the private sector and communities. See Opperman 2022 *The Citizen* <http://bit.ly/3HHjING>.

Energy is needed for the pumping of water to irrigate grain stock and for livestock. Not surprisingly, the impacts of load shedding also are also starting to impact on food security. The agriculture sector reports that the intermittent availability of energy impacts on the ability of farmers to produce crops and keep livestock. Three main impacts of load shedding in the agriculture sector include (i) the insufficient irrigation of crops and water for livestock, (ii) mechanical breakdowns of spill-points due to continuous process of restarting them (bursting of pipes and air trapped in the system), and (iii) an increase in financial cost due to farmers having to use energy during peak energy use periods (farmers have 30-40 percent less energy available but the cost of energy use increased to 40 percent).⁷⁹¹ These impacts filter down to a number of other levels, including farmers' ability to afford and employ workers (permanent and harvest-season contract workers).⁷⁹² The examples above confirm the practical impacts of the interlinked nature of relations between water, energy and food resource systems. South Africa is (unfortunately) an example of how impacts in one sector (energy) have major consequences for other sectors (water and food). The country is therefore facing major issues of water, energy and food insecurity, even without impacts from hydraulic fracturing.⁷⁹³

The following paragraphs focus on the other main (second) element of the nexus approach, namely the socio-ecological systems element that relates to sustainable development and the SDGs.⁷⁹⁴

3.6 Complexity and uncertainty: a wicked problem

The security framing of the nexus stemming from the framing of the nexus in the Bon2011 recommendations, views the nexus as something that is manageable.⁷⁹⁵

⁷⁹¹ Horne 2022 Netwerk 24 <https://bit.ly/3WWMG0n>; Attaché Report July 2022 <https://bit.ly/3CbsnEs>.

⁷⁹² In addition, the storage and in particular the cooling storage of food produce are negatively impacted. Fridges and freezers cannot keep the food produce cool. This leads to food wastage and loss. This impacts people and businesses at all levels, from bigger retailers to restaurants to individuals. Meyer 2022 Cape Talk <https://bit.ly/3GtIzyz>; Attaché Report July 2022 <https://bit.ly/3CbsnEs>.

⁷⁹³ Within an already political and economic unstable state this could also potentially lead to social unrest.

⁷⁹⁴ See chapter 3.4.

⁷⁹⁵ Leese and Meisch 2015 *Water Alternatives* 704.

There is, however, a multitude of interactions between the social, material and biophysical world.⁷⁹⁶ These interactions are more complex as social, technological, political, economic and ecological systems interact.⁷⁹⁷ Water, energy and food are interconnected, comprising a logical system and dominated by complexity and feedback.⁷⁹⁸ Pressure on one part of the nexus system can create trade-offs on other parts of the system.⁷⁹⁹ Ignoring interlinkages between water, energy and food sectors may have adverse consequences.⁸⁰⁰ It is difficult to capture the dynamics of these interactions.⁸⁰¹ This is because of numerous uncertainties within these interactions – the unknown unknowns.⁸⁰² This includes uncertainties on temporal, and spatial scales and levels, and includes externalities such as climate change.⁸⁰³

Wicked problems tend to be understood merely as the flip-side of tame problems.⁸⁰⁴ This originated from the perceived binary division between scientific/technical problems and social problems. According to these, social problems (commonly associated with values) are inherently different from scientific/technical problems (commonly associated with knowledge).⁸⁰⁵ One should be cautious of following a binary division between scientific/technical problems and social problems.⁸⁰⁶ It is more accurate to refer to the wicked tendencies of problems, that is, using the complexity of the problem as a measurement of the wickedness of the problem.⁸⁰⁷ Rittel and Webber's⁸⁰⁸ framework of conditions that characterises a wicked problem can be summarised as follows:

- The range of possible causes is uncertain. The same applies for possible interactions of those causes;

⁷⁹⁶ Allouche, Middleton and Gyawali "Water-Food-Energy Nexus" 34.

⁷⁹⁷ Allouche, Middleton and Gyawali "Water-Food-Energy Nexus" 34.

⁷⁹⁸ Brouwer "The water-energy-food nexus" 1.

⁷⁹⁹ Brouwer "The water-energy-food nexus" 1.

⁸⁰⁰ Brouwer "The water-energy-food nexus" 1.

⁸⁰¹ Allouche, Middleton and Gyawali "Water-Food-Energy Nexus" 34.

⁸⁰² Allouche, Middleton and Gyawali "Water-Food-Energy Nexus" 34.

⁸⁰³ Stirling "Uncertainty" 120-126.

⁸⁰⁴ Newman and Head 2017 *Policy and Society* 416.

⁸⁰⁵ Newman and Head 2017 *Policy and Society* 416.

⁸⁰⁶ Newman and Head 2017 *Policy and Society* 416.

⁸⁰⁷ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 62-64; Newman and Head 2017 *Policy and Society* 416.

⁸⁰⁸ Rittel and Webber 1973 *Policy Sciences* 155-169.

- The range of possible solutions is equally uncertain;
- Every solution is a "one-shot operation" and will have certain consequences. There are significant "sunk costs" that means that a decision, for example, to develop unconventional natural gas, cannot easily be backed out once started.
- Many people, organisations and social domains are involved, such as multiple stakeholder groups with the power to assert their values. This includes issues of conflicting objectives and values.
- The problem or issue is unique and novel because it is dynamic. This is due to its complexity and uncertainty in the scientific, political and administrative domains.
- Every attempt at resolving the problem leads to new problems.
- There are no absolute right solutions.⁸⁰⁹

Chapter 2 identified a number of social and ecological impacts stemming from UGD. These included multiple uncertainties and complexities in terms of the impacts from exploitation technology used (i.e. hydraulic fracturing). The existence of multiple uncertainties and complexities create serious challenges for regulation and decision-making frameworks on UGD. The complexity and uncertainty combined with the characteristics (above) that indicate a certain wicked tendency that applies to the regulation of UGD. The nexus acknowledges the complexities associated within interlinked systems, particularly water, energy and food. This aligns well with the complexities that emanate from UGD.

The nexus approach to water, energy and food is multi-centric and has a number of uses.⁸¹⁰ It is used "either as an analytical tool, a conceptual framework, a discourse or as part of a decision support system."⁸¹¹ As an analytical tool, the nexus approach uses quantitative and qualitative methods to understand the interactions" between water, energy and food resources and systems.⁸¹² As a conceptual or theoretical framework it guides an understanding of water, energy and food linkages to promote coherence in policy-making and augments sustainability to promote cross-sectoral

⁸⁰⁹ Thompson "Wicked Environmental Problems" 259.

⁸¹⁰ Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 142.

⁸¹¹ Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 142.

⁸¹² Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 142.

approaches.⁸¹³ As a discourse it is a tool for problem framing and the promoting of cross-sectoral approaches.⁸¹⁴ As part of a decision support system it is used to inform resource planning and management decisions.⁸¹⁵

The nexus approach has the potential to enable more sustainable outcomes to water, energy and food security.⁸¹⁶ As stated before,⁸¹⁷ applied to resource management and governance, this approach is an alternative and useful tool or platform to support sustainable development in general, and more specifically, to address concerns on water, energy and food security.⁸¹⁸ The nexus approach advances integration under the sustainable development framework.⁸¹⁹ The nexus approach, in a sense, has become the latest vocabulary defining sustainable development,⁸²⁰ in order to address complex or wicked⁸²¹ challenges in the governance and management of water, energy and food security, amongst others.⁸²²

3.7 Defining the WEF nexus

The nexus concept (as is the case with other concepts) is interpreted differently by different stakeholders, and therefore its precise meaning is contested.⁸²³ The nexus approach aims to understand the interdependency (or critical connections) of

⁸¹³ Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 142.

⁸¹⁴ Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 142.

⁸¹⁵ Mabhaudhi *et al* "Emerging Water-Energy-Food Nexus Lessons" 142.

⁸¹⁶ Hoff 2011 "Understanding the nexus".

⁸¹⁷ See para 3.3 in this chapter.

⁸¹⁸ Salam *et al* "Need for the Nexus" 3; Das Gupta "WEF Nexus and Sustainable Development" 237; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 2; Report by UN Water "Water, Food and Energy" <https://www.unwater.org/water-facts/water-food-and-energy/>.

⁸¹⁹ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 3; Report by UN Water "Water, Food and Energy" <https://www.unwater.org/water-facts/water-food-and-energy/>

⁸²⁰ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 1.

⁸²¹ Thompson "Wicked Environmental Problems" 259; Newman and Head 2017 *Policy and Society* 416; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 62-64; Rittel and Webber 1973 *Policy Sciences* 155-169; Crowley and Head 2017 *Policy Sciences* 539-547. Also see Chapter 1 para 10.

⁸²² Von Bormann and Gulati "The Food Energy Water Nexus" 3; Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 1.

⁸²³ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 2.

interactions between different resource sectors (such as water, energy, and food).⁸²⁴
It is about the relationships that exist between resources.⁸²⁵ Per Mabhaudhi *et al.*⁸²⁶

The water-energy-food nexus approach is a pathway for understanding complex and dynamic interlinkages between issues related to water, energy and food security.

A general definition offered by Hoff⁸²⁷ turns to the benefits of understanding the interdependence between water, energy and food:

The nexus approach highlights the interdependence of water, energy and food security and the natural resources that underpin that security – water, soil and land. Based on a better understanding of the interdependence of water, energy and climate policy, this new approach identifies mutually beneficial responses and provides an informed and transparent framework for determining trade-offs and synergies that meet demand without compromising sustainability,

while Mayor *et al.*⁸²⁸ offer another definition namely:

... the set of interconnections, trade-offs and interdependencies existing between water, energy (and food) as a result of their natural cycles and human use.

UNU-FLORES⁸²⁹ states:

The Nexus Approach to environmental resources' management examines the inter-relatedness and interdependencies of environmental resources and their transitions and fluxes across spatial scales and between compartments. Instead of just looking at individual components, the functioning, productivity, and management of a complex system is taken into consideration.

Lastly, Albrecht *et al.* state:⁸³⁰

The nexus approach aims to maximize synergies (mutually beneficial outcomes), minimize trade-offs (which may potentially include non-optimal outcomes), improve resource-use efficiency, and internalize social and environmental impacts, particularly across a range of contexts and scales. The underlying aims are to strengthen cross-

⁸²⁴ Das Gupta "WEF Nexus and Sustainable Development" 228.

⁸²⁵ Mabhaudhi *et al.* "Emerging Water-Energy-Food Nexus Lessons" 142.

⁸²⁶ Mabhaudhi *et al.* "Emerging Water-Energy-Food Nexus Lessons" 142.

⁸²⁷ Hoff "Understanding the nexus" Background Paper for the Bonn 2011 Nexus Conference. Also, see Avellán and Roidt "The nexus" 18.á.

⁸²⁸ Mayor *et al.* 2015 *Water International* 792.

⁸²⁹ The United Nations University "The Nexus Approach to Environmental Resource Management" <https://flores.unu.edu/en/research/nexus>.

⁸³⁰ Albrecht, Crootof and Scott 2018 *Environmental Research* (13) 1-2.

sectoral integration and improve management outcomes to enhance water, energy, and food security.

Three main characteristics of interactions between resource sectors exist: "some interactions are interdependent; some impose constraints or conditions on one another; and some reinforce one another".⁸³¹ Interactions between resource sectors are analysed to identify both (possible) synergies and trade-offs.⁸³² While it is arguably not that difficult (or new) to identify synergies (for example aspects of resource reuse, recycle, waste management, etc.) between resource interactions, the nexus approach vitally acknowledges the existence of inherent conflicts in those resource interactions.⁸³³ Holley and Kennedy state that the nexus approach⁸³⁴

...emphasises understanding each individual system's complexity, their cross-sectoral and cross-scale interactions, and the opportunities for increasing efficiency, reducing trade-offs, building synergies and improving governance across sectors.

As per Allouche, Middleton and Gyawali⁸³⁵

Elements of the nexus concept ... include aspirations for understanding and managing scarcity, synergies, and trade-offs, increasing efficiency, bridging across fragmented food, water and energy policy and institutions, improving governance and ultimately ensuring that development is sustainable.

From the above definitions, the following can be deduced, namely, that the WEF nexus approach aims to provide a way to understand a) complex interconnections and interdependencies between water, energy and food, (b) as well as (in relation to their scarcity) their synergy and "natural cycles and human use", (c) "their cross-sectoral and cross-scale interactions", also in relation to socio-economic impacts, "and the opportunities for increasing efficiency", (d) the minimising of their trade-offs, (e) the improvement of the integrated governance (also in relation to the legislation and policy context and institutions), (f) in order to ensure efficient resource use, and finally (g) "to enhance water, energy, and food security" and ensure "that development is sustainable".

⁸³¹ Das Gupta "WEF Nexus and Sustainable Development" 231.

⁸³² Das Gupta "WEF Nexus and Sustainable Development" 228.

⁸³³ Das Gupta "WEF Nexus and Sustainable Development" 228.

⁸³⁴ Holley and Kennedy 2019 *Jurimetrics* 4.

⁸³⁵ Allouche, Middleton and Gyawali *Water-Food-Energy Nexus* 2.

Water, energy and food are inextricably linked causing impacts on one or both of the others. The nexus approach emphasises mutual influence, dependency and impact between natural resources such as that of water, energy and food.⁸³⁶ It is based on a need to understand, assess and manage these three resource systems.⁸³⁷ Isolated, sectoral and linear approaches are not suitable to solve the complex problems that exist within natural resource management systems.⁸³⁸ The nexus approach recognises the link between water, energy and food resource systems and emphasises the need to manage them in a more integrated way.⁸³⁹ The nexus concept is useful "for understanding and guiding integrated resource management and planning by highlighting the consequences of sectoral silos and inadequate acknowledgement of trade-offs and externalities".⁸⁴⁰ The WEF nexus approach is useful because it enables the contextualisation and consideration of ecological and societal dimensions as they interact.⁸⁴¹ It aims to achieve better sustainable solutions by identifying potential synergies and minimising trade-offs between water, energy and food resource sectors or systems.⁸⁴² The linkages/feedback loops/interactions between water, energy and food are dynamic in their time dimension (temporal) which refers to differences in time lag, that is an internal impact in one system which simultaneously produces multi-directional influences/impacts on the sub-system and other sub-systems. This initial impact will be repeated multi-directionally over time.⁸⁴³

The nexus approach is about the reduction of unintended consequences to be achieved through increasing performances within the water, energy and food sectors, and at the same time creating cross-sectoral synergies not only between different levels (international, national, regional and local), but also across administrative boundaries (governance at horizontal and vertical levels).⁸⁴⁴

⁸³⁶ Schneider, Avellan and Le Hung "Water–Energy–Food Nexus and Sustainability" 2.

⁸³⁷ Schneider, Avellan and Le Hung "Water–Energy–Food Nexus and Sustainability" 2.

⁸³⁸ Schneider, Avellan and Le Hung "Water–Energy–Food Nexus and Sustainability" 2.

⁸³⁹ Maas 2017 *Frontiers in Environmental Science* 2.

⁸⁴⁰ Report to the Water Commission 2021 *Exploring the evidence of water-energy-food nexus linkages in South Africa* 184.

⁸⁴¹ Hamidov *et al* 2022 *Ecology and Society* 1.

⁸⁴² Hamidov *et al* 2022 *Ecology and Society* 1; Schneider, Avellan and Le Hung "Water–Energy–Food Nexus and Sustainability" 1.

⁸⁴³ Yan, Fang and Mu 2020 *Science of the Total Environment* 3-4.

⁸⁴⁴ Leese and Meisch 2015 *Water Alternatives* 700.

While there is yet to emerge a generally agreed-upon definition of the nexus approach, a study by Roidt and Avellán found that the nexus approach (in all its different conceptualisations) strives towards sustainability.⁸⁴⁵ According to the study, the goals of the WEF nexus displays the following elements:

- attain water, energy and food security;
- support the SDGs and sustainable development;
- increase resource efficiency;
- mainstream resource governance and boost rational decision-making;
- improve policy coherence and cooperation within and between resource sectors; and
- focus on cross-sectoral integration.⁸⁴⁶

The elements linked to the water, energy and food nexus are therefore based on the recognition and identification of possible trade-offs and synergies between the water, energy and food sectors.⁸⁴⁷ The nexus is about efficiency (increasing the efficiency of resource use), trade-offs, synergies (knowledge generation that informs and recognises trade-offs and synergies between sectors), ecosystem services (recognising the significance of ecosystem services, particularly the provisioning of services such as freshwater and food)⁸⁴⁸ and resource access to the poor communities (accelerating resource access to the poor by including them in resource management).⁸⁴⁹

⁸⁴⁵ Schneider, Avellan and Le Hung "Water–Energy–Food Nexus and Sustainability" 1; Avellán and Roidt "The nexus" 20.

⁸⁴⁶ Avellán and Roidt "The nexus" 20.

⁸⁴⁷ Das Gupta "WEF and Sustainable Development" 228.

⁸⁴⁸ See also para 3.2 in this chapter. Suarez and Dempsey "Ecosystem Services" 173. The main core of 'ecosystem services' as a concept is the recognition that nature is valuable because it provides many benefits to humans. While the concept is based on recognizing the value of nature, it is contested between two main groups who hold different views on how to quantify nature's value to humans. One group aims to quantify the value of nature in monetary terms (with its market orientated connotations) while another group points to the difficult-to-quantify complexities of ecosystems (in other words it is not possible to put a monetary value on nature). For the purpose of this study the definition provided by The Millennium Ecosystem Assessment on ecosystem services suffice, namely 'the benefits people obtain from ecosystems'. See the Millennium Ecosystem Assessment (MA) synthesis report "Ecosystems and Human Well-Being" v.

⁸⁴⁹ Hoff "Understanding the nexus".

In addition to the above, the main nexus elements further include the advancement of sustainable and efficient resource use (doing more with less), ensuring access to resources for the most vulnerable in society, and the maintenance of healthy and productive ecosystems.⁸⁵⁰ Common elements of the water, energy and food nexus are interdependency between sectors, the need for integrated management and governance across sectors and a focus on promoting resource security.⁸⁵¹ The nexus approach is about the need for integration across sectors, silos, scales and stakeholders.⁸⁵² As stated before, it calls for a move away from a sector-by-sector approach to policy, science, and practice towards a more interlinked governance approach.⁸⁵³

The next paragraph first explores governance in general, discussing different approaches to governance and nexus governance and then linking governance to the WEF nexus.

3.8 Governance

3.8.1 Governance defined

Governance is a widely used term in social sciences.⁸⁵⁴ Numerous definitions aim to describe "governance".⁸⁵⁵ Bennet⁸⁵⁶ provides the following general definition:

Governance is an umbrella term that refers to the structures, institutions (i.e., laws, policies, rules, and norms), and processes that determine who makes decisions, how decisions are made, and how and what actions are taken and by whom.

⁸⁵⁰ Das Gupta "WEF and Sustainable Development" 228.

⁸⁵¹ On securitisation see para 3.5 in this chapter. Stein, Barron and Moss "Governance of the Nexus" 6.

⁸⁵² Gomez "Foreword" xxiii.

⁸⁵³ Dodds and Bartram "History of the Nexus" 27.

⁸⁵⁴ The concept straddles different disciplines, such as law, public administration, political sciences, economy, sociology and management. See Benson *et al* "Governing for the nexus" 82; *Global Environmental Governance* 294-298.

⁸⁵⁵ See Von Benda-Beckmann F, Von Benda-Beckmann K and Eckert J "Rules of Law and Laws of Rule: Law and Governance between Past and Future" in Von Benda-Beckmann F, Von Benda-Beckmann K and Eckert J (eds) *Rules of Law and Laws of Rule: On the Governance of Law* (Ashgate Farnham 2009) 1-30; Kotzé *Global Environmental Governance* 294-298.

⁸⁵⁶ Bennett 2015 *Conservation Biology* 303.

It encompasses multiple theoretical approaches, each with different objects of study.⁸⁵⁷ The concept of governance, like other popular concepts that derive from diverse disciplines, is prone to different understandings and assumptions.⁸⁵⁸ Governance is a rather flexible concept and can take on a number of forms.⁸⁵⁹ This is due to its ability to be applied in different contexts and purposes.⁸⁶⁰ The objective of governance is usually understood as aiming to achieve a collective goal (or goals) or to solve a collective social issue.⁸⁶¹ Governance can be either state-based (in a coercive and top-down manner) or be hybrid that includes numerous non-state actors across different levels (in a bottom-up manner).⁸⁶² Traditionally ascribed to indicate the steering, regulation and directional function of the state (state-centric) the concept of governance has indeed expanded to include a multi-level, multi-actor, hybrid and multiple number of regulatory arrangements.⁸⁶³ Multi-level governance consists of networks of actors that straddle different institutional levels and policy sectors.⁸⁶⁴

Whichever form of governance is used or focused on within a specific context, a number of core elements are indicative of its character.⁸⁶⁵ This includes its focus on the steering or regulating of human activities generally, and particularly, at an institutional level to achieve common objectives that provide the means for cooperation, interaction and coordination.⁸⁶⁶ Governance can therefore be understood in terms of process, namely that a number of instruments (such as policy) and institutions are used to steer human actions (society) to more sustainable outcomes.⁸⁶⁷ In this sense, achieving common goals and/ or solving collective issues require cooperation, interaction and coordination among and between different actors, and

⁸⁵⁷ Benson *et al* "Governing for the nexus" 82.

⁸⁵⁸ Benson *et al* "Governing for the nexus" 82; Kotzé *Global Environmental Governance* 294-295.

⁸⁵⁹ Kotzé *Global Environmental Governance* 98.

⁸⁶⁰ Kotzé *Global Environmental Governance* 98.

⁸⁶¹ Kotzé *Global Environmental Governance* 82.

⁸⁶² Jordan and Benson "Multi-level environmental governance" 783; Kotzé *Global Environmental Governance* 98.

⁸⁶³ Jordan and Benson "Multi-level environmental governance" 783; Kotzé *Global Environmental Governance* 98.

⁸⁶⁴ Jordan and Benson "Multi-level environmental governance" 785.

⁸⁶⁵ Kotzé *Global Environmental Governance* 98.

⁸⁶⁶ Governance has distinct characteristics linked to authority (legitimacy), politics and law (normative law and law like rules). See Kotzé *Global Environmental Governance* 98-99.

⁸⁶⁷ Jordan and Benson "Multi-level environmental governance" 785.

institutions.⁸⁶⁸ The collective goal of more sustainable outcomes across an ever-increasing number of governance instruments, institutions and organisations therefore requires some sort of coordination, interaction and coordination.⁸⁶⁹ This arguably could include some elements of a systems approach whereby the interlinked objective of sustainable outcomes across different policy sectors is acknowledged.⁸⁷⁰ In other words, there is an increasing need to govern systems of governance.⁸⁷¹

Governance can be approached from different philosophical points of departure. The following paragraphs refer to governance in relation to recent debates, such as anthropocentrism, systems-thinking, and the socio-ecological approach.⁸⁷² This will be followed by a discussion of nexus governance leading to defining WEF nexus governance.

3.8.2 Systems thinking: linking the socio-ecological to governance

Systems thinking⁸⁷³ has changed the way we understand the world, namely conceptualising it as a socio-ecological system resulting from human and ecological systems interacting in time and space on different hierarchical scales.⁸⁷⁴ Systems thinking emphasises that an integrative approach to human (social) and biophysical environments has value for sustainability.⁸⁷⁵ The realisation that humans are powerful actors in transforming nature already existed some four decades ago. For example, Godelier⁸⁷⁶ states:

Human beings have a history because they transform nature. It is indeed this capacity which defines them as human. Of all forces which set them in movement and prompt

⁸⁶⁸ Kotzé *Global Environmental Governance* 78. For a more in-depth description of related concepts on governance, such as regulation; government, bureaucracy, management and law, see Kotzé *Global Environmental Governance* 82-98.

⁸⁶⁹ Jordan and Benson "Multi-level environmental governance" 786.

⁸⁷⁰ Kotzé and Kim 2022 *Global Policy* 87.

⁸⁷¹ Jordan and Benson "Multi-level environmental governance" 785; Kotzé and Kim 2022 *Global Policy* 87.

⁸⁷² See for example Soyapi 2023 *Potchefstroom Electronic Law Journal* 5.

⁸⁷³ See also Colding and Barthel 2019 *Ecology and Society* 1-10; Biggs *et al* "Social-ecological systems" 3-26; Ebbesson and Hey 2013 *Ecology and Society* 1-4.

⁸⁷⁴ Maas 2017 *Frontiers in Environmental Science* 2. Others, like Kotzé and Kim use an earth system perspective. See Kotzé and Kim 2022 *Global Policy* 86-97.

⁸⁷⁵ Aarts and Drenthen 2020 *Sustainability* 5.

⁸⁷⁶ Godelier "The Mental and the Material" 1.

them to invent new forms of society, the most powerful is their ability to transform their relations with nature by transforming nature itself.

Maturana and Varela also refer to society's inability to adequately react to disturbances in the natural environment, even if these disturbances were detrimental to society.⁸⁷⁷ Continuing this line of thought Beck⁸⁷⁸ posited that society was characterised by the ways in which it creates and handles environmental risks and redistributes their consequences (between humans, i.e. members of society). This idea was taken up within a debate on "ecological modernisation", which supported the idea that modern societies are capable of technological and organisational learning to lessen or solve environmental problems.⁸⁷⁹

The core tenet of socio-ecological systems is that human social and natural (biophysical) systems interact, co-evolve over time and greatly influence one another with casualty pointing in both directions.⁸⁸⁰ Socio-ecological systems capture interactions between energy and society, land-use and food production, the metabolism of societies, and the environmental impacts of human activities.⁸⁸¹ The motive for moving to a more integrative approach that views social and ecological interactions as operating within a system, is to respond to critical sustainability issues that stem from society's inability to properly understand and address its relation to the natural environment.⁸⁸²

Humans (social) are intrinsically linked with ecological systems.⁸⁸³ Human values, social structures and norms largely determine how humans interact with the physical environment. Similarly, the physical environment has significant impacts on humans and societies.⁸⁸⁴ Recent understanding of the interactions that exist between social and ecological systems acknowledges the importance of valuing the social and

⁸⁷⁷ Maturana and Varela "Autopoietic Systems"; Kotzé and Kim 2022 *Global Policy* 92.

⁸⁷⁸ Beck "Risikogesellschaft".

⁸⁷⁹ Jänicke "Ökologische Modernisierung" 13-26; Mol and Spaargaren 200 *Environmental Politics* 17-49.

⁸⁸⁰ Fischer-Kowalski 2015 *Social Ecology* 254.

⁸⁸¹ Fischer-Kowalski 2015 *Social Ecology* 254.

⁸⁸² Fischer-Kowalski 2015 *Social Ecology* 254.

⁸⁸³ Aarts and Drenthen 2020 *Sustainability* 1.

⁸⁸⁴ Aarts and Drenthen 2020 *Sustainability* 1.

ecological systems in equal margin.⁸⁸⁵ This understanding of socio-ecological interactions consider the social and ecological as different aspects of the same reality.⁸⁸⁶ Interactions are therefore not merely between those systems but take place within the socio-ecological whole.⁸⁸⁷ This interpretation attempts to move away from a silo perspective where socio-ecological interactions were traditionally framed either from a social science (humanistic) or a natural science perspective.⁸⁸⁸ In other words, there is a call for a perspective that treats socio-ecological interactions in a more holistic way.⁸⁸⁹ While the equal importance of social and ecological perspectives is generally acknowledged, truly integrated or holistic research that covers both perspectives in one comprehensive framework, is neither straight-forward nor complex for many examples thereof exists.⁸⁹⁰ There is a continuous reciprocal influence of social and ecological aspects. In this sense socio-ecological interactions are interlinked.⁸⁹¹ There is a need for an integrative approach to socio-ecological interactions,⁸⁹² which will require the understanding of both the social science and the natural science perspective.⁸⁹³ Notably, literature in socio-ecological systems recognises its usefulness as an intertwined complex adaptive system.⁸⁹⁴

The complex nature of linked socio-ecological systems calls for governance models or approaches that can respond and deal with such complexity.⁸⁹⁵ The dynamic and non-linear nature of socio-ecological systems makes it complex, particularly as it includes a broad range of actors operating over spatial and temporal scales.⁸⁹⁶ The concept of "adaptive governance" is a popular governance model used to address complexity in social-ecological systems. This is due to its reflexive characteristic, namely, the ability to continuously reassess dynamic interactions and their impacts within socio-ecological

⁸⁸⁵ Aarts and Drenthen 2020 *Sustainability* 1.

⁸⁸⁶ Aarts and Drenthen 2020 *Sustainability* 1.

⁸⁸⁷ Aarts and Drenthen 2020 *Sustainability* 1.

⁸⁸⁸ Fischer-Kowalski 2015 *Social Ecology* 254; Aarts and Drenthen 2020 *Sustainability* 1.

⁸⁸⁹ Aarts and Drenthen 2020 *Sustainability* 1.

⁸⁹⁰ Aarts and Drenthen 2020 *Sustainability* 2.

⁸⁹¹ Aarts and Drenthen 2020 *Sustainability* 5. For example, trying to understand how humans impact the physical environment and at the same time how the environment impacts human life.

⁸⁹² Aarts and Drenthen 2020 *Sustainability* 5.

⁸⁹³ Aarts and Drenthen 2020 *Sustainability* 1.

⁸⁹⁴ Preiser *et al* "Complexity based social-ecological systems research" 27.

⁸⁹⁵ Humby 2014 *PELJ* 1683.

⁸⁹⁶ Humby 2014 *PELJ* 1683.

systems and its being able to adapt to changing circumstances.⁸⁹⁷ This reflexive characteristic requires the ability to identify a range of critical actors that function over spatial and temporal scales.⁸⁹⁸

Humby⁸⁹⁹ states:

One needs to know how a socioecological system extends over multiple scales and what kind of different roles and responsibilities different kinds of actors (including different levels of government ...) have in relation to maintaining that systems integrity. This places great emphasis on the values of working together (through coordination, the exchange of information, and so on) and continuous learning.

As stated before, critical to the enhancement of water, energy and food security entails an improved understanding of complex socio-ecological systems.⁹⁰⁰ Complex socio-ecological systems are apparent at many levels. From a regulatory and decision-making perspective, complexity is to be found within the "rules in use" that affect decisions on the allocation of resources.⁹⁰¹ Systems theory indicates "that uncertainty can be addressed in part by understanding inter-dependence and inter-connectedness of social and biophysical systems".⁹⁰²

There is a need for regulatory frameworks to understand and assess the WEF nexus from a socio-ecological perspective.⁹⁰³ The socio-ecological approach makes the human (socio) and biophysical (ecological) nature of interactions very explicit. The socio-ecological system approach views humans as internal drivers of natural systems (as opposed to external ones).⁹⁰⁴ In this sense humans are seen as agents acting within socio-ecological systems.⁹⁰⁵ Human (social) and biophysical (ecological)

⁸⁹⁷ Humby 2014 *PELJ* 1683.

⁸⁹⁸ Humby 2014 *PELJ* 1683.

⁸⁹⁹ Humby 2014 *PELJ* 1684.

⁹⁰⁰ Scott, Kurian and Wescoat "The water-energy-food nexus" 23.

⁹⁰¹ Kotzé and Kim 2022 *Global Policy* 87.

⁹⁰² Biophysical understood here as the physical environment (water, soil etc.) as well as the biological activity within it that consists of biotic, climatic and abiotic factors. Scott, Kurian and Wescoat "The water-energy-food nexus" 24.

⁹⁰³ Ghodsvalli, Dane and de Vries *ESP* (130) 23. For example, Villavicencio and Mauger use the case of energy transition in Bolivia to show how regulatory and policy frameworks are shifting from a human centric (anthropogenic) to a more ecocentric approach. See Villavicencio and Mauger "Bolivia's energy transition" 56.

⁹⁰⁴ Maas 2017 *Frontiers in Environmental Science* 2. Also, see Black J "The Mobilization of Law" 1973 *Journal of Legal Studies* 125-149.

⁹⁰⁵ Maas 2017 *Frontiers in Environmental Science* 2.

qualities are recognised as an integrated and interconnected system.⁹⁰⁶ Decision-makers are therefore not in a position to make well-informed decisions on the impacts of development activities on socio-ecological systems if they do not take their interconnectedness or nexus into account.⁹⁰⁷ The WEF nexus is underpinned by the human-nature interaction.⁹⁰⁸ Many definitions only focus on the WEF system itself, but Daohan *et al* confirm that the WEF nexus is:⁹⁰⁹

... a set of complex linkages across the natural and human systems, including resource interdependence at a larger scale and governance at the local scale.

The next paragraph considers nexus governance.

3.8.3 Nexus governance

Studies that specifically focus on nexus governance⁹¹⁰ are relatively few and limited.⁹¹¹ There is, however, a growing recognition of the need for more nexus governance studies. This is motivated by the increasing need for the critical examination of the role of nexus governance in tackling sustainability issues.⁹¹² While nexus governance studies are increasing, most studies fail to capture some critical aspects of nexus governing.⁹¹³ Sustainable outcomes require a nexus approach that serves both humans and nature.⁹¹⁴ It therefore requires more holistic theorising.⁹¹⁵ An example is then that, regulation, as a concept, is understood differently by different actors and institutions.⁹¹⁶

⁹⁰⁶ Maas 2017 *Frontiers in Environmental Science* 2.

⁹⁰⁷ Scott, Kurian and Wescoat "The water-energy-food nexus" 25. The WEF nexus also has many implications for social-ecological systems – 33.

⁹⁰⁸ Daohan *et al* 2020 *Science of the Total Environment* 2.

⁹⁰⁹ Daohan *et al* 2020 *Science of the Total Environment* 2.

⁹¹⁰ See also Melloni *et al* "Multi-level governance challenges" 346-360; Kurian *et al* 2019 *Frontiers in Environmental Science* 1-17; Benson *et al* "Governing for the Nexus" 77-88.

⁹¹¹ Pahl-Wostl *et al* 2020 *Sustainability Science* 615; Benson *et al* "Governing for the nexus" 78. In comparison to nexus governance studies, there are substantially more studies focusing on the quantitative aspects of nexus modelling etc.

⁹¹² Benson *et al* "Governing for the nexus" 79; Pahl-Wostl *et al* 2020 *Sustainability Science* 356-367; Kotzé and Kim 2022 *Global Policy* 86-97.

⁹¹³ Benson *et al* "Governing for the nexus" 79; Pahl-Wostl *et al* 2020 *Sustainability Science* 356-367; Kotzé and Kim 2022 *Global Policy* 86-97.

⁹¹⁴ Marx 2015 *Change Adaptation in Socio-ecological Systems* 79.

⁹¹⁵ Benson *et al* "Governing for the nexus" 79.

⁹¹⁶ Peel "Regulation of the nexus" 199.

In a narrow, legal sense, regulation might be confined to the rules developed by government departments or independent agencies to implement a legislative mandate. More commonly, regulation is conceived broadly as the 'intentional activity of attempting control, order or influence the behavior of others'. This activity may be undertaken by governments directly, through the promulgation of standards backed up by sanctions, or indirectly, through creating incentives for behavioral change by private actors.

Decision-makers operate within numerous decision-making frameworks (such as regulatory frameworks) that are for the most part located within an institutional set-up. Government regulation tends to consist of multiple tiers or spheres that straddle the South African scenario in national, provincial and local spheres.⁹¹⁷ This is also the case in South Africa where decisions on UGD consist of a process involving numerous government departments at different spheres (national, provincial and in some instances local/municipal).⁹¹⁸

Regulation can be categorised as either "direct government regulation" such as legal measures (legislation) or "indirect government regulation" such as delegated regulation undertaken by non-governmental or quasi-public bodies.⁹¹⁹ Non-governmental organisations or institutional rules, as well as social and cultural norms of societies, may constitute regulatory frameworks that need to be considered.⁹²⁰

⁹¹⁷ Adom, Simatele and Reid 2022 *JWCC* 2765; Larcom and Van Gevelt *ESP* 55-56. This differs from one jurisdiction to the other and within government structures (at a horizontal level between different ministerial departments and at vertical levels between different national, provincial and local government spheres).

⁹¹⁸ See Chapter 4. This is also true of integrated environmental management and environmental governance, see in this regard Nel and Alberts "Environmental Management and Environmental Law in South Africa: An introduction" 1-55; Nel, Du Plessis and Du Plessis "Chapter 3 Instrumentation for local environmental governance".

⁹¹⁹ Benson *et al* "Governing for the nexus" 84. Benson *et al* "Governing for the nexus" 82 identify four main governance approaches that can be applied to the water, energy and food nexus. They are regulatory governance, global governance (82), collaborative governance (83) and market governance (83).

⁹²⁰ Larcom and Van Gevelt *ESP* 56. For cases where cultural arguments were raised in South Africa courts, see *Sustaining the Wildcoast v Minister of Mineral Resources and Energy* [2022] 1 All SA 796 (ECG); *Adams v Minister of Mineral Resources and Energy* (1306/22) [2022] ZAWCHC 24 (1 March 2022); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* [2022] 4 All SA 533 (ECG); *Gongqose v Minister of Agriculture, Forestry, Gongqose and S* [2018] 3 All SA 307 (SCA); 2018 (5) SA 104 (SCA); 2018 (2) SACR 367 (SCA). It is not always easy to determine what African customary law or cultural norms are and requires law to also consult Anthropology, see in this regard Comaroff and Comaroff "Reflections on the Anthropology of Law, Governance and Sovereignty" 31-60.

Nexus regulation or regulating for the nexus "can be understood as the different forms of regulation by which government seeks to achieve nexus objectives for sectoral integration, thereby enhancing synergies and reducing conflicts between the water, energy and the food sectors".⁹²¹ Nexus governance in turn can "be understood as the different patterns of governing by which political actors seek to achieve nexus objectives for sectoral integration, thereby enhancing synergies between water, energy and food resource systems and reducing conflicts".⁹²²

Nexus governance requires actors and institutions such as different government departments to coordinate their actions on a continuous basis.⁹²³ This implies coordination between actors and government departments at both the horizontal and vertical levels.⁹²⁴ Further, any effort at coordination requires, at a minimum, the sharing of information and data between the different actors and or departments.⁹²⁵ Coordinating efforts depend on the different actors and institutions informing one another of their actions (e.g. policy, regulation, decision-making).⁹²⁶

Nexus governance can be compared to environmental governance and integrated environmental management. Kotzé defines environmental governance as:⁹²⁷

A management process executed by institutions and individuals in the public and private sector to holistically regulate human activities and the effects of human activities on the total environment (including all environmental media, and biological, chemical, aesthetic and socio-economic processes and conditions) at international, regional, national and local levels; by means of formal and informal institutions, processes and mechanisms embedded in and mandated by law, so as to promote the common interests human-beings hold in the environment.

Similar to socio-ecological and nexus governance, Kotzé links human activities as a catalyst for environmental impacts and indicates that formal and informal institutions, processes and mechanisms of the law play an important part. He also emphasises that humans have a common interest in the environment. His definition correlates with the

⁹²¹ Benson *et al* "Governing for the nexus" 78.

⁹²² Benson *et al* "Governing for the nexus" 78.

⁹²³ Marx 2015 *Change Adaptation in Socio-ecological Systems* 79.

⁹²⁴ Marx 2015 *Change Adaptation in Socio-ecological Systems* 79.

⁹²⁵ Marx 2015 *Change Adaptation in Socio-ecological Systems* 79.

⁹²⁶ Marx 2015 *Change Adaptation in Socio-ecological Systems* 79.

⁹²⁷ Kotzé "Environmental Governance" 107-108.

concept of integrated environmental management. Nel and Alberts state that integrated environmental management is not merely a reflection of principles, philosophies or a series of tools, but that:⁹²⁸

IEM should integrate a wide range of issues that affect both environmental management and governing, such as (a) the collective efforts of all organs of state in all three spheres of government that have some jurisdiction over the environment or parts thereof; (b) the tools that cover all phases of the PDCA & R⁹²⁹ cycle, (c) all the separate line functions of government mandated to govern elements of the environment, (d) the integration of suitable tools along the decision and planning phases of a policy, plan or project, (e) the integration of environmental governing tools, as well as (f) an integrated consideration of all of the environmental media.

Integrated management takes place throughout the life-cycle of a project or product. A life-cycle commences with a planning and design phase, the operational phase and the closure and decommissioning phases.⁹³⁰ During each phase there should be continuous monitoring and auditing to determine whether the developer complies with the conditions in the relevant authorisations.⁹³¹

According to Nel and Alberts, environmental governance and integrated environmental management face various challenges that can also relate to the governance of water, energy and food.⁹³² These challenges include, amongst others, that government agencies need to drive (a) change and implementation of policies and legislation, (b) new technology, and (c) the management and governance of strategic infrastructure projects (e.g. UGD).

Implicated in the definitions of nexus governance, environmental governance and integrated environmental governance, is cooperative governance. Cooperative governance means that all government departments in the same sphere as well as

⁹²⁸ Nel and Alberts "Environmental Management and Environmental Law in South Africa: An Introduction" 41. This definition is built on the work of Du Plessis and Nel 2004 *SA Public Law* 181-190.

⁹²⁹ Plan, Do Check, Act and Report. See in this regard Du Plessis and Nel "Driving Compliance to and Enforcement of South African Legislation by Means of a Hybrid of 'New' Environmental Governance Instruments" 259-285.

⁹³⁰ Nel and Alberts "Environmental Management and Environmental Law in South Africa: An introduction" 30.

⁹³¹ Nel and Alberts "Environmental Management and Environmental Law in South Africa: An introduction" 42.

⁹³² Nel and Alberts "Environmental Management and Environmental Law in South Africa: An introduction" 44.

between spheres of government (national, provincial and local in the case of South Africa) should work together in decisions that may impact on the work of the different departments or spheres.⁹³³ There are many challenges with cooperative governance, that include silo-based decision-making, fear of interference in another department or sphere's mandate or protectionism of a department of the sphere's own mandate.⁹³⁴ The idea of cooperative governance is also linked to integrated decision-making as indicated above.⁹³⁵ In UGD cooperative governance will have to play a major role, as Chapter 2 indicates, so that the impacts of UGD relate not only to environmental issues but also have an impact upon social and cultural issues, amongst others – all regulated by different departments and spheres.⁹³⁶

WEF nexus governance takes nexus governance further, as more than merely governance or cooperation issues need to be taken into account, and focuses on the integration between water, energy and food itself.

3.9 Nexus governance in the WEF context

Governing the WEF nexus should aim for cross-sectoral integration and coordination at horizontal (between different institutions, departments and or ministries) and vertical (i.e. regional, national, provincial and local) levels.⁹³⁷ Governing the nexus is about acknowledging that the different sectors of water, energy and food are interconnected and dynamic in nature. In other words, it is not simply about governing the different sectors by acknowledging connections between them but also governing the non-linear (dynamic) nature of these.⁹³⁸

Pahl-Wostl *et al* indicate that water, energy and food resource systems operate at multiple levels and hence a multi-level governance approach that acknowledges issues

⁹³³ Chapter 3 of the Constitution requires cooperative governance. See Chapters 4.5-4.6 and Chapter 5.8.

⁹³⁴ See in this regard Du Plessis 2008 *SA Public Law* 87-110; Makoti and Odeku 2021 *African Journal of Public Affairs* 43-60.

⁹³⁵ See Chapters 4.6 and 5.8 where new integrated decision-making is now incorporated into South African legislation and policy.

⁹³⁶ See Chapter 4.6.

⁹³⁷ Benson *et al* "Governing for the nexus" 86.

⁹³⁸ Marx 2015 *Change Adaptation in Socio-ecological Systems* 79.

of scale, is required.⁹³⁹ Nexus governance needs to identify and understand issues of scale in the sense of the following: scalar fit (different processes between different resource systems), scalar strategies (different agendas i.e. strategic); institutional interplay (context specific and complex, depending on number of factors such as entrenched historical arrangements), uncertainty (impact of external factors such as climate change, and finally, internally from interactions within and between systems, such as, for example, energy transitions (governance needs to be flexible and reflexive and adaptive). Within the water, energy and food nexus construct, research and practice regarding regulation of the WEF nexus, are at an emerging stage.⁹⁴⁰ It is noted that there should be close links between water, energy and food resource systems in regulatory frameworks,⁹⁴¹ as Dawoud⁹⁴² states:

Integration of legal and institutional frameworks refers to the need for cross-sectoral interconnectivity so as to minimize the potential conflicts between the various legal, policy, and institutional frameworks that apply to the management of the water, food, and energy nexus or each of these resources.

Although several instruments within any regulatory framework could be used to meet water, energy and food security target(s), it takes direct regulatory instruments such as laws, policies, rules, regulations and institutional decision-making frameworks, (stipulating, for example, quality standards, bans on certain products or practices, requirements for the application of best available techniques) and obligations to obtain authorisations, that represent the bulk of instruments used.⁹⁴³

Forms of regulatory integration may vary from weak to moderate to strong.⁹⁴⁴ A weak form of regulatory integration is defined as a requirement within a regulatory framework (government policy, legislation, regulation, authorisations and rules) to

⁹³⁹ Pahl-Wostl *et al* 2020 *Sustainability Science* 615.

⁹⁴⁰ Peel "Regulation of the nexus" 198.

⁹⁴¹ Dawoud "Water, Energy and Food Security Nexus" 163

⁹⁴² Dawoud "Water, Energy and Food Security Nexus" 163.

⁹⁴³ Peel "Regulation of the nexus" 199; OECD 2013. Law is a social construct (it owes its existence to human activities, beliefs, intentions and practices) that makes use of legal and regulatory frameworks to change human behaviour and to achieve certain outcomes. See Menkel-Meadow 2017 *FSULR* 93, 96; Giudice *Social Construction of Law* 1; Barton "The Theoretical Context of Regulation" 12-13; Peel "The Regulation of the Nexus" 199. Also, see Kotzé *Global Environmental Governance* 2-3; Richardson 2011 *CRLPE* 29.

⁹⁴⁴ Peel "Regulation of the Nexus" 201.

consider elements of the nexus that include water, energy and or food.⁹⁴⁵ In other words, the requirement is neither mandatory nor does it seek to optimise outcomes for other elements of the nexus.⁹⁴⁶ On the other end of the spectrum, strong forms of regulatory integration include a requirement within a regulatory framework that seeks to maximise synergistic, mutually-beneficial outcomes for all the nexus elements (water, energy, and food).⁹⁴⁷ An integrative regulatory framework can be defined as one that provides for:⁹⁴⁸

...comprehensive standards and rules on the use, treatment, waste management and discharge, emission reduction, savings and efficiency, project design, approval, reporting and monitoring with respect to WEF resources and projects.

Government policy, legislation, regulation, rules and procedures, authorisation and approval,⁹⁴⁹ responsibilities and institutional coordination and cooperation⁹⁵⁰ should be clear across the WEF sectors.⁹⁵¹ There should be a focal institution or administrative unit that coordinates information, expertise and knowledge-sharing in relation to the WEF nexus. The main elements that are indicative of a nexus (integrated) approach to water, energy and food include the following: diversification of sources of information, use of information-gathering tools such as reporting, monitoring and strategic planning; participative and collaborative decision-making processes, a move away from a front end regulatory approach (such as EIA or to some extent a strategic environmental assessment which seeks to predict and manage all impacts in advance of development⁹⁵²) or strengthening a back-end approach that focuses on adaptation

⁹⁴⁵ Peel "Regulation of the Nexus" 201.

⁹⁴⁶ Peel "Regulation of the Nexus" 201.

⁹⁴⁷ Peel "Regulation of the Nexus" 201.

⁹⁴⁸ Olawwuyi 2020 *Environmental Science and Policy* 7.

⁹⁴⁹ Olawwuyi 2020 *Environmental Science and Policy* 7.

⁹⁵⁰ Olawwuyi 2020 *Environmental Science and Policy* 7.

⁹⁵¹ Olawwuyi 2020 *Environmental Science and Policy* 7.

⁹⁵² Hussey and Pittock 2012 indicate that mechanisms, such as environmental impact assessment (EIA) and strategic environmental assessment (SEA) offer potential for integrating decision-making across water, energy and food sectors. Both EIA and SEA offer a structured approach for obtaining and evaluating information in order to identify potential social-ecological impacts in advance of development taking place. See Abaza, Bisset and Sadler "Environmental impact assessment and strategic environmental assessment" 113-128. Whereas an EIA is applied most commonly in respect of physical development and discrete projects, SEA targets 'higher' level policies, plans and programmes that may have broad-scale, cumulative environmental impacts. See Marsden and Dovers "Prospects for SEA" 211-218; Humby "Environmental assessment of shale gas" 92-97. For regulation of the water, energy and food nexus, EIA and SEA offer the

and adjustment over time, enabling the regulatory framework to be more flexible, resilient and agile, which is not being locked into a single decision-making process, but is open to possible adjustments.⁹⁵³

Avellán and Roidt developed a useful assessment model by identifying indicators that could be used to determine possible governance gaps in WEF policies, legislation and projects or programmes.⁹⁵⁴ Their assessment model assesses the following:

- Accountability gaps (roles and responsibilities and mechanisms to ensure social and environmental responsibility).⁹⁵⁵
- Administrative gaps (vertical and horizontal mismatch between geographic and administrative scale and problem configuration).⁹⁵⁶
- Policy gaps (Definition of shared governance principles).⁹⁵⁷

953 prospect of integration by providing a decision-making framework within which water, energy and food impacts and trade-offs can be evaluated. Peel "Regulation of the nexus" 204.
Peel "Regulation of the nexus" 209-212; Urbinatti *et al* 2020 Science of the total environment 5-7; Melloni *et al* "Governance challenges of nexus" 346-359; Pahl-Wostl 2019 *Environmental Science & Policy* 356-367.

954 Avellán and Roidt "The nexus" 23-25.

955 They pose the following questions: "Identify and engage all stakeholders involved? Are roles and responsibilities clearly allocated for WEF decision-making structures – numerous levels and stakeholders? Political will on accountability? Civil society organisations or citizen-driven accountability initiatives with enough resources information demanding accountability of government and other powerful actors? Are regulations and sanctions present and regularly enforced?"

956 Noting the following question: "Are there overlapping jurisdictional boundaries in the resource systems considered (national, provincial and local)? Does the scale of the problem addressed match the scale of governance involved in the decision-making process (national, provincial, local)? Is there only one responsible organization ministry for each WEF sector in the areas considered? Is there a mismatch in the definition of environmental and resource security concerning the WEF sectors among public-sector bodies? Have trade-offs among resources been balanced to not cause conflict between sector users and providers? Have compensatory measures been considered for the nexus sector that is more negatively affected by trade-offs? Are there conflict mitigation and resolution mechanisms to manage trade-offs across WEF sectors?"

957 Questions include: "Does the project/policy provide a clear definition of nexus security considering sectoral priorities and national, provincial and local perspectives? Have local actors been involved in defining the nexus problem solution for a bottom up approach and definition of social priorities? Does the project build a comprehensive understanding of social, environmental and economic risks and opportunities considering all nexus sectors? Is there any explicit willingness by the national, provincial, local government or public sector agencies to adopt the WEF nexus approach in its strategy and social plan?"

- Policy gaps (Vertical and horizontal integration of objectives across different scales (geographic and temporal) and sectors (ministries, public sector agencies)).⁹⁵⁸
- Power imbalances and negotiation.⁹⁵⁹
- Capacity gaps (assessment of existing policies and institutions).⁹⁶⁰
- Capacity gaps (attitude towards knowledge-sharing and participation).⁹⁶¹
- Data and information gaps (data availability and nexus system boundaries).⁹⁶²
- Data and information gaps (communication).⁹⁶³

⁹⁵⁸ Questions include: "Are there existing mandates and mechanisms (planning processes, budgetary processes, guidelines or regulations) that allow ministries and public-sector agencies to align respective sectoral programmes, budgets and policies? Are there existing coordination mechanisms that allow for systematic consultation, collaboration and alignment of efforts at the national, provincial, local levels? Does the project/policy foresee a strategic framework that considers long-term effects and ensures commitment to the nexus approach? Does the project/policy include a strategy for future systematic and periodic assessment of potential positive and negative impacts on WEF sectors? Is the project/policy supported by alignment among short-, medium- and long term objectives and actions e.g. regulatory framework concerning the WEF nexus?"

⁹⁵⁹ Questions include: "Have power relations among key stakeholders been analysed? Have vulnerable actors been identified and included in the decision-making process? Are actors of each sector and scale represented and included in an equal manner in the decision-making process? Does the project foresee a meeting or consultation of stakeholders to examine conflict and to support negotiation?"

⁹⁶⁰ Questions posed: "Does policy/project foresee a review of existing barriers to policy and or areas where WEF practices, policies or regulations are misaligned? Is there in the area an operating interministerial body or organisations for horizontal coordination of wef policies? Have property rights of users and providers of resources been assessed in the definition of the stakeholder engagement strategy?"

⁹⁶¹ Questions posed: "Does the level of technical knowledge on the WEF nexus of implementing organisations match project/policy requirements? Has there been previous nexus based programme or policy implementation in the area? Are local authorities and organisations engaged and provided with a thorough understanding of the nexus approach and related benefits and costs? Is there a positive attitude by local organisations and authorities to participate in knowledge sharing activities (e.g. participate in workshops, focus groups, share data)?"

⁹⁶² Questions posed: "Do researchers convene on the definition of the WEF nexus system, scope and scale to collect data? Do researchers convene on a selection of indicators at local scale to evaluate the system's biophysical interlinkages? Are there sufficient existing integrated data on WEF nexus resources in the region to define full complexity of the nexus system? Is there a mechanisms for cross-sectoral coordination that allows ministries and public-sector agencies to share data and information and to allocate responsibilities and resources for WEF nexus objectives?"

⁹⁶³ Questions to ask: "Does the project foresee clear and straightforward communication mechanisms for all stakeholders on the risks and opportunities of the selected practice of WEF services? Is complexity visually represented in an easily understandable way for stakeholders to support dialogue? Does the project/policy promote public awareness on the WEF nexus?"

- Data and information gaps (monitoring).⁹⁶⁴

They pose several questions that could be used when assessing whether laws or policies actually address WEF nexus issues.

Based on the above discussion, for purpose of this study, WEF nexus governance should take the following into account:⁹⁶⁵

- There should be a holistic perspective/approach to natural resource management and then specifically in relation to water, energy and food.
- The emphasis should be on the interdependence of these natural resource systems, taking into account their interlinkages and interdependencies.
- Integration and coordination across resource sectors, both horizontal and vertical levels to possibly include diagonal integration and coordination (both at the same time), taking into account that resource systems have a multi-level nature:
 - Number of scale (dimensions) characteristics, namely space (spatial) and time scales (temporal);
 - Scale refers to the dimensions (space or time);

Does the project/policy promote legal and institutional frameworks and responsible authorities that are conducive to stakeholder engagement and inform and maintain access to environmental justice and demand for resource security?"

⁹⁶⁴ Questions to ask: "Does the project/policy promote a uniform and standardized monitoring system to foster integrated data collection? Are there evaluations and reporting mechanisms to support evidence-based compliance on the level of conservation of the resource system? (i.e. indicators of progress, cost/benefit analysis, impact assessments) Does the project/policy promote a transparent and independent system reporting to governments and the public on the state of the art of the WEF nexus?"

⁹⁶⁵ Marx 2015 *Change Adaptation in Socio-ecological systems* 79-81; Staupe-Delgado 2020 *Environment, Development and Sustainability* 6131-6147; Wiegler and Bruns 2018 *Frontiers in Environmental Science* 9; Fontana *et al* 2021 *Frontiers in Water* 1-12; Scott "Making governance work for nexus approaches" 1-15; Pereira and McElroy "Nexus thinking and sustainability governance" 1-20; Adom, Simatele and Reid 2022 *Journal of Water and Climate Change* 2761-2778; Jacobson and Pekarcik "Water-energy-food nexus approaches" 211-227; Pandey and Shrestha "Evolution of the Nexus" 11-20; Salam *et al* "The need for the nexus approach" 3-10; Shinde "Water-Energy-Food Nexus" 67-76; Ololade, Esterhuyse and Levine "The Water-Energy-Food Nexus" 129-140; Pradhanang "Water-Energy-Food Nexus: Examples from the USA" 141-149; Liu "WEF Nexus Cases from California" 151-162; Dawoud "Water, Energy, and Food Security Nexus" 163-180; Da Gupta "WEF Nexus and Sustainable Development" 223-241.

- Levels refer to units located at different positions on the scale (for example levels on the spatial scale may be national, provincial or local; while on the temporal scale it may be multi-year, annual ,etc.).
- Complexity and uncertainty within WEF resource systems: non-linear (needs flexible, reflexivity, adaptive, innovation and best practices).
- There is a spatial and temporal misfit between WEF resource systems (differences in planning cycles, different infrastructure investment horizons and lifespans between systems, measuring in different units, etc.).
- Decision-making on water, energy and food should ensure sustainable outcomes.
- Water, energy and food scarcity and security should be taken into account. The outcome of decision-making should
 - lead to a better understanding and the addressing of synergies and trade-offs among natural resource systems;
 - result in efficient resource use (doing more with less).

The following elements of WEF nexus governance can be distilled: WEF nexus governance should consider the following:

- The interconnection of water, energy and food in a holistic perspective, taking into account inter-dependency, complexity and scale as well as the impact of climate change;
- Synergies and trade-offs amongst natural systems;
- The recognition of socio-ecological systems and the introduction of new technology;
- The capacity to introduce new projects and programmes (training);
- Water, energy and food insecurity which should be addressed with sustainable outcomes and should work towards achieving the SDGs;
- Integration on a policy and regulation level;
- Inter-governmental cooperation and integrated decision-making;
- Clear roles and responsibilities for different government departments and spheres;
- Informed public participation;

- Flexible approaches, i.e. being able to adapt or adjust when necessary;
- Lifecycle approach;
- Integration of sources of information or data and information/data-gathering tools;
- Integration of multiple governance tools;
- Provision for strategic planning and reporting; and
- Provision for monitoring and auditing.

The number of WEF nexus governance elements distilled is numerous, namely 15 in total and more can certainly be distilled. While it is acknowledged that the nexus approach calls for an integrated and holistic view of these elements, it is necessary for purposes of this study to distinguish between the elements. This is due to the aim of this study, namely to make WEF nexus governance in relation to UGD, clearer.

3.10 Conclusion

The aim of this chapter was to identify the main governance elements that are indicative of the WEF nexus approach. In order to attain this goal, this chapter first identified and discussed the main drivers of the nexus approach. It was shown that these drivers provide an important understanding of what the nexus approach represents. Two main narratives emerged from this, namely, one consisting of a risk/resource security/green/circular economic element, and the other consisting of a socio-ecological systems element. The WEF nexus governance was defined from a socio ecological perspective. This was done by examining and discussing a number of these concepts separately, namely, governance, systems thinking, and the links between governance and socio-ecological systems.

It was also shown that the WEF nexus concept had undergone several iterations and is still evolving. Initially the WEF nexus approach focused more on the technical aspects of the interactions within water, energy and food systems; an example would be, by quantifying water, energy and food use, the value was in finding more efficient ways in the use of water, energy and food. While this focus on efficiency remains an important aspect of the WEF nexus, it was realised that governance systems (including institutions, regulation, legislation, rules, etc.) are critical to the WEF nexus. The

governance of the WEF nexus system is important because as an institutional framework it can be both villain and hero. It is the villain when it governs or steers water, energy and food in a sectoral and uncoordinated way. It is the hero when it governs and steers water, energy and food systems in an integrated way. In this way, governance of the WEF nexus is both the problem and solution to fragmented, sectoral, and unsustainable resource systems. As the WEF nexus is viewed and interpreted differently by different stakeholders, it is not surprising, that there is no agreement on its exact meaning, nor agreement on a definition thereof.

It was furthermore shown that the nexus approach is not a completely "new" approach to integrated resource management and the governance thereof. It has developed from previously integrated resource management attempts such as IWRM, environmental governance and integrated environmental management. It was shown that the nexus approach differs in at least one aspect from previously integrated approaches, namely its claim to be multi-centric. Being a multi-centric approach, the WEF nexus has value in its view of water, energy and food resource systems as being part of the same bigger socio-ecological system. In other words, its multi-centric characteristic enables it to identify and understand interlinkages (in the form of trade-offs and synergies) between resource systems on an equal weighting. This ability to identify and understand numerous and sometimes complex (non-linear) interactions between water, energy and food resource systems makes for better-informed decision-making within regulatory and governance frameworks.

A description of water, energy, and food security issues in South Africa followed the examples provided of the interlinked impacts between water, energy and food systems in South Africa, and particularly, the way in which energy insecurity is having complex and non-linear impacts on water and food security. In terms of food security in South Africa, three main features exist in the form of commercial agriculture, smallholder agriculture and subsistence farmers. While commercial agriculture is responsible for the bulk of agricultural output, both smallholder agriculture and subsistence farming are growing in use and importance within rural areas specifically. Its increasing value in creating resilience against food insecurity sits against numerous resource challenges, such as lack of access to water, transport, general infrastructure and

financial assistance. A further conclusion is that the agricultural sector is still embedded in conventional farming methods and therefore on a unsustainable path. In terms of climate change impacts on agriculture (water and food security) and the impacts of agriculture practices in increasing climate change (GHG emissions), the need for organic and regenerative farming practices in South Africa is pressing.

Examples of the nexus approach in the notion of sustainable development and the sustainable development goals (SDGs), were also indicated. It was found that although some links between targets and goals exist, its success, in terms of a coordinated and an integrated approach (nexus), remains questionable.

It was further shown that the WEF nexus approach plays a critical role within regulatory and governance frameworks for more sustainable outcomes. To this end a number of governance elements were distilled from the literature on the WEF nexus that included examining numerous definitions and general governance literature of the WEF nexus. In the next chapter the WEF nexus governance distilled elements are tested against the South African regulatory framework applicable to UGD. This is done to get an indication of whether, and if so, to what extent the South African regulatory framework follows a WEF nexus approach. The conclusions reached from this, inform the final chapter.

CHAPTER 4: THE SOUTH AFRICAN FRAMEWORK REGULATING UNCONVENTIONAL NATURAL GAS DEVELOPMENT

4.1 Introduction

Rapid technological development, such as hydraulic fracturing combined with horizontal drilling within the UGD process creates new challenges for regulatory frameworks.⁹⁶⁶ Because technological development (hydraulic fracturing) tends to outpace regulatory development, it leaves existing regulatory frameworks to play catch up.⁹⁶⁷ Ideally, a process of *ex ante* assessment would take place before the use of new technology.⁹⁶⁸ South Africa has not yet started with physical UGD and accordingly this provides an opportunity for an *ex ante* assessment of UGD via the WEF nexus.

Unlike other jurisdictions, such as the USA, South Africa can develop its regulatory framework before it starts the physical extraction and exploitation of unconventional gas. While the USA in many of its federal states seemed to have followed a "learn as we go" approach to UGD, it is clear that this approach to the regulation of UGD has missed numerous socio-ecological impacts that directly relates to the interlinkages between water, energy and food.⁹⁶⁹ South Africa, with its own social, ecological and economic circumstance/context, should therefore assess its regulatory framework against the WEF nexus before embarking on UGD. An *ex ante* assessment has value in that it will point out whether interlinkages (particularly trade-offs) between water, energy and food are identified/incorporated in the regulation of UGD. This is invaluable, since once a certain course of action has been taken (i.e. the exploitation of unconventional gas) the issue of "path dependency" or "lock in" can lead to social-ecological consequences that are difficult to reverse.

The previous chapter provided a theoretical framework from which a number of governance elements were distilled that are indicative of a WEF nexus approach.

⁹⁶⁶ Numerous social and ecological impacts emanating from UGD. See Chapter 2.

⁹⁶⁷ Peel "Regulation of the nexus" 206-207.

⁹⁶⁸ Peel "Regulation of the nexus" 207.

⁹⁶⁹ Peel "Regulation of the nexus" 207.

This chapter aims to identify and describe the regulatory framework applicable to UGD in South Africa. It is necessary to understand the workings of the regulatory framework applicable to UGD in South Africa. This includes the identification of possible water, energy and food links that exist within the regulatory framework on UGD. The need for this approach is to provide a well-defined framework against which the key WEF nexus elements can be tested in the following chapter (Chapter five). Chapter four therefore describes South Africa's international and regional commitments on water, energy and food. This also includes (i) South Africa's response to climate change via its adoption of the Paris Agreement, (ii) the Constitutional provisions applicable to water, energy, food and the environment, (iii) the overarching policy framework at a general strategic level, a water strategic level, an energy strategic level and a food strategic level. This is followed by the government structure in South Africa, specifically the application of cooperative government instruments within and between the three spheres of government, namely, national, provincial and local/municipal. This is followed by an explaining of which legislation is generally applicable to an UGD authorisation(s). This consists of authorisations that is directly applicable to UGD and other authorisations specific to water, energy and food. The final part of this chapter incorporates the findings of the three empirical studies that straddle the WEF nexus and UGD in South Africa. By examining three sets of empirical data that cover different geographical, cultural and socio-economic realities, a number of conclusions can be drawn on the extent of WEF nexus integration within UGD.

Before a description of the regulatory framework on UGD can commence it is first necessary to provide a background description of the general realities of water, energy and food in South Africa. The next section aims to do that.

4.2 Background

South Africa is water scarce with a highly variable climate.⁹⁷⁰ Water is of strategic importance to the country, both in terms of water services at the household level (drinking water and sanitation) and the dependence of the energy and agriculture

⁹⁷⁰ NCCRWP 17; Mabhaudhi *et al* "Nexus in South Africa" 1. See also chapter 3.5.7 and 3.5.8.

sectors to function.⁹⁷¹ The allocation of limited water resources between numerous users (agriculture, industry, and domestic urban) already point to water shortages and general water insecurity.⁹⁷² This is exacerbated by the impacts of climate change.⁹⁷³ While post-apartheid saw basic water services (general access to water for drinking and sanitation) expanded to reach some nine million "additional" people that were previously excluded, this notable improvement was mainly restricted to urban areas.⁹⁷⁴ Water services in rural areas remain lagging.⁹⁷⁵ Poor communities in rural areas are dependent on natural water resources, namely ground water, springs and rivers.⁹⁷⁶ These water resources are vulnerable to pollution and droughts.⁹⁷⁷ This is problematic for the poor rural communities because they do not have the means to control water quality and quantity (bulk water storage) aspects.⁹⁷⁸ They can neither control the quality of water, nor the quantity thereof.⁹⁷⁹ While basic water services have been expanded, a combination of factors (existing and new) are impacting negatively on water security.⁹⁸⁰ While the impacts of climate change have been known and studied, the increasing reality of energy insecurity is directly impacting water security.⁹⁸¹

While South Africa's continued reliance on coal-based energy is making it economically vulnerable to GHG reduction measures at both the international and national level, the single coal-based energy based approach is failing to provide energy security.⁹⁸² A combination of poor governance of the state run Eskom (state capture and corruption at an institutional level⁹⁸³) and a slow or reluctant transition to other forms of energy

⁹⁷¹ Mabhaudhi *et al* "Nexus in South Africa" 15.

⁹⁷² NCCRWP 17.

⁹⁷³ An increase in extreme weather events. This includes both frequency and intensity of floods and droughts in different part of the country. NCCRWP 17; Mabhaudhi *et al* "Nexus in South Africa" 23.

⁹⁷⁴ Since 1994. NCCRWP 17.

⁹⁷⁵ NCCRWP 17.

⁹⁷⁶ NCCRWP 17.

⁹⁷⁷ NCCRWP 17.

⁹⁷⁸ NCCRWP 17.

⁹⁷⁹ NCCRWP 17.

⁹⁸⁰ Aging infrastructure (leads to water leaks), an increase in water pollution, climate change (droughts) and lack of energy to pump water.

⁹⁸¹ Load shedding leads to failing water services in that pumps for water supply and sanitation are lacking. See paras 3.5.5 and 3.5.9.

⁹⁸² See chapter 3.5.5. Economic impacts due to GHG reduction measures include trade barriers, change in consumer preferences, and likely change in investor options. NCCRWP 30.

⁹⁸³ Zondo "Report of the Judicial Commission of Inquiry into allegations of State Capture" Part IV Volumes 3 and 4.

(such as renewables) have resulted in energy shortages (on an intermittent basis since 2008) and on a continuous basis since 2022.⁹⁸⁴ As indicated earlier, South Africa's uptake on alternative energy resources, particularly renewables has been slow.⁹⁸⁵ Notwithstanding numerous government policy, white papers, programmes, and initiatives, such as the *White Paper on the Energy Policy of the Republic of South Africa*, 1998 (Energy White Paper), the *White Paper on Renewable Energy* (Renewable White Paper), 2004,⁹⁸⁶ the *Renewable Energy Flagship Programme*, 2011, the *National Climate Change Response White Paper*, 2011⁹⁸⁷ (NCCR-WP) the *Draft South African Renewable Energy Masterplan*, 2023⁹⁸⁸ (SAREM) and the much anticipated *Renewable Energy Independent Power Producer Procurement Programme*,⁹⁸⁹ (REIPPPP) that calls for the need of lessening reliance on coal and that other alternative energy sources should be used, actual progress on these projects are years behind and hence do not offer much in the way of energy supply to the grid.⁹⁹⁰ A more recent addition to the government's plan to combat climate change is the publishing of the *Just Transition Framework in South Africa* in July 2022.⁹⁹¹ As per the Presidential Climate Change Commission (PCC) this report contains a framework to facilitate South Africa's transition to a low-emission economy. While the coal sector is identified as a key aspect within the just transition plan, much of the focus in the report is on limiting potential economic and job losses.⁹⁹² On the positive side, the Framework indicates the potential benefits of renewable energy and links the SAREM with the IRP2019.⁹⁹³ Not surprisingly, the government is also contemplating the exploitation of unconventional gas (such as shale gas).⁹⁹⁴ However, with no short-term fixes

⁹⁸⁴ See Chapter 3.5.5.

⁹⁸⁵ See Chapter 3.5.5.

⁹⁸⁶ GN 513 in GG 26169 of 14 May 2004.

⁹⁸⁷ *National Climate Change Response White Paper* – General Notice 757 in GG 34895 of 19 October 2011.

⁹⁸⁸ Draft published for comment 17 July 2023. South African Renewable Energy Masterplan (SAREM) Draft III.pdf (dmr.gov.za).

⁹⁸⁹ REIPPPP is a competitive tender process that was designed to facilitate private sector investment into grid-connected renewable energy (RE) generation in South Africa. See GN 957 in GG 46206 of 6 April 2002 for bids under Bid Window 6 of the Renewable Energy Independent Power Producers Procurement Programme.

⁹⁹⁰ See Chapter 2.2.5 and 3.5.5.

⁹⁹¹ <https://www.climatecommission.org.za/just-transition-framework>.

⁹⁹² *Framework for a Just Transition in South Africa* 11.

⁹⁹³ GN 1360 in GG 42784 of 18 October 2019, issued in terms of the *Electricity Regulation Act* 4 of 2006.

⁹⁹⁴ This includes both onshore and offshore gas.

available, energy insecurity is part of the daily reality in South Africa and will remain for some time.⁹⁹⁵ What is of particular concern is that the impact of energy insecurity straddles both water and food security and hence all aspects of life and society in South Africa are negatively impacted.⁹⁹⁶ The result of this scale of energy insecurity has spilled over to the water and agriculture sectors. Energy is a required input for both water and agriculture. The frequency and duration of a lack of energy provision is leading to water and food insecurity, as well as an impact on water quality.⁹⁹⁷ These impacts are now apparent at all levels of society in South Africa.⁹⁹⁸

Being a water-scarce country, arable land in South Africa is limited (approximately 13%).⁹⁹⁹ Notably, large parts of this limited arable land competes with other land use, such as the extraction of mineral resources, particularly coal.¹⁰⁰⁰ Commercial agriculture make up 12 percent to the gross domestic product (GDP) and 30 percent of national employment in South Africa.¹⁰⁰¹ It is also the largest consumer of water.¹⁰⁰² This is due to the need for crop irrigation in large parts of the country.¹⁰⁰³ Around 30 percent of crops in the country are produced on irrigated land.¹⁰⁰⁴ This makes up approximately 75 percent of the total national use for agriculture.¹⁰⁰⁵ While South Africa used to be a net food exporter (1985-2008), a general reduction in agricultural yields (impacts of climate change) and population growth (demand for food) changed this situation.¹⁰⁰⁶ In terms of climate change agriculture is both a key contributor (via GHG emissions) and particularly vulnerable to its impacts (more frequent extreme weather events including droughts, higher frequency and intensity of fires etc.).¹⁰⁰⁷ Increasing evaporation rates due to higher temperatures due to climate change are predicted to lead to less land areas suitable for crop production.¹⁰⁰⁸ In other words,

⁹⁹⁵ Nyathi 2023 *Mail & Guardian*; Van Diemen 2023 *Daily Maverick*.

⁹⁹⁶ Chapter 3.5.5.

⁹⁹⁷ See Chapters 3.5.5; 3.5.7 and 3.5.9. Also, see Ebrahim *News24* 16 January 2023.

⁹⁹⁸ See Chapter 3.5.9.

⁹⁹⁹ Mabhaudhi *et al* "Nexus in South Africa" 1.

¹⁰⁰⁰ Mabhaudhi *et al* "Nexus in South Africa" 1-2.

¹⁰⁰¹ NCCRWP 18.

¹⁰⁰² NCCRWP 18.

¹⁰⁰³ NCCRWP 18.

¹⁰⁰⁴ Mabhaudhi *et al* "Nexus in South Africa" 1.

¹⁰⁰⁵ Mabhaudhi *et al* "Nexus in South Africa" 1.

¹⁰⁰⁶ Mabhaudhi *et al* "Nexus in South Africa" 1.

¹⁰⁰⁷ Mabhaudhi *et al* "Nexus in South Africa" 23; NCCRWP 18.

¹⁰⁰⁸ Mabhaudhi *et al* "Nexus in South Africa" 23.

less land available for agriculture outputs. Agriculture is, in addition to water, also reliant on energy. Energy is needed as input for the pumping of water (irrigation and watering of livestock) and includes other uses such as cooling (dairy and meat products) and temperature control for certain livestock such as chicken feeds. In this sense, energy insecurity is directly impacting food security.¹⁰⁰⁹ Further negative impacts on farmers include the increasing price of fertilisers.¹⁰¹⁰

The paragraphs above aimed to provide a background of on the ground realities of water, energy and food (in)security in South Africa. Notably, the shortage in energy supply is cascading to the water and energy sectors. The impacts from energy insecurity on the water and food sectors confirm the existence of numerous interlinkages between the three sectors. This affirms the understanding that these resource sectors should be viewed and managed (governed and regulated) not from a single silo sectoral perspective, but as a holistic system. What was mainly viewed as an energy insecurity issue in the country is starting to become a water, energy and food insecurity problem.

The government declared a national state of disaster on electricity supply constraints on 9 February 2023.¹⁰¹¹ Applicable regulations to this effect has been published and notably these include references to (i) water and food security and (ii) cooperation between government spheres.¹⁰¹² The national state of disaster on electricity supply constraints was subsequently lifted on 5 April 2023.¹⁰¹³ This was followed by the creation of the Minister of Energy. The new minister of energy's role is to reduce the severity and frequency of load shedding as matter of urgency. President Ramaphosa stated that the Minister of Energy "will have political responsibility over all aspects of the energy action plan".¹⁰¹⁴ Notably, this includes the fast tracking of regulatory

¹⁰⁰⁹ See Chapter 3.5.7.

¹⁰¹⁰ Mainly due to the ongoing invasion of Russia into the Ukraine. See para 2.2.5.

¹⁰¹¹ In terms of sections 3 and 27(2) of *the Disaster Management Act 57 of 2002*. Emergency declared on 9 February 2023 - GN 3019 in GG 48009 of 9 February 2023 issued in terms of section 27(5)(b) of the *Disaster Management Act 57 of 2002*.

¹⁰¹² See GN R3809 in GG 48145 of 27 February 2023; see regulations 2 and 3.

¹⁰¹³ See GN R3265 and GN R3266 in GG 48400 of 5 April 2023.

¹⁰¹⁴ Nyathi 2023 *Mail & Guardian*. Also, see the *Electricity Regulation Amendment Act 28 of 2007*.

processes for energy projects. These energy projects include non-renewable, renewable and bridging fuels such as natural gas within UGD.¹⁰¹⁵

4.3 International and regional commitments on water, energy and food

South Africa follows a combination of a monistic and dualistic approach in the implementation of international law.¹⁰¹⁶ That means that customary international law is generally viewed to automatically be part of South African law, bar the limitation that it does not conflict with the Constitution or other South African legislation.¹⁰¹⁷ Section 233 of the Constitution obliges the South African courts to prefer any reasonable interpretation of legislation that is consistent with international law *vis-à-vis* any interpretation that is not.¹⁰¹⁸ In the interpretation of the Bill of Rights, the courts must interpret international law.¹⁰¹⁹ Treaties, however do not (automatically) become part of South Africa's local law without actual legislative transformation to that affect. This points to a dualist approach.¹⁰²⁰ This is done by (i) including the treaty document in an Act of Parliament, (ii) including the treaty as a schedule to a statute, or (iii) by proclamation in the *Government Gazette*.¹⁰²¹

South Africa is a signatory to the Paris Agreement on limiting greenhouse gas emissions and mitigate climate change in general.¹⁰²² South Africa, like other countries, has committed to up the pace towards a low carbon economy and society. In short, South Africa had committed to endorse a goal of net zero by 2050. This includes South Africa's commitment to produce data per its Nationally Determined Contributions

¹⁰¹⁵ Only time will tell how the fast tracking of regulatory processes will translate into actual new energy projects and what the distribution between non-renewable, renewables and bridging fuels such as UGD will be.

¹⁰¹⁶ Sections 231-233 of the Constitution. Also see Ferreira and Ferreira-Snyman 2014 *PELJ* 1473; Kidd *Environmental law* 45. Section 38(1) of the *Statute of the International Court of Justice* lists the sources of international law. They consist of (i) international conventions (treaties), (ii) international custom (general practice accepted as law), (iii) general principles of recognised by civilise nations, and (iv) judicial decisions (courts) and sources of highly qualified publicists.

¹⁰¹⁷ Section 232 of the Constitution.

¹⁰¹⁸ Section 232 of the Constitution.

¹⁰¹⁹ Section 39(2) of the Constitution. The courts may consider foreign law.

¹⁰²⁰ Ferreira and Ferreira-Snyman 2014 *PELJ* 1473.

¹⁰²¹ Kidd *Environmental law* 49.

¹⁰²² Adopted in December 2015 at the 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC CoP21).

(NDC). South Africa submitted its NDC in September 2021.¹⁰²³ Government developed institutions to coordinate the implementation of the SDGs that may also work towards the introduction of the WEF nexus. The cooperation instruments are discussed in par 4.6 below.

The United Nations *International Covenant on Economic, Social and Cultural Rights* (ICESCR) in articles 11.2 and 11.2 confirm the human right to adequate food.¹⁰²⁴ Section 27(1)(b) of the Constitution confirms a right to sufficient food and the progressive realisation of this right which is discussed in paragraph 4.4.

The African Charter Human and People's Rights (Banjul Charter)¹⁰²⁵ states in article 16(1) that "[e]very individual shall have the right to enjoy the best attainable state of physical and mental health",¹⁰²⁶ while, article 24 posits that "people shall have the right to a general satisfactory environment favourable to their development".¹⁰²⁷ While not directly referring to water, energy and food there is a strong argument that physical, mental health and a satisfactory environment are dependent for its realisation on water, energy and food resources.¹⁰²⁸

In relation to water, the Convention on Wetlands of International Importance 1971 (RAMSAR Convention) is of importance.¹⁰²⁹ This Convention acknowledges the ecological value of wetlands and aims the protection of wetlands while promoting the "wise use" of water.¹⁰³⁰ South Africa has 28 sites designated as wetlands of international importance (i.e. Ramsar sites).¹⁰³¹ While the current geographical areas

¹⁰²³ Available at South Africa.pdf (unfccc.int).

¹⁰²⁴ South Africa ratified the document on 12 January, 2015. See OCHR <https://www.ohchr.org/en/instruments-mechanisms/instruments/international-covenant-economic-social-and-cultural-rights>.

¹⁰²⁵ Agreed to 1 June 1981, and it came into operation 21 October 1986. South Africa signed and ratified it on 9 July 1996.

¹⁰²⁶ Article 16(1) of the Banjul Charter.

¹⁰²⁷ Article 24 of the Banjul Charter.

¹⁰²⁸ Boshoff 2022 *RECIEL* 33-34.

¹⁰²⁹ Adopted 2 February 1971, as amended by a Protocol of 3 December 1982 and Amendments of 27 May 1987. Adopted by South Africa on 12 March 1975 and entered into force on 21 December 1975. DIRCO 19710202RamsarConvention.pdf (dirco.gov.za).

¹⁰³⁰ See also Kidd *Environmental law* 62.

¹⁰³¹ The 28 Ramsar sites in South Africa covers a surface area of just over 572, 000 hectares. For detailed information on the 28 Ramsar sites in the country see the Ramsar Convention South Africa | Convention on Wetlands (ramsar.org).

earmarked for UGD (the Karoo area) do not fall within any of the Ramsar sites, it remains important to monitor for potential new areas. This is particularly so as some mining in South Africa takes place in wetlands.¹⁰³² This is problematic, not only for water use and for water quality but it also impacts on people's livelihoods. The coalfields may generate energy, but its impact on water and food security is immense.¹⁰³³

The African Convention on the Conservation of Nature and Natural Resources 1968 (Algiers) has undergone a main revision in 2003.¹⁰³⁴ South Africa is not a party to the Convention, but the courts may take this into account when interpreting the Bill of Rights as set out above. Article VII of the revised version requires parties to manage water resources to the highest quantitative and qualitative levels by taking measures planned to maintain ecological processes, the prevention of water pollution, and the avoiding of excessive abstraction.¹⁰³⁵ These are supported by a set of measures to include the study of water cycles and water catchment areas, the prevention and control of water pollution, the administration and management of all water utilisation (water allocation), and the co-ordinated planning of water resources development projects.¹⁰³⁶ Member states are required to establish policies for the conservation, utilisation and development of underground (groundwater) and surface water.¹⁰³⁷ In addition, member states are required to guarantee sufficient and continuous supply of suitable water to their populations.¹⁰³⁸ Article VI deals with land and soil and requires measures to prevent land degradation.¹⁰³⁹ Land-use plans must be established based on scientific investigations. The implementation of agricultural

¹⁰³² For example, the Blesbokspruit Wetland, 40 km southeast of Johannesburg, South Africa, was listed as a Ramsar site in 1986 but due to the discharge of mine waste water during the 1990s it lost its Ramsar status. See Ambani and Annegarn 2015 *Water SA* 648-659.

¹⁰³³ Also see Ramsar <https://www.ramsar.org/wetlands-and-miningextraction>; Water Research Commission "Mine Water Atlas" WRC Project No. K5/2234//3; Driver *et al* 2012 "National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis Report"; South African National Biodiversity Institute and Department of Environmental Affairs, Department of Water Affairs and Forestry (DWAF) "A practical field procedure for identification and delineation of wetland and riparian areas"; Grundling "Agriculture, mining and wetlands interaction workshop starter document".

¹⁰³⁴ CAB/LEG/24.1.

¹⁰³⁵ Article VII(1)(a-c).

¹⁰³⁶ Article VII(2)(a-e).

¹⁰³⁷ Article VII(2).

¹⁰³⁸ Article VII(2).

¹⁰³⁹ Article VI(1-2).

practices must focus on improving soil conservation and sustainable farming practices.¹⁰⁴⁰ Notably, parties must ensure that non-agricultural land use (including mining) do not result in pollution, erosion or other forms of land degradation.¹⁰⁴¹ Although South Africa is not a party to this Convention, the *National Water Act* 36 of 1998, the *Water Services Act* 108 of 1998 and the *Conservation of Agricultural Resources Act* 43 of 1983 include some of these concepts, except the idea of sustainable farming practices. The protection of high potential agricultural land also does not feature in the law yet. In 2021 the *Preservation and Development of Agricultural Land Bill* (B8-2021) was introduced but has not been approved by parliament yet. The Bill aims, amongst others, to "(ii) discourage land use changes from agricultural to non-agricultural uses to prevent the fragmentation of the agro-ecosystems; and (iii) facilitate concurrent land uses on agricultural land without jeopardising long term food security".¹⁰⁴² It is foreseen that provinces will compile plans, indicating high potential agricultural land to ensure its preservation.¹⁰⁴³ The Minister of Agriculture, Land Reform and Rural Development would be able to exclude land from agriculture, which implies that agricultural land could be used for energy related projects (such as UGD).¹⁰⁴⁴

South Africa is further party to numerous programmes, memorandum of understandings (MoU), general agreements, and declarations of intent that straddle

¹⁰⁴⁰ Article VI(3)(a-b).

¹⁰⁴¹ Article VI(3)(c-d).

¹⁰⁴² Clause 2(d). Clause 1 defines 'food security' as "physical, social and economic access by all people in the Republic, at all times, to sufficient, safe and nutritious food, which meets their dietary needs for an active and healthy life".

¹⁰⁴³ Clauses 6 and 7, read with clause 11. These plans will have to be integrated with municipal Integrated Development Plans (s 25 of the *Local Government: Municipal Systems Act* 32 of 2000) and spatial development frameworks in terms of the *Spatial Planning and Land Use Management Act* 16 of 2013.

¹⁰⁴⁴ If read with clause 11 this could not happen to high potential agricultural land.

water,¹⁰⁴⁵ energy¹⁰⁴⁶ and food security,¹⁰⁴⁷ as well as to environmental protection.¹⁰⁴⁸ The international and regional law will therefore inform how the courts interpret water, energy and food-related rights and obligations in the Constitution, while the programmes, MoUs, agreements and declarations of intent must assist government in achieving the international and regional obligations.

The Constitution as the overarching framework for water, energy and food will be discussed in the next paragraph.

4.4 Constitutional framework

Chapter 2 of the Constitution (the Bill of Rights) obliges the state to take reasonable measures, within available resources, to achieve the progressive realisation of a number of rights. Notably, section 7(2) obliges the government to "respect, protect, promote and fulfil the rights in the Bill of Rights". In terms of the WEF nexus the environmental right and the right of access to water, and food will, for example, be

¹⁰⁴⁵ South Africa has a number of MoUs (cooperation) in relation to water such as the protection and rehabilitation of water resources, and water quality. These include Russia, China, Brazil, , and various African countries, see e.g. Botswana, Kingdom of Lesotho, and Namibia. There is also a declaration of intent between the United Kingdom of Great Britain and Northern Ireland and South Africa on environmental cooperation. This declaration of intent has a general environmental management focus via the exchange of scientific and technical knowledge, among other, freshwater.

¹⁰⁴⁶ Agreement between South Africa and Denmark regarding development cooperation concerning the Energy Partnership Programme 2017. The objective of this agreement is to assist South Africa in moving to a lower carbon-intensive electricity production. Exchange of notes between South Africa and Germany concerning the Climate Support Programme Phase III. The aim of this project is to assist South Africa's efforts for climate protection by promoting measures for the mitigation of GHG emissions and climate change adaptation measures. Declaration of intent between South Africa and Denmark on green transition, sustainable development and climate change adaptation.

¹⁰⁴⁷ The Agreement between of South Africa and the Russian Federation on cooperation in the field of agriculture focuses on cooperation on general agriculture aspects such as investment, marketing, personnel training, plant cultivation, livestock farming and veterinary medicine. MoU between South Africa and Thailand on agricultural cooperation. This MoU aims to promote technology transfer, scientific and technical operation on agriculture aspects, including food security. MoU between South Africa and the Kingdom of Saudi Arabia for technical cooperation in the field of agriculture.

¹⁰⁴⁸ MoU between South Africa and Canada to enhance environmental cooperation. This MoU promotes cooperate on environmental protection and climate change issues. Agreement between South Africa and France on cooperation in the field of the environment and climate change; Declaration of intent between South Africa and Switzerland on ooperation in the field of biodiversity, climate change and cnvironmental management; MoU between South Africa and Sweden on cooperation in the field of environmental protection and licmate change.

applicable.¹⁰⁴⁹ The constitutional environmental right includes "health" and "well-being" within its ambit. The inclusion of "health" and "well-being" differs from many other constitutions in the world that generally refer to a clean or a healthy environment. By listing and describing numerous interpretations of well-being by academics and case law, Du Plessis confirms that "well-being" warrants a wide interpretation to include both physical and mental aspects. The environmental right links with human health and well-being in that human health and well-being are affected by environmental impacts, such as on water, energy and food production. The definition of "environment" in the NEMA confirms the conditions within the environment that influence human health and well-being.¹⁰⁵⁰ It therefore affirms a wide interpretation of the constitutional environmental right. Section 24(b) places an obligation on the state to ensure that the environment is protected through reasonable and other measures, while ensuring "ecological sustainable development and use of natural resources while promoting justifiable economic and social development". The courts have interpreted section 24(b) as that development should not take place on a deteriorating environment and sustainable development to include environmental, social and economic considerations.¹⁰⁵¹ The court in *Trustees for the Time Being of Groundwork Trust and One Other v The Minister of Environmental Affairs* ruled that section 24 of the Constitution is immediately realisable.¹⁰⁵² It indicated that poor air quality is a breach of residents section 24 right to a an environment that is not harmful to their health and well-being.¹⁰⁵³

¹⁰⁴⁹ Sections 24 and 27 of the Constitution.

¹⁰⁵⁰ Also see Nel and Alberts "Environmental Management and Environmental Law in South Africa: An Introduction" 2-10.

¹⁰⁵¹ *HTF Developers v Minister of Environmental Affairs and Tourism* [2007] 4 All SA 1108 (SCA); 2007 (11) BCLR 1230 (SCA); 2007 (5) SA 438 (SCA); *MEC: Department of Agriculture, Conservation and Environment v HTF Developers (Pty) Limited* 2008 (2) SA 319 (CC); 2008 (4) BCLR 417 (CC) par 60; *Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province* (2007 (10) BCLR 1059 (CC); 2007 (6) SA 4 (CC) paras 44 and 61 and *Trustees for the Time Being of Groundwork Trust and One Other v The Minister of Environmental Affairs* in the Gauteng Division of the High Court on 18 March 2022.

¹⁰⁵² *Trustees for the Time Being of Groundwork Trust and One Other v The Minister of Environmental Affairs* (39724/2019) [2022] ZAGPPHC 208 para 37.

¹⁰⁵³ *Trustees for the Time Being of Groundwork Trust and One Other v The Minister of Environmental Affairs* (39724/2019) [2022] ZAGPPHC 208 para 241.

The constitutional rights of access to food and water are dealt within the same section within the Bill of Rights. Section 27(1)(b) states that "everyone has the right to have access to sufficient food and water", while section 27(1)(b) confirms access to sufficient food and water. Section 27(2) places a limitation on both by stating, "the state must take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of each of these rights". In other words, while there is a positive duty on government to gradually realise both these rights (water and food), it is qualified in so far as there is "available resources". While the meaning of "within available resources" and "the progressive realisation of rights" have been examined in a number of cases, the interpretation thereof by the courts differ depending on the specific circumstances of each case.¹⁰⁵⁴ While the right of access to sufficient water was the focus in the *Mazibuko* case¹⁰⁵⁵ there has been, bar the *Equal Education* case,¹⁰⁵⁶ considerable less focus on the content of the right to have access to sufficient food (from a case law perspective). What is true for both rights is that they are dependent for their realisation on a range of other rights. Simply put, without access to sufficient water and food, other rights such as human dignity,¹⁰⁵⁷ the right to life,¹⁰⁵⁸ social security cannot be realised. In the *Makeshift v Cilliers* case¹⁰⁵⁹ the court indicates that the "right to receive electricity and water is

¹⁰⁵⁴ *Government of the Republic of South Africa v Grootboom* 2001 1 SA 46 (CC) para 45; *Black Sash Trust v Minister of Social Development* [2017] ZACC 8 para 2; *Glenister v President of the Republic of South Africa* 2011 (3) SA 347 (CC) para 107; *Minister of Health v New Clicks South Africa (Pty) Ltd* 2006 8 BCLR 872 (CC) para 705; *President of the Republic of South Africa v Modderklip Boerdery (Pty) Ltd* 2005 8 BCLR 786 (CC) para 49; *Mazibuko v City of Johannesburg* 2010 3 BCLR 239 (CC) paras 40, 67; *Soobramoney v Minister of Health (KwaZulu Natal)* 1998 1 SA 765 (CC) para 46; *Minister of Health v Treatment Action Campaign* 2002 5 SA 721 (CC) para 32; *Khosa v Minister of Social Development* 2004 6 SA 505 (CC) para 62; *Occupiers of 51 Olivia Road v City of Johannesburg* 2008 (5) BCLR 475 (CC) paras 18, 44.

¹⁰⁵⁵ *Mazibuko v City of Johannesburg* 2010 (4) SA 1 (CC).

¹⁰⁵⁶ *Equal Education v Minister of Basic Education* 2021 (1) SA 198 (GP).

¹⁰⁵⁷ On human dignity, section 10 of the Constitution states that "Everyone has inherent dignity and the right to have their dignity respected and protected". A number of cases deal with human dignity in relation to instances of eviction and non-access to electricity. See *Jafta v Schoeman*; *Van Rooyen v Stoltz* 2005 (2) SA 140 (CC) at para 39; *Afriforum NPC v Eskom Holdings SOC Ltd* 2017 3 All SA 663 (GP) paras 68-69; *Daniels v Scribante* 2017 4 SA 341 (CC) paras 209-210; *Joseph v City of Johannesburg* 2010 (4) SA 55 (CC). See also Dube and Moyo 2022 PELJ 9-10.

¹⁰⁵⁸ Per section 11 of the Constitution, "Everyone has the right to life". *Ex Parte Minister of Safety and Security: In Re S v Walters* 2002 (4) SA 613 paras 3, 28, 30, 46; *S v Makwanyane* 1995 (3) SA 391 paras 281, 317, 326, 327, 346.

¹⁰⁵⁹ *Makeshift 1190 (Pty) Ltd v Cilliers* 2020 (5) SA 538 (WCC) para 34.

part of the cluster of alleged rights ... ". In this sense, the rights within the Bill of Rights are interrelated.

While the rights applicable to the environment, water and food are directly included in the Bill of Rights, no such mention is made of any right of access to "energy" and or "electricity". In the *Joseph* case¹⁰⁶⁰ the court emphasises that human dignity is inherently linked to access to adequate housing. This case is arguably the first where the Constitution court dealt with an energy issue in the form of access to electricity.¹⁰⁶¹ What the implications of this omission of "energy" or "electricity" within the Bill of Rights are, may soon be more clear because a case has been brought against the government's use of load-shedding as being unconstitutional and being in breach of a number of human rights.¹⁰⁶² Notably, the government's opposing affidavit states that there is no constitutional responsibility to supply electricity to the people of South Africa.¹⁰⁶³ Put differently, the government argues that because there is no mention of any direct right on energy stipulated in the Bill of Rights, there is no constitutional duty on the government to supply energy.¹⁰⁶⁴ There is, however, a duty on local government per section 156 to administer matters listed in Part B of Schedule 4 and 5 of the Constitution. One of these functions of local government is the reticulation of electricity and gas. It should be noted that this duty on local government is not part of a right in the Bill of Rights and further, the reticulation of electricity and gas refers to the trading or distribution thereof (i.e. not energy generation). The court recently ruled on this and ordered the government to ensure that there is sufficient supply or

¹⁰⁶⁰ *Joseph v City of Johannesburg* 2010 (4) SA 55 (CC).

¹⁰⁶¹ Du Plessis *Energy Law in South Africa* 21-22; Dube and Moyo 2022 *PELJ* 7.

¹⁰⁶² *The United Democratic Movement (UDM), the National Union of Metalworkers of South Africa (Numsa), the Health and Allied Workers Indaba Trade Union (HAITU), Build One South Africa (BOSA), the Inkatha Freedom Party (IFP), the South African Federation of Trade Unions (Safu), and Democracy In Action (DIA) v the Presidency, the National Energy Regulator of South Africa (Nersa), the Department of Public Enterprises (DPE), and the Department of Mineral Resources and Energy, (DMRE)* 2023/005779 (GP).

¹⁰⁶³ *United Democratic Movement and Others v Eskom Holdings SOC Ltd and Others* [2023] ZAGPPHC 1949 paras 28, 34 and 37.

¹⁰⁶⁴ There were several other cases where the court ordered that cut-off electricity must be reinstated, see in this regard *Joseph v City of Johannesburg* 2010 (4) SA 55 (CC); *Copper Sunset Trading 443 (PTY) Ltd v Centlec Soc Ltd* 2189/2019 (FSHC); *Wilrus Trading CC v Dey Street Properties (Pty) Ltd* (1750/2021) [2021] ZAGPPHC 42; *Eskom Holdings SOC Limited v Masinda* 2019 (5) SA 386 (SCA); *Darries v City of Johannesburg* 2009 (5) SA 284 (GSJ); *Eskom Holdings SOC Ltd v Vaal River Development Association (Pty) Ltd* 2023 (5) BCLR 527 (CC); and *Eskom Holdings SOC Limited v Emfuleni Local Municipality* [2023] ZAGPPHC 1567.

generation of electricity to all public health establishments (e.g. hospitals and clinics), all public schools and the South African Police Service and police stations (includes satellite stations) stations by the end of January 2024.¹⁰⁶⁵ In other words, the court exempts hospitals, schools and police stations from load shedding employed by government. The court in its ruling indicating that the government has breached the Constitution and the human rights of its citizens because it had failed to protect and promote a number of rights contained in the Bill of Rights.¹⁰⁶⁶ Notably, the court lists those rights to include the right to access of sufficient food and water,¹⁰⁶⁷ the right to an environment that is not harmful to health and wellbeing,¹⁰⁶⁸ the right to life,¹⁰⁶⁹ the right to human dignity,¹⁰⁷⁰ the right to freedom and security of person,¹⁰⁷¹ the right to basic education,¹⁰⁷² and the right of access to healthcare services.¹⁰⁷³ This judgement therefore confirms that the rights within the Bill of Rights are interrelated. Notably, by acknowledging that impacts from energy insecurity are interrelated with water, food, health, wellbeing, education, and human dignity etc. the argument can be made that the court is in agreement with one of the key principles of the WEF nexus approach, namely that water, energy and food systems are interrelated and interdependent.

Before the Constitution and legislation can be discussed, it is necessary to provide an overview of the overarching policy framework that informs UGD governance and the WEF nexus.

4.5 Overarching policy framework

4.5.1 Strategic level - general

Various policies (including white papers), plans, and frameworks are applicable to water, energy and food within UGD. The NDP, Vision 2030 (NDP) aims to eliminate

¹⁰⁶⁵ Ruling on 1 December 2023 – see *United Democratic Movement and Others v Eskom Holdings SOC Ltd and Others* [2023] ZAGPPHC 1949 para 3.

¹⁰⁶⁶ *United Democratic Movement and Others v Eskom Holdings SOC Ltd and Others* [2023] ZAGPPHC 1949 para 1.

¹⁰⁶⁷ S 27(1)(b) of the Constitution.

¹⁰⁶⁸ S 24(a) of the Constitution.

¹⁰⁶⁹ S 11 of the Constitution.

¹⁰⁷⁰ S 10(5) of the Constitution.

¹⁰⁷¹ S 12 of the Constitution.

¹⁰⁷² S 29(1)(a) of the Constitution.

¹⁰⁷³ S 27(1)(a) of the Constitution.

poverty and reduce inequality by 2030.¹⁰⁷⁴ It consists of a number of objectives and actions covering a wide spectrum of features linked to economic growth (employment, infrastructure, education and fighting corruption), health care, environmental sustainability, and the general making of a development state (government) that is capable.¹⁰⁷⁵ Numerous references are made in terms of access to electricity and water (including sanitation) and food security.¹⁰⁷⁶ The NDP also proposes to introduce gas exploration (shale gas and coal bed methane) to contribute to the energy mix and contribute to reducing CO₂ emissions.¹⁰⁷⁷

The NDP is supported by the Medium Term Strategic Framework (MTSF). The MTSF consists of a series of five year frameworks to ensure medium and short-term planning of government is aligned to the NDP's vision of eliminating poverty and reducing inequality by 2030.¹⁰⁷⁸ The current MTSF is for the period 2019-2024. While it focuses on a number of priorities. Priority five focuses on supporting integrated spatial planning and development across all scales, namely from local level and up.¹⁰⁷⁹ It refers to the provision of basic services such as clean drinking water, sanitation, electricity, and nourishment for enabling general health of people.¹⁰⁸⁰

The National Spatial Development Framework (NSDF), a strategic long-term spatial plan,¹⁰⁸¹ is legally mandated by the *Spatial Planning and Land Use Management Act* 16 of 2013 (SPLUMA)¹⁰⁸² and is required to be aligned with the 2030 NDP.¹⁰⁸³ The NSDF recognises the need for gas infrastructure such as new gas pipelines and states that the exploration of shale gas should be managed and planned carefully.¹⁰⁸⁴

¹⁰⁷⁴ NDP 24. For specific targets and expected outcomes, see NDP at 34.

¹⁰⁷⁵ NDP at 62.

¹⁰⁷⁶ NDP at 34 and at the various objectives and actions within the plan.

¹⁰⁷⁷ NDP at 46.

¹⁰⁷⁸ See Chapter 4.6. for MTSF. https://www.dpme.gov.za/keyfocusareas/outcomesSite/MTSF_2019_2024/2019-2024%20MTSF%20Comprehensive%20Document.pdf.

¹⁰⁷⁹ This follows the proposal of the NDP for the development of a National Spatial Development Framework (NSDF). MTSF at 145.

¹⁰⁸⁰ MTSF at 145.

¹⁰⁸¹ Gen Not 1549 in GG 47999 of 1 February 2023.

¹⁰⁸² For a discussion of SPLUMA, see Chapter 4.7.

¹⁰⁸³ NSDF at 17. The framework development was managed by the Department of Agriculture, Land Reform and Rural Development (DALRRD) and the Department of Planning, Monitoring and Evaluation (DPME).

¹⁰⁸⁴ NSDF at 100, 113, 133, 178. Also, see GN 143 in GG 44191 of 26 February (strategic corridors for the development of gas transmission pipelines); GN 411 in GG 44551 of 7 May 2021

However, any exploration for gas will have to comply with South Africa's obligations in terms of the Paris Agreement and the reduction of greenhouse gases.

The NSDF should be read with the 2011 NCCR-WP that focuses on climate change mitigation and climate change adaptation. It confirms the country's commitment in contributing to lower the GHG concentrations in the atmosphere. The NCCR-WP recognises the cross-cutting nature of climate change impacts and responses thereto and hence calls for a coordinated, coherent, efficient and effective approach to deal with the issue. The cross-cutting nature of climate change includes the water, energy and food sectors. A similar type of approach needs to be identified within the regulatory framework applicable to UGD. The WEF nexus approach may be such an approach. Following the National Response White Paper, the *National Climate Change Adaptation Strategy* (NCCAS) was published.¹⁰⁸⁵ It focuses specifically on adaptation measures to climate change (mitigation measures are addressed in other policy documents). Per the NCCAS it:

... serves as South Africa's National Adaptation Plan and fulfils South Africa's commitment to its international obligations as outlined in the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC). The NCCAS will be used as the basis for meeting South Africa's obligations in terms of the adaptation commitments outlined in the NDC.¹⁰⁸⁶

The NCCAS gives effect to the NDP's vision of creating a low-carbon society. The NCCAS was followed by the Presidential Commission's The "Framework for a Just Transition in South Africa" (September 2022) sets the framework for reaching South Africa's vision for a just and equitable transition towards climate resilience and zero-emissions development.¹⁰⁸⁷ It is a continuation of Chapter 5 of the NDP, namely "Ensuring Environmental Sustainability and an Equitable Transition to a Low Carbon, Climate Resilient Economy Society" whereby the National Planning Commission identified the water, energy and land-use sectors as of particular importance to a just

(procedures for applying for an environmental authorisation for gas transmission pipelines in the corridor) and GN 373 in GG 44481 of 23 April 2021 (generic environmental management programme (EMPr)).

¹⁰⁸⁵ GN 644 in GG 42446 of 6 May 2021.

¹⁰⁸⁶ NCCAS at 10.

¹⁰⁸⁷ Presidential Climate Commission https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf.

and equitable transition. The Presidential Climate Commission identified policy measures and actions to give effect to a just and equitable transition. While the Framework does not refer to gas exploration as such, it does indicate that planning and land management need to be regulated in a way that supports the aim of a just transition.¹⁰⁸⁸ Land management and planning are main management and regulatory aspects within UGD. The Framework places emphasis on policy and adaptation measures linked to water, food and health.¹⁰⁸⁹ Notably, the Framework indicates that policies should be integrated and be aligned.¹⁰⁹⁰ This is to ensure that policies in one field do not undermine objectives and measures in other policy fields.¹⁰⁹¹ In this regard, the Framework emphasises the role of provincial and local governments in ensuring coordination measures to facilitate a just transition.¹⁰⁹²

In 2022, a *Climate Change Bill*¹⁰⁹³ was introduced, stating several objects aiming at mitigation and adaptation.¹⁰⁹⁴ Notably, one of its objects is to, within the principles of cooperative governance, for a coordinated and integrated approach to manage the impacts of climate change.¹⁰⁹⁵ Further, it aims to enhance the country's adaptive capacity and simultaneously reduce the country's vulnerability to the impacts of climate change.¹⁰⁹⁶ In general, its objective is to ensure a just transition towards a low carbon society.¹⁰⁹⁷ There are however, no specific implementation measures to facilitate this. It remains set only within framework legislation.

All the policy documents above culminated in the National Infrastructure Plan (hereafter NIP 2050) that emphasises the critical role that infrastructure development plays in attaining the country's long-term socio-economic goals.¹⁰⁹⁸ It identifies key actions needed for bettering public infrastructure delivery.¹⁰⁹⁹ Phase one of the NIP

¹⁰⁸⁸ Presidential Climate Commission 22.
¹⁰⁸⁹ Presidential Climate Commission 2.
¹⁰⁹⁰ Presidential Climate Commission 16.
¹⁰⁹¹ Presidential Climate Commission 16.
¹⁰⁹² Presidential Climate Commission 22.
¹⁰⁹³ (B9-2022).
¹⁰⁹⁴ GG 45299 of 11 October 2021.
¹⁰⁹⁵ Section 2(a) of the Bill.
¹⁰⁹⁶ Section 2(b) of the Bill.
¹⁰⁹⁷ Section 2(d) of the Bill.
¹⁰⁹⁸ GN 1874 in GG 46033 of 11 March 2022.
¹⁰⁹⁹ NIP 2050 at 3.

2050 focuses on four sectors namely, energy, water, freight transport and digital infrastructure.¹¹⁰⁰ A second phase is to follow that focuses on distributed infrastructure linked with municipal services that includes improving coordination through district development models (DDMs).¹¹⁰¹ The DDMs aim to improve service delivery and general development by focusing on coordination between national, provincial and local government.¹¹⁰² The emphasis is on joint and collaborative planning metropolitan, district and local level by all three spheres of government.¹¹⁰³ The central Karoo area being the most likely area where UGD may take place consists of three local municipalities and they are Laingsburg Local Municipality, Prince Albert Local Municipality and Beaufort West Local Municipality. These three municipalities make up the Central Karoo District Municipality (CKDM). The DDM for CKDM refers to shale gas exploration as a strategic project.¹¹⁰⁴ There is no mention of an integrated approach within the strategic project. It is a stand-alone project and does not link with any other projects. While reference is made to water scarcity, this is only mentioned in relation to service delivery and sanitation aspects.¹¹⁰⁵ No link is made to UGD. Agriculture is mentioned in relation to scarce water resources and its high dependency on groundwater.¹¹⁰⁶ No link is made between UGD and agriculture. Apart from stating the shale gas exploration falls within a strategic project, no links exist on water, energy and food within the DDM. There is a need for a mechanism to facilitate integration between water, energy and food in the DDM, generally and specifically in relation to UGD.

4.5.2 Strategic level – water

The NWRS-2¹¹⁰⁷ is published in terms of the *National Water Act* 36 of 1998.¹¹⁰⁸ The NWRS is a legal instrument that operationalises the NWA. The NWA requires "the

¹¹⁰⁰ NIP2050 at 3.

¹¹⁰¹ Department of Cooperative Governance and Traditional Affairs <https://www.cogta.gov.za/ddm/>.

¹¹⁰² NIP2050 at 3.

¹¹⁰³ DDM at 2-3.

¹¹⁰⁴ DDM at 33.

¹¹⁰⁵ DDM at 26.

¹¹⁰⁶ DDM at 34.

¹¹⁰⁷ Gen Not 856 in GG 36736 of 16 Aug 2013.

¹¹⁰⁸ For the NWA see para 4.9.1 below.

progressive development of a National Water Resource Strategy".¹¹⁰⁹ The NWRS-2 "provides the framework for the protection, use, development, conservation, management and control of water resources for the entire country".¹¹¹⁰ In this regard, it "provides the framework within which water will be managed at the regional or catchment level, in defined water management areas".¹¹¹¹ Notably, "the national water resource strategy is binding on all authorities and institutions exercising power or performing functions under the NWA".¹¹¹² The NWRS-2 is responsible for coordinating regulatory standards and processes with other government departments and regulatory institutions.¹¹¹³ As part of its targets and actions for Vision 2030, NWRS-2 confirms the need to develop the food, energy and water markets in South Africa.¹¹¹⁴

The country is particularly vulnerable to the effects of climate change on water and food, health and livelihoods.¹¹¹⁵ The net effect of climate change for South Africa will be a reduction of water availability. The country can expect more intense and prolonged periods of drought.¹¹¹⁶

The NWRS-2 proposes the use of renewable energy sources to mitigate carbon emissions. It acknowledges linkages between energy and water (using example of desalination).¹¹¹⁷ Also in terms of water re-use projects where environmental footprint and energy usage depend on the water reclamation technologies used.¹¹¹⁸ It states "Water re-use must be evaluated in the context of other water supply and water augmentation options with consideration of environmental impacts, carbon footprint, ecological footprint and energy usage".¹¹¹⁹ It also refers to the need of understanding water requirements and water re-use opportunities in renewable and nuclear power generation.¹¹²⁰

¹¹⁰⁹ NWA preamble to Part 1 of Chapter 2.

¹¹¹⁰ NWRS-2 at 1.

¹¹¹¹ NWRS-2 at 1.

¹¹¹² NWRS-2 at 1.

¹¹¹³ NWRS-2 at iv.

¹¹¹⁴ NWRS-2 at 6.

¹¹¹⁵ NWRS-2 at 75.

¹¹¹⁶ NWRS-2 at 11.

¹¹¹⁷ NWRS-2 at 4-5.

¹¹¹⁸ NWRS-2 at 5.

¹¹¹⁹ NWRS-2 at 5.

¹¹²⁰ NWRS-2 at 8.

Mining and related activities require significant quantities of water and impact on the environment through associated potential pollution. The mining sector is also faced with legacy issues of past pollution, for example, acid mine drainage. The development of new mines in water-scarce areas requires planning to arrange for the transfer of water and development of new sources, and appropriate attention to waste processing and remediation.¹¹²¹

The NWRS-2 acknowledges that water plays a key role in numerous sectors, including agriculture, energy, mining, and rural development.¹¹²² In this respect, it states that water is the major limiting factor in the growth of this sector and poor water quality has a negative impact on agricultural exports and associated foreign income.¹¹²³ Therefore, water resources should be used in an ecologically sustainable way.¹¹²⁴ Water conservation and water demand management must become embedded in the agriculture sector.¹¹²⁵ It is also involved in creating a mechanism whereby resource-poor farmers can apply for financial assistance.¹¹²⁶ The focus area is on agricultural water use development.¹¹²⁷

Notably the NWRS-2 recognises the need for co-operative government, specifically the need for coherence between national and local water related strategies and plans. In this vein, all water resource management and water services strategies, plans and instruments at local, regional and national level, must be aligned to achieve coherence.¹¹²⁸ The roles and responsibilities of the three spheres of government and of the water resource and water services institutions are clearly defined, with overlapping mandates being eliminated wherever possible. The imperative of co-operative government is recognised.¹¹²⁹

¹¹²¹ NWRS-2 at 10.

¹¹²² NWRS-2 at 3.

¹¹²³ NWRS-2 at 10.

¹¹²⁴ NWRS-2 at 109.

¹¹²⁵ NWRS-2 at 55.

¹¹²⁶ NWRS-2 at 88.

¹¹²⁷ NWRS-2 at 88-89.

¹¹²⁸ NWRS-2 at 61.

¹¹²⁹ NWRS-2 at 61.

The NWRS-2 has numerous examples where it makes provision for integration across the water, energy and food sectors. There seems to be a clear recognition of the interrelation between water, energy and food and therefore confirms the WEF nexus.

The NWRS-2 is being reviewed and NWRS-3 Draft 2.6 (47133)¹¹³⁰ was published for comment. The aim of the NWRS-3 is to ensure the

... protection and management of water resources to enable equitable and sustainable access to water and sanitation services in support of socio-economic growth and development for the well-being of current and future generations in South Africa.¹¹³¹

Per goal three of the NWRS-3 "Water must be protected, used, developed, conserved, managed and controlled sustainably and equitably".¹¹³² There is a need for protecting and restoring ecological infrastructure and the managing of water under a changing climate.¹¹³³

The NWRS-3 states that the security of water, energy and food resources is a key priority for South Africa. Water, energy and food (WEF) are stressed due to extreme weather events of drought, flood and water pollution.¹¹³⁴ Notably, the NWRS-3 specifically refer to the WEF nexus. It acknowledges the importance of increasing the application of the WEF nexus approach in planning, policymaking and implementation.¹¹³⁵

The NWRS-3 indicates that in order to achieve a balance between social equity and environmental sustainability, the National Water Conservation and Water Demand Management (NWC/WDM) strategy was developed.¹¹³⁶ It continues to indicate that the principles guiding the development and implementation of NWC/WDM must consider the integration of the WEF nexus.¹¹³⁷

¹¹³⁰ GN 2327 in GG 47133 of 29 July 2022.

¹¹³¹ Section 1 of the NWRS-3.

¹¹³² NWRS-3 at 7.

¹¹³³ NWRS-3 at 7.

¹¹³⁴ NWRS-3 at 15.

¹¹³⁵ NWRS-3 at 15.

¹¹³⁶ NWRS-3 at 20.

¹¹³⁷ As included in the National Water Security Framework, and its implications for future water security. NWRS-3 at 20.

4.5.3 Strategic level – energy

In relation to energy, the IEP deals with South Africa's overall energy needs and forecasts for the period 2015-2050.¹¹³⁸ The IEP is a guide for energy infrastructure investments.¹¹³⁹ It does this by taking into account a range of possible energy supply options and guiding the selection of the suitable technology.¹¹⁴⁰ It includes electrical power, gas and liquid fuels across the industrial, commercial, residential, transport and agricultural sectors.¹¹⁴¹ Against the backdrop of rapid changes across a number of factors (e.g. the macroeconomic environment, new technologies, and change in national priorities), the development of the IEP is a continuous process that requires periodical review.¹¹⁴²

The IEP must be based on the results of the energy analysis and take account of plans relating to a number of sectors.¹¹⁴³ In this vein the IEP must inform and also be informed by plans from all supply, production and demand sectors that may impact on or be impacted by the IEP.¹¹⁴⁴ The aim of which is to ensure integrated planning across different sectors such as (i) agriculture¹¹⁴⁵ and (ii) electricity, gas and water.¹¹⁴⁶ Energy carriers considered for agriculture in the IEP is limited to electricity, coal and diesel.¹¹⁴⁷ There is no mention of gas or renewables. The electricity, gas and water sector considers electricity, coal, and natural gas as energy carriers.¹¹⁴⁸

The IEP does indicate the potential of unconventional gas as an energy source in the country. Notably, the IEP states that the process of hydraulic fracturing within UGD requires substantial amounts of water.¹¹⁴⁹ This presents a challenge in water-scarce

¹¹³⁸ GN 1430 in GG 40445 of 25 September 2015 issued in terms of the *National Energy Act* 34 of 2008.

¹¹³⁹ IEP at 23-24.

¹¹⁴⁰ IEP at 23-24.

¹¹⁴¹ IEP at 5.

¹¹⁴² See 4.7.3. IEP at 11.

¹¹⁴³ As identified per section 6(3)(a) of the *National Energy Act*.

¹¹⁴⁴ IEP at 73.

¹¹⁴⁵ The agricultural sector includes animal husbandry, crop farming, forestry and fishing per the IEP. See IEP at 73.

¹¹⁴⁶ Electricity, gas and water is listed as a separate sector in the IEP. See IEP at 73.

¹¹⁴⁷ IEP at 73.

¹¹⁴⁸ IEP at 73.

¹¹⁴⁹ IEP at 49.

areas.¹¹⁵⁰ The IEP further indicates that the contamination of ground water due to improper disposal of fluids during the hydraulic fracturing process remains high risk.¹¹⁵¹

In terms of co-ordinated policy and development planning the IEP confirms the need for clearly defined roles and mandates within the DoE.¹¹⁵² The same goes for the different plans such as the IEP, the IRP and the Gas Utilisation Masterplan (hereafter GUMP).¹¹⁵³

The IEP states that the linkages and feedback loops between national, provincial and local government within energy planning need to be strengthened.¹¹⁵⁴ It therefore requires integrated planning across the three spheres of government. In this regard, the DoE identifies the need to have representation from local government in its governance structures.¹¹⁵⁵ This is envisioned through the South African Local Government Association (hereafter SALGA).¹¹⁵⁶ The same principle of representation is essential in the provincial government structures.¹¹⁵⁷ It is stated that co-ordination with provincial and local government structures should be facilitated through the DoE's Regional Offices.¹¹⁵⁸

The IRP2019 is a component of the IEP (above) and is mandated to provide a strategy for energy requirements.¹¹⁵⁹ Being an electricity capacity plan, the IRP aims to provide an indication of (i) electricity demand, (ii) how this demand will be supplied and (iii) the costs thereof.¹¹⁶⁰ Since its promulgation, some electricity generation capacity developments have taken place.¹¹⁶¹ The IRP indicates that there is huge potential and opportunity for gas use exploration, production and use. While the IRP refers in the

¹¹⁵⁰ IEP at 49.

¹¹⁵¹ IEP at 49.

¹¹⁵² IEP at 184.

¹¹⁵³ IEP at 184.

¹¹⁵⁴ IEP at 185.

¹¹⁵⁵ IEP at 185.

¹¹⁵⁶ IEP at 185.

¹¹⁵⁷ IEP at 185.

¹¹⁵⁸ IEP at 185.

¹¹⁵⁹ GN 1360 in GG 42784 of 18 October 2019.

¹¹⁶⁰ IRP at 8.

¹¹⁶¹ IRP at 9.

main to the potential of off-shore gas, mention is also made of onshore gas like coal-bed methane and ultimately shale gas.¹¹⁶²

The IRP has a section with the heading "Water energy nexus".¹¹⁶³ In this section the IRP refers to the impact of recurring droughts and changing climatic conditions on agriculture.¹¹⁶⁴ Further reference is made to coastal towns such as Cape Town and Mossel Bay that faced severe water shortages despite their proximity to seawater.¹¹⁶⁵ The IRP suggests the consideration of desalination and notably acknowledges that renewable energy (wind or solar) should be used in the desalination effort.¹¹⁶⁶ While this section makes a relative strong link between water and energy there is no further description on the matter.

Government published an action plan to address the energy crisis in the country.¹¹⁶⁷ The plan "Confronting the Energy Crisis: An Action Plan to End Load Shedding" indicates that it will, among other interventions, accelerate procurement of new energy capacity from gas, namely some 3000 MW (both onshore and offshore gas).¹¹⁶⁸ The action plan establishes a dedicated National Energy Crisis Committee (NECOM). An update on the "Energy Action Plan" was published in January 2023 and from this, it is clear that the authorisation process for energy projects (including gas) has been streamlined to include:

- exempting transmission infrastructure development from obtaining an environmental authorisation in areas where the environmental impact is low;
- reducing the timeframes of environmental authorisations for projects on energy that are identified and gazetted as Strategic Infrastructure Projects; and
- reducing the time frame for land-use authorisations of energy projects.¹¹⁶⁹

¹¹⁶² IRP at 13.

¹¹⁶³ IRP at 17.

¹¹⁶⁴ IRP at 17.

¹¹⁶⁵ IRP at 17.

¹¹⁶⁶ IRP at 17.

¹¹⁶⁷ See President Ramaphosa's address to the nation on 25 July 2022 and the subsequent publishing of the plan "Confronting the Energy Crisis: An Action Plan to End Load Shedding".

¹¹⁶⁸ "Confronting the Energy Crisis" at 4 and 10.

¹¹⁶⁹ Energy Action Plan - Six Month Update: January 2023 at 3.

The GUMP focuses on planning a roadmap for more use of natural gas within the country's energy mix.¹¹⁷⁰ The GUMP, via its base case report establishes baseline information for the natural gas sector in South Africa. The base case report explores options on the incorporating more natural gas via onshore, offshore, local and the importing thereof. It includes both conventional and UGD. The report provides base line information on numerous aspects of natural gas, such as existing gas pipelines, infrastructure, regulatory aspects etcetera. The GUMP aims to fulfil the NDPs vision of providing "an energy sector that promotes economic growth and development through adequate investment in energy infrastructure".¹¹⁷¹

4.5.4 Strategic level – food

South Africa is lacking on food security policies, also in relation to developments such as UGD. The strategic goal of the National Policy on Food and Nutrition Security, 2014 (NPFNS) is ensuring safe and nutritious food at national and household levels.¹¹⁷² The policy follows the NDP's call for food security by defining food security in terms of availability, accessibility and affordability.¹¹⁷³ The NPFNS provides a broad framework for the fulfilment of this Constitutional imperative and should serve as a guide to national, provincial and local government in pursuing food security at every level.¹¹⁷⁴ The policy indicates that because food and nutrition security is a complex issue by inter-disciplinary approaches are needed to manage it. It lists rising input costs, especially electricity and fuel, as well as labour costs, as reasons for undermining the ability to sustain food production. It also lists climate change and poor land management (over grazing and other practices), together with the use of land for mining and urban development, as factors that pose a threat to domestic food

¹¹⁷⁰ South African Gas Master Plan: Basecase Report (v 01) published for consultation in September 2021.

¹¹⁷¹ NCCR-WP at 1.

¹¹⁷² The Draft Document was published in GN 637 in GG 37915 of 22 August 2014 for comment. The final document is dated 20 August 2013 but was published in 2014 – GN 644 in GG 37915 of 22 August 2014. See para 2.2 of NPFNS.

¹¹⁷³ Paragraph 3 of the NPFNS.

¹¹⁷⁴ NFNSP at 2.1.

production.¹¹⁷⁵ Notably, it indicates that there has been an overall loss of high agricultural potential land to non-agricultural activities such as mining.¹¹⁷⁶

In this vein, the NPFNS seeks to provide an overarching framework to maximise synergy between the different strategies and programmes of government and civil society.¹¹⁷⁷ The NPFNS acknowledges that food and nutrition security requires well-managed inter-sectoral co-ordination and the integration of existing policies and programmes in health and environmental protection, as well as in agricultural reform and development.¹¹⁷⁸ It places an emphasis on agro-ecological approaches to farming.¹¹⁷⁹

4.5.5 Preliminary conclusion

While some policies make provision for integration and acknowledges the WEF nexus (linkages), others do so in a limited way, or not at all. While the NDP, MTFs, NSDF, NCCR-WP and NCCAS make some links between water (climate change) and energy or agriculture they are not that clear. The NIP informs the DDMs and it is clear that the DDM for CKDM makes little to no links between water, energy and food. Apart from stating the shale gas exploration falls within a strategic project, no links are made between water, energy and food.

The NWRS-2 has numerous examples where it makes provision for integration across the water, energy and food sectors and it does the same across national, provincial and local government structures. There seems to be a clear recognition of the interrelation between water, energy and food and therefore confirms the WEF nexus. While the NWRS-2 is a good example of recognizing the WEF nexus, the NWRS-3 makes even stronger linkages between water, energy and food. The NWRS-3 not only directly refers to the WEF nexus but also continues to explore and explain the linkages between water, energy and food.

¹¹⁷⁵ NFNSP at 7.

¹¹⁷⁶ NFNSP at 8.1.

¹¹⁷⁷ NFNSP at 1.2.

¹¹⁷⁸ NFNSP at 4.

¹¹⁷⁹ NFNSP at 1.3.

The IEP makes a relative strong link between water, energy and food. This is reflected in its classification of agriculture and electricity, gas and water as primary economic sectors. Notably, the IEP explicitly refers to the substantial water use requirement of UGD and the high risk of ground water contamination due to hydraulic fracturing fluids. The IEP makes a strong claim on the need for co-ordinated policy and development planning. This includes clearly defined roles and mandates within the DoE and for the different plans such as the IEP, the IRP and the GUMP. The IEP focuses on integrated planning across the three spheres of government. It actions on this by making SALGA part of the planning process.

The IRP refers to the impact of recurring droughts and changing climatic conditions on agriculture under a specific heading namely, "Water energy nexus". It continues to make some promising links between water and energy in terms of desalination and recommend that renewable energy should be used for desalination. There is however no further expansion on this.

While the NPFNS seem to recognise the impact of climate change and other land use such as mining on agriculture the links between water, energy and food are less explicit. The NPFNS states that inter-sectoral co-ordination and the integration of policies and programmes are key for agriculture but does not expand on this.

The result is therefore a mixed bag. While some of the policies show strong examples of WEF linkages and integration, others either indicate weaker linkages or very little.

In the following paragraph, the South African government structure and the cooperative governance instruments will be discussed.

4.6 Government structures and cooperative government instruments

Section 40(1) of the Constitution sets the structure of the South African government to consist of national, provincial and local government spheres.¹¹⁸⁰ Notably, the three government spheres are distinctive, interdependent and interrelated.¹¹⁸¹ This quasi-federal division of power across three levels or spheres of government "differs from

¹¹⁸⁰ Section 40(1) of the Constitution.

¹¹⁸¹ Section 40(1) of the Constitution.

the traditional federal system where the powers and functions of different levels of government are clearly delineated and where each sphere is empowered to deal exclusively with certain distinct subject matters".¹¹⁸² While the quasi-federal division of powers between the national, provincial and local government spheres in South Africa is unique, it does not exclude the separation of powers doctrine. In short, while the doctrine of separation of powers is applicable, it does not provide for a strict separation of powers between the executive and the legislature in South Africa.¹¹⁸³ There is however, a strict separation of powers between the judiciary and the other two branches (i.e. the executive and the legislature). Thus, the powers of the individual branches of government, namely, the legislature, the executive and the judiciary are to an extent limited by the separation of powers doctrine.¹¹⁸⁴ Common principles that make up the separation of powers doctrine include:

- *Trias politica* – divides governmental power between the three government branches i.e. the legislature (parliament), the executive (the President and the cabinet), and the judiciary (the courts);
- Separation of functions - to prevent one government branch to usurp another branch's task, each of the three branches have separate areas of responsibility and authority, however, taking into account cooperative governance;¹¹⁸⁵ and
- Separation of personnel – government branches have their own assigned personnel.¹¹⁸⁶

Section 43 of the Constitution deals with the legislative authority.¹¹⁸⁷ In terms of section 43, the legislative authority vests in the national, provincial and local government spheres.¹¹⁸⁸ The national legislative authority vests in Parliament, the provincial legislative authority vests in the provincial legislatures, and the legislative

¹¹⁸² De Vos and Freedman *South African Constitutional Law in Context* 54.

¹¹⁸³ For a more detailed discussion, see De Vos and Freedman *South African Constitutional Law in Context* 62-63. Also see *De Lange v Smuts* 1998 (3) SA 785; 1998 (7) BCLR 779.

¹¹⁸⁴ Which by its nature aims to prevent the abuse of power. De Vos and Freedman *South African Constitutional Law in Context* 56.

¹¹⁸⁵ See 4.5.1 below.

¹¹⁸⁶ De Vos and Freedman *South African Constitutional Law in Context* 57.

¹¹⁸⁷ Parliament consists of the National Assembly and National Council of Provinces (there are nine provinces in South Africa). See De Vos and Freedman *South African Constitutional Law in Context* 107.

¹¹⁸⁸ Section 43 of the Constitution.

authority of the local sphere of government vests in the Municipal Councils.¹¹⁸⁹ The legislature has the power to and are indeed required to make, consider, pass, amend or reject legislation.¹¹⁹⁰ It is also mandated to hold the executive accountable.¹¹⁹¹

Section 85 of the Constitution states that the national executive authority is vested in the President, who with the members of the cabinet, are required to prepare, initiate and implement national legislation, develop and implement policy, co-ordinate the functions of government departments, and perform any other executive function as stipulated in the Constitution or national legislation.¹¹⁹² The executive is required to implement legislation.¹¹⁹³ To facilitate the implementation of legislation the executive is required to develop policy, plans and programmes.¹¹⁹⁴

The judicial authority vests in the courts and is responsible for the administration of justice.¹¹⁹⁵ The judiciary is required to adjudicate legal disputes, including issues relating to the interpretation and application of the Constitution.¹¹⁹⁶ As indicated in the previous chapter, the principle of separation of powers is absolute in the relationship between the judiciary and the other two branches.¹¹⁹⁷ The Constitutional Court's powers of judicial review means that it can declare any conduct or law that contravenes the Constitution as unconstitutional and therefore invalid. The judiciary therefore has the power to check whether the executive and legislative branches exercise their functions within the limits of the Constitution.¹¹⁹⁸ The recent ruling by the court in *United Democratic Movement and Others v Eskom Holdings SOC Ltd and Others*¹¹⁹⁹ is such an example. The court ordered the Minister of Electricity to ensure

¹¹⁸⁹ Section 43(a)-(c) of the Constitution.

¹¹⁹⁰ Du Plessis "Understanding the legal context" 29.

¹¹⁹¹ De Vos and Freedman *South African Constitutional Law in Context* 62-63.

¹¹⁹² Section 85(1) and s 85(2)(a)-(e) of the Constitution. See also Du Plessis "Understanding the legal context" 20-33; and De Vos and Freedman *South African Constitutional Law in Context* 163, 170-171, 176, 182, 302-306.

¹¹⁹³ Du Plessis "Understanding the legal context" 13.

¹¹⁹⁴ Du Plessis "Understanding the legal context" 29.

¹¹⁹⁵ Section 165(1) and s 166 of the Constitution.

¹¹⁹⁶ Section 167(1-7) of the Constitution. De Vos and Freedman *South African Constitutional Law in Context* 66.

¹¹⁹⁷ De Vos and Freedman *South African Constitutional Law in Context* 66.

¹¹⁹⁸ See s 172 of the Constitution on different types of orders available to the courts. De Vos and Freedman *South African Constitutional Law in Context* 66.

¹¹⁹⁹ *United Democratic Movement and Others v Eskom Holdings SOC Ltd and Others*¹¹⁹⁹ [2023] ZAGPPHC 1949 para 120. Ruling made on 1 December 2023.

the sufficient supply or generation of electricity to a number of institutions before a set date. The court indicates that the state is responsible for the energy crises, and thereby failed to protect and promote a number of rights contained in the Bill of Rights.¹²⁰⁰ The court may an effort to ensure compliance with its order, follow this up with a structural interdict.¹²⁰¹ Section 172(1)(b) of the Constitution provides that in constitutional matters courts may grant "any order that is just and equitable". In this vein, the use of a structural interdict is about the court seeking to adjust future behaviour and is therefore a deliberate attempt to remedy systemic violations.¹²⁰² A structural interdict usually contains a reporting back element but the court will also supervise the implementation of the remedy.¹²⁰³ This may include further directions as to ensure effective assertion of the relevant constitutional right(s). The court is therefore a participant in the structural interdict remedy and not merely an observer.¹²⁰⁴

This type of ruling and further use of structural interdicts on the executive branch of government may very likely be applicable to water and food (access and availability) in the near future. This is based on the many instances of water shortages and water insecurity due to failing infrastructure and general service delivery failures by government.

Section 41 of the Constitution makes it clear that while the three spheres of government (national, provincial and local) are distinct, they should co-operate with one another.¹²⁰⁵ The requirement of co-operative government is to have a mechanism

¹²⁰⁰ Para 120.

¹²⁰¹ For examples of structural interdicts granted see *Pheko v Ekurhuleni Metropolitan Municipality* (3) [2016] ZACC 20 para 26-27; and *Kenton on Sea Ratepayers Association and Others v Ndlambe Local Municipality and Others* (4341/2014) [2016] ZAECGHC para 94-101.

¹²⁰² It therefore differs from a reporting order whereby progress needs to be reported on implementation. Swanepoel *The potential of structural interdicts* 85-86.

¹²⁰³ Swanepoel *The potential of structural interdicts* 85-86.

¹²⁰⁴ Swanepoel *The potential of structural interdicts* 86.

¹²⁰⁵ Section 41(1)(h)(i)-(vi) of the Constitution states that "all spheres of government and all organs of state within each sphere must exercise their powers and perform their functions in a manner that does not encroach on the geographical, functional or institutional integrity of government in another sphere; cooperate with one another in mutual trust and good faith by fostering friendly relations; assisting and supporting one another; informing one another of, and consulting one another on, matters of common interest; coordinating their actions and legislation with one another; adhering to agreed procedures; and avoiding legal proceedings against one another".

that regulates possible overlaps between the three spheres of government and to ensure that instead of competing with one another, they co-operate in sharing responsibilities in an interdependent manner.¹²⁰⁶ To give effect to these principles, Schedules 4 and 5 of the Constitution list a number of government functions and ascribe them to the different government spheres, namely:

- Schedule 4 lists functional areas of concurrent national and provincial competence. This includes functions on among other, agriculture, environment, nature conservation, pollution control, regional planning and development, soil conservation, urban and rural development.¹²⁰⁷
- Schedule 5 lists functional areas of exclusive provincial competence and includes functions on among other, provincial planning, and provincial roads and traffic.¹²⁰⁸
- Part B of Schedule 4 lists functional areas that are under the domain of local government. This includes functions on, among other, air pollution, electricity and gas reticulation, and "water and sanitation services limited to potable water supply systems and domestic waste-water and sewage disposal systems".¹²⁰⁹

Notably, the managing of the country's water reserve, electricity generation, and the extraction of petroleum or gas resources (mining) are not mentioned in either Schedule 4 or 5 and therefore fall under the competency of the national government sphere.¹²¹⁰ Agriculture and the environment are both provincial and national competencies,¹²¹¹ while the provisioning of services such as energy and water is a local government competency.¹²¹² Sometimes the overlapping jurisdictions cause tension as is apparent from South Africa's 2023 energy crisis. The Minister of Trade and Industry oversees Eskom as a state enterprise, while the decisions in relation to

¹²⁰⁶ De Vos and Freedman *South African Constitutional Law in Context* 306.

¹²⁰⁷ Schedule 4 of the Constitution.

¹²⁰⁸ Part B of Schedule 5 of the Constitution.

¹²⁰⁹ Part B of Schedule 4 of the Constitution.

¹²¹⁰ Glazewski "The Constitutional and legal framework" 39-40. See also the potential conflicts in the interpretation of the definition of environment in relation to water, Bosman, Kotzé and Du Plessis 2004 *SAPL* 411-421.

¹²¹¹ Schedule 4A.

¹²¹² Schedule 4B. On local government and service delivery, see Van der Walddt and Fuo "Municipal Service Delivery and the environment" Chapter 10; Swart *et al* "Water services provision and the protection of water resources" Chapter 13; Du Plessis and Murombo "Energy" Chapter 24.

energy licencing and registration are taken by an independent body, namely the National Energy Regulator of South Africa (NERSA),¹²¹³ while the Minister of Mineral Resources and Energy may make regulations and has oversight over the implementation of energy-related legislation, as well as making decisions on exploration and production rights (also in relation to environmental matters). The President assigned functions to the new Minister of Electricity in order to integrate decision-making and planning on energy.¹²¹⁴ However, decisions on exploration and production (as well as the environment) will most probably remain with the Ministry of Mineral Resources and Energy.¹²¹⁵ In principle, the Minister of Cooperative Governance and Traditional Affairs should ensure cooperation amongst line ministries, provinces, local government and traditional councils.

The Department of Forestry, Fisheries and Environment (hereafter DFFE) has on several occasions attempt to protect the environment in relation to mining activities, but the Western Cape High Court found that the then Minister of Mineral Resources and its mineral resource inspectors are the enforcers.¹²¹⁶ However, the courts confirmed that mining activities must comply with all relevant legislation and must obtain all authorisations, whether at the national, provincial or local level.¹²¹⁷

The *Spatial Planning and Land Use Management Act* 16 of 2013 (hereafter SPLUMA) aims to address spatial planning and land use management.¹²¹⁸ Per SPLUMA 'land use' means

... the purpose for which land is or may be used lawfully in terms of a land use scheme, existing scheme or in terms of any other authorisation, permit, or consent

¹²¹³ Established in terms of the *National Energy Regulator Act* 40 of 2004. NERSA regulates the electricity, piped-gas and petroleum pipelines industries in terms of the *Electricity Regulation Act* 4 of 2006, the *Gas Act* 48 of 2001 and the *Petroleum Pipelines Act* 60 of 2003.

¹²¹⁴ Proc 121 in GG 48662 of 26 May 2023.

¹²¹⁵ Sections 80 and 84 of the MPRDA, through the South African Agency for Promotion of Petroleum Exploration and Exploitation SOC Ltd (Petroleum Agency SA).

¹²¹⁶ See e.g. *Mineral Sands Resources (Pty) Ltd v Magistrate for the District of Vredendal, Kroutz* [2017] 2 All SA 599 (WCC).

¹²¹⁷ *City of Cape Town v Maccsand (Pty) Ltd* 2010 (6) SA 63 (WCC); [2011] 1 All SA 506 (WCC); *Maccsand (Pty) Ltd v City of Cape Town* (6) SA 633 (SCA); [2011] 4 All SA 601 (SCA); *Maccsand (Pty) Ltd v City of Cape Town* 2012 (4) SA 181 (CC); 2012 (7) BCLR 690 (CC).

¹²¹⁸ Retief and Celliers "Land use management and planning" 563.

issued by a competent authority, and includes any conditions related to such land use purposes.¹²¹⁹

and 'land development' means

... the erection of buildings or structures on land, or the change of use of land, including ... any deviation from the land use or uses permitted in terms of an applicable land use scheme.¹²²⁰

Retief and Celliers¹²²¹ refer to 'land use development' as "being concerned with the establishment and implementation of mechanisms to regulate land-use rights by way of land-use schemes and land development procedures". In order to change land use (from its specific current determination) or develop land, decision-making is required in the form of authorisations from a competent authority.¹²²²

UGD is inherently linked to land use and land development and will therefore require a number of land use and development authorisations.¹²²³ Land is the basis for both planning and environmental management.¹²²⁴ Since land use and management straddles so many issues, it is inevitable that environmental matters are central to all aspects of planning.¹²²⁵ A number of court decisions confirm that environmental considerations must be taken into account within the context of planning generally and specifically applicable to land use.¹²²⁶ For example, the Constitutional court in *Minister of Public Works and Others v Kyalami Ridge Environmental Association and Others*¹²²⁷ ruled that government's power to use its own land for specific land use does not entitle it to ignore rights that people may have under environmental and or other legislation.¹²²⁸ The Constitutional court in *Fuel Retailers Association of Southern*

¹²¹⁹ S 1 of SPLUMA.

¹²²⁰ S 1 of SPLUMA.

¹²²¹ Retief and Celliers "Land use management and planning" 563.

¹²²² Van Wyk "Law on planning" 1131.

¹²²³ This may include multiple authorisations in terms of an application for rezoning a property in addition to obtaining an authorisation for a listed activity per the NEMA, waste management activities in terms of NEMWA, water use in terms of the NWA, and mining and petroleum activities in terms of the MPRDA. See Van Wyk "Law on planning" 1170-1171.

¹²²⁴ Van Wyk "Law on planning" 1134.

¹²²⁵ Van Wyk "Law on planning" 1134.

¹²²⁶ See also Van Wyk "Law on planning" 1133.

¹²²⁷ *Minister of Public Works and Others v Kyalami Ridge Environmental Association and Others* 2001 (3) SA 1151 (CC) at para 106.

¹²²⁸ In this instances the rights of neighbours adjacent to a transit camp created by government.

*Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province, and Others*¹²²⁹ indicated that "[u]nlimited development is detrimental to the environment and the destruction of the environment is detrimental to development". The court in *Tergiet en Toekoms Action Group v Outeniqua Kreosoolpale (Pty) Ltd*¹²³⁰ ruled that failure to comply with zoning provisions equals to a violation of the right to an environment that is not harmful to a person's health or well-being.¹²³¹

The preamble of SPLUMA states that the protection of present and future generations rely on the sustainable development of land.¹²³² It states that environmental, economic and social considerations must be taken into account in both planning and current land use management.¹²³³ This is also reflected in one of the objects of SPLUMA, namely, the sustainable and efficient use of land.¹²³⁴ In order to ensure transparency, SPLUMA provides for public participation in a number of mechanisms such as in the compilation of SDFs and land use schemes.¹²³⁵ A number of principles within SPLUMA are key to development. For example, the principle of spatial sustainability includes the protection of prime agricultural land and the protection of the environment and other identified lands.¹²³⁶ The principle of spatial sustainability includes the use of environmental management instruments.¹²³⁷ The principle of efficiency focuses on the use of existing resources in land development and the use of decision-making procedures in a way that limit negative social and environmental impacts.¹²³⁸ Another principle is that of spatial resilience whereby flexibility in land use management systems (such as spatial plans and policies) is used to ensure sustainable livelihoods for communities most likely to suffer negative environmental impacts.¹²³⁹ A further

¹²²⁹ *Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province, and Others* 2007 (6) SA 4 (CC) at para 44.

¹²³⁰ *Tergiet en Toekoms Action Group v Outeniqua Kreosoolpale (Pty) Ltd* 2009 ZAWCHC 6 at para 40.

¹²³¹ Van Wyk "Law on planning" 1133.

¹²³² Preamble.

¹²³³ Preamble.

¹²³⁴ S 3(d).

¹²³⁵ S 12(1)(o) and s 24(1) respectively.

¹²³⁶ S 7(b)(iii).

¹²³⁷ S 7(b)(iii).

¹²³⁸ S 7(d).

¹²³⁹ S 7(c).

principle is that of good administration.¹²⁴⁰ This requires all spheres of government to follow an integrated approach to land use and land development.¹²⁴¹ This includes ensuring transparency on plans and application procedures, notably so that I&APs are afforded the opportunity to provide inputs on those matters that affect them.¹²⁴² These general principles are applicable to all organs of state and other authorities that deal with the use and development of land.¹²⁴³

SPLUMA makes specific provision for environmental considerations in the decision-making process.¹²⁴⁴ Notably, SPLUMA¹²⁴⁵ and the NEMA¹²⁴⁶ recognises the integration of separate authorisations. The respective SPLUMA and NEMA provisions¹²⁴⁷ provide that the competent authority and other authority empowered to authorise the activity may agree to issue an integrated authorisation. In this manner SPLUMA, the NEMA and other environmental sectoral legislation such as the NWA¹²⁴⁸ and the NEMWA¹²⁴⁹ are aligned.¹²⁵⁰ In such instances, the municipality and the other organ of state may enter into a written agreement to specify a framework to co-ordinate the procedures to be followed.¹²⁵¹ The details of such a written agreement contain the circumstances under which an integrated authorisation will be actioned.¹²⁵² In order to avoid duplication in the instance of an integrated authorisation (such as the submission of information) the NEMA provides that the Minister or MEC may consult with any organ of state on the matter.¹²⁵³

While SPLUMA shows a great deal of promise in embracing a more holistic and integrated approach to decision-making on land use and planning matters that includes environmental considerations, some challenges remain. These challenges are

¹²⁴⁰ S 7(e).

¹²⁴¹ S 7(e).

¹²⁴² S 7(e).

¹²⁴³ S 6(1).

¹²⁴⁴ S 30.

¹²⁴⁵ S 30.

¹²⁴⁶ S 24L.

¹²⁴⁷ S 30 and s 24L respectively.

¹²⁴⁸ A water use licence is required for certain water use – see Schedule 1 of NWA.

¹²⁴⁹ S 45 requires a waste management licence for certain waste management activities.

¹²⁵⁰ S30 SPLUMA and S 24L NEMA.

¹²⁵¹ Regulation 17.

¹²⁵² Regulation 17.

¹²⁵³ S24K(2).

evident in the inherent complexity in the legislative and administrative scheme on planning and land use.¹²⁵⁴ Notably, all three spheres of government (national, provincial and local) are required to co-operate on decision-making.¹²⁵⁵ This is not an easy task to complete. Further, because municipalities are required to adopt their own by-laws on planning and land use, they carry a lot of responsibility. The adoption of by-laws within the transition from old-order laws on planning to the new regime requires skills, capacity and resources.¹²⁵⁶ Municipalities do not necessarily have the required skills, capacity and resources to administer this.

Notwithstanding these challenges, the previous paragraphs confirmed the integrated and co-operative approach within the SPLUMA.

The *Intergovernmental Relations Framework Act* 13 of 2005 (hereafter IGRFA) must give effect to the Constitutional mandate on cooperative governance. The IGRFA provides for intergovernmental (national, provincial and local) instruments, policy and legislation on intergovernmental issues, including the management of intergovernmental disputes.¹²⁵⁷ The aim of the IGRFA is twofold, namely, (i) to promote and facilitate relations between the national, provincial and local government, and (ii) to manage intergovernmental disputes by way of prescribed mechanisms and procedures in the settlement thereof.¹²⁵⁸ Part of this aim at enhancing coordination and integration across government levels includes a number of mechanisms, such as coordinating forums that include:

- the President's Coordinating Council (PCC);
- The Cabinet Cluster System;
- the Forum of South African Director-Generals (FOSAD) and
- Inter-Ministerial Committees (IMCs).¹²⁵⁹

¹²⁵⁴ Van Wyk "Law on planning" 1176.

¹²⁵⁵ In terms of chapter 3 of the Constitution.

¹²⁵⁶ Van Wyk "Law on planning" 1176.

¹²⁵⁷ Chapters 2, 3 and 4 of IGRFA.

¹²⁵⁸ Chapters 2, 3 and 4 of IGRFA.

¹²⁵⁹ Chapter 3 of IGRFA. See also De Vos and Freedman *South African Constitutional Law in Context* 310. The Department of Forestry, Fisheries and Environment also established a Committee for Environmental Coordination. The committee consists of directors-general of various departments and inter-departmental technical committees assist them.

The President further established a Department of Planning, Monitoring and Evaluation. This department provides oversight for strategic planning, policy design as well as the implementation of the NDP and the Medium-Term Strategic Framework 2019-2024.¹²⁶⁰ The MTSF foresees job creation and improvement of services in relation to water, energy and food production. The MTSF does not specifically refer to UGD but indicate that exploration should increase to 2.5 percent by 2024. In addition, an Inter-Ministerial Committee on Sustainable Development Agendas has to oversee the implementation of the SDGs, the African Union's Agenda 2063¹²⁶¹ and the Southern African Development Community Regional Indicative Strategic Development Programme (SADC RISDP).¹²⁶² A committee consisting of the Director-Generals of specific departments must ensure the integrated implementation of these instruments.¹²⁶³ Not all departments are involved¹²⁶⁴ and noticeably the Department of Agriculture, Rural Development and Land Reform, the Department of Water and Sanitation and the Department of Mineral Resources and Energy are absent from this oversight committee. However, various working groups may provide inputs, including provincial and local government, as well as the excluded government departments. The National Development Stakeholders Forum, consisting of non-state actors within civil society and academia, provides input to all the above-mentioned departments and committees.

The President appointed a Presidential Climate Commission consisting of representatives of the public and private sector as well as non-government organisations and activists to develop a framework for a just transition from coal-

¹²⁶⁰ Department of Planning, Monitoring and Evaluation https://www.dpme.gov.za/keyfocusareas/outcomesSite/MTSF_2019_2024/2019-2024%20MTSF%20Comprehensive%20Document.pdf. Also, see *2019 South Africa Voluntary National Report* par 3.1.

¹²⁶¹ African Union *Agenda 2063: The Africa We Want* (May 2013), for more information see <https://au.int/en/agenda2063/overview>.

¹²⁶² Approved August 2003, for more information see <https://www.sadc.int/pages/regional-indicative-strategic-development-plan-risdp>.

¹²⁶³ *2019 South Africa Voluntary National Report* par 3.1.

¹²⁶⁴ "Directors-General from the Departments of Planning, Monitoring and Evaluation (meeting chair), International Relations and Cooperation, Environmental Affairs, Women, Basic Education, Higher Education, Cooperative Governance and Traditional Affairs, Finance, Science and Technology, Public Service and Administration, and Government Communications" - *2019 South Africa Voluntary National Report* par 3.1.

based energy to renewable energy.¹²⁶⁵ This culminated in the official adoption of the Just Transition Framework.¹²⁶⁶

As indicated earlier, various government departments have responsibilities for UGD. The DFFE oversees all matters related to the environment.¹²⁶⁷ The "environment" is a functional area of concurrent national and provincial legislative competence.¹²⁶⁸ At the provincial level, each of the nine provinces has a department that addresses environmental matters. Local government, however, also has an environmental mandate in that it is responsible for promoting a safe and healthy environment,¹²⁶⁹ however, not with regard to mining and exploration. The DMRE is mandated to deal with exploration, production and energy matters.¹²⁷⁰ Because mineral and petroleum (includes natural gas) resource extraction is not mentioned in either Schedule 4 or 5 of the Constitution, it automatically qualifies as a functional area of national legislative competence.¹²⁷¹ Provincial government is therefore not involved in energy matters.¹²⁷² Local government is only involved in so far as the overseeing of aspects related to the reticulation of electricity and gas.¹²⁷³

The Department of Water and Sanitation (DWS) is mandated to deal with the country's water reserve.¹²⁷⁴ It being a national function, the DWS is responsible for the allocation of water for industry, agriculture and human consumption and use.¹²⁷⁵ The DWS is required to do this by making water determinations for "water catchment areas" and the issuing of water use licenses for certain water use and users.¹²⁷⁶ Local government

¹²⁶⁵ See 4.5.1 above.

¹²⁶⁶ Adopted 27 May 2022. See 4.2. and 4.4.1 above. On the work of the commission, see Presidential Climate Commission <https://www.climatecommission.org.za/just-transition-framework>.

¹²⁶⁷ Matters related to mining are however not within the ambit of the DFFE.

¹²⁶⁸ Per Schedule 4, Part A of the Constitution, 1996.

¹²⁶⁹ Section 152(1)(d) of the Constitution, 1996. Also see Feris and Fuo "The Local Government–Environmental Law Interface: Notions and Perspectives" Chapter 6; Du Plessis 2010 *Stell LR* 265–297.

¹²⁷⁰ Per the MPRDA.

¹²⁷¹ Glazewski "The Constitutional and legal framework" 39.

¹²⁷² Glazewski "The Constitutional and legal framework" 39.

¹²⁷³ Per Part B of Schedule 4 of the Constitution.

¹²⁷⁴ Chapter 6 of the NWA.

¹²⁷⁵ See preamble of the NWA.

¹²⁷⁶ Chapter 2 of the NWA.

however, is responsible for service delivery of water and sanitation that is "limited to potable water supply systems and domestic waste water and sewage disposal".¹²⁷⁷

Agriculture is a functional area of concurrent national and provincial legislative competence.¹²⁷⁸ The Department of Agriculture, Land Reform and Rural Development (DALRRD) is required to develop agricultural value chains, provide inputs and monitor production and consumption within the agriculture sector.¹²⁷⁹ In terms of food compliance, DALRRD and another two government departments regulate different aspects of food. The Department of Health (DoH) is responsible for ensuring food safety for consumers (in the form of regulations on additives, contaminants, and labelling), while the Department of Trade, Industry and Competition (DTIC) sets specifications on certain food categories.¹²⁸⁰

Decision-making and regulatory measures applicable to UGD, within the South African context, straddles all three spheres of government (national, provincial and local). This is so because UGD comprises multiple activities that legally require authorisation from a number of governmental departments at both horizontal and vertical levels.¹²⁸¹ This is due to legally defined and delineated roles and functions ascribed to the national, provincial and local government spheres. In the case of UGD in the Karoo, it includes at the national level the departments responsible for mineral resources, water, energy and environmental matters, amongst others. At provincial level, the Western and Eastern Cape authorities responsible for planning, rural development and the environment will be involved. District municipalities (e.g. the Central Karoo) including a number of local municipalities will also be involved, namely Beaufort West, Laingsburg and Prince Albert.

¹²⁷⁷ Schedule 4B of the Constitution, 1996.

¹²⁷⁸ Schedule 4A of the Constitution, 1996.

¹²⁷⁹ See <https://www.gov.za/about-sa/agriculture-land-reform-and-rural-development-1>.

¹²⁸⁰ This includes The South African National Standards (SANS). While the implementation of SANS standards is usually voluntary, some specifications are compulsory.

¹²⁸¹ On the acquisition of permissions, permits and rights to minerals and petroleum, see Van der Schyff *Property in Minerals and Petroleum* chapters 10 and 12.

In the case of UGD, an applicant will have to apply for numerous authorisations.¹²⁸² These will briefly be referred to in the next paragraph as background to the next chapter, which will determine whether the South African legislation provides for WEF nexus decision-making in relation to UGD.

4.7 Authorising UGD: an overview

In order to understand the application of the WEF nexus elements to UGD in the next chapter (Chapter five), it is necessary to explain what legislation is generally applicable to an UGD application. In this regard, authorisations directly applicable to UGD, and then authorisations particular to water, energy and food will then be discussed.

4.7.1 General – exploration and production authorisations

Firstly, an applicant for an UGD will have to comply with the requirements of the MPRDA and NEMA.¹²⁸³ As indicated above,¹²⁸⁴ the Minister of Mineral Resources and Energy is the decision-maker for both gas exploration as well as environmental authorisations in this regard. The MPRDA deals with both mining and petroleum extraction and production and requires applicants for UGD to apply for a reconnaissance permit,¹²⁸⁵ technical cooperation permit,¹²⁸⁶ an exploration right¹²⁸⁷ and eventually a production right.¹²⁸⁸ Petroleum is widely defined in the MPRDA to include hydrocarbon gas such as shale gas.¹²⁸⁹

Chapter 6 of the MPRDA deals specifically with petroleum and is therefore key on the provisions applicable to unconventional gas development. An application for the grant

¹²⁸² On the acquisition of permissions, permits and rights to minerals and petroleum see Van der Schyff *Property in Minerals and Petroleum* chapters 10 and 12.

¹²⁸³ Section 37 of the MPRDA states that the principles per section 2 of the NEMA are applicable to all prospecting and mining operations. See also Van der Schyff *Property in Minerals and Petroleum* chapters 10 and 12.

¹²⁸⁴ Paragraph 4.6.

¹²⁸⁵ Section 74 of MPRDA.

¹²⁸⁶ Section 76 of MPRDA.

¹²⁸⁷ Section 79 of MPRDA. This study focuses on exploration and production.

¹²⁸⁸ Section 85 of MPRDA. See also Van der Schyff *Property in Minerals and Petroleum* 433-447.

¹²⁸⁹ Section 1 of MPRDA. For a discussion on the definition of 'mineral' and 'petroleum' in the MPRDA see Van der Schyff *Property in Minerals and Petroleum* 301-327. See also *Minister of Mineral Resources v Stern and Others; Treasure the Karoo Action Group and Another v Department of Mineral Resources and Others* [2019] 3 All SA 684 (SCA) (4 July 2019) para 9.

of an exploration right are set out and listed in Section 79 of the MPRDA read with regulation 28 and Form M, Annexure I of the Petroleum Regulations.¹²⁹⁰ Exploration rights are granted for an initial period of three years and, on an application, can be renewed for up to three further periods not exceeding two years each.¹²⁹¹ An application for renewal of an exploration right must be granted if the holder of the exploration right has complied with the terms and conditions of the exploration right, the approved exploration work programme and the provisions of the Act.¹²⁹² Exploration rights are transferable, and the holder of an exploration right has the exclusive right to apply for a production right over the exploration area.¹²⁹³ An application for the grant of a production right are set out and listed in Section 83 of the MPRDA read with regulation 34 and Form N, Annexure I of the Petroleum Regulations.¹²⁹⁴ A production right is valid for 30 years and is renewable for further periods, each of which cannot extend beyond 10 years.¹²⁹⁵ As is the case with exploration rights, production rights are transferable.¹²⁹⁶

The *Upstream Petroleum Resources Development Bill*¹²⁹⁷ sets to introduce a separation of the regulatory framework that governs mining and petroleum exploration and production. Mining and petroleum exploration and production is currently dealt with within the MPRDA.¹²⁹⁸ The Bill defines gas:

any hydrocarbon which at a temperature of 21 degrees Celsius and a pressure of one atmosphere, is in a gaseous phase existing in a natural condition in the earth's crust, regardless of the nature of the host rock, and includes condensate of such gas, but does not include hydrocarbon gas obtained by destructive distillation or gas arising from a marsh or other surface deposit.¹²⁹⁹

The Bill confirms the government's intention to develop the gas and oil sector within its aim for energy security. The Bill is currently out for public comment (written

¹²⁹⁰ This includes a description of the documents to be submitted in support of the application.

¹²⁹¹ Section 80(5) and 81(4) of the MPRDA respectively.

¹²⁹² Section 81(3) of MPRDA.

¹²⁹³ Section 82(a)(d) and 82(1)(a) of MPRDA.

¹²⁹⁴ This includes a description of the documents to be submitted in support of the application.

¹²⁹⁵ Section 84(4) and 85(4) of MPRDA.

¹²⁹⁶ Section 86(1)(c) of MPRDA.

¹²⁹⁷ [B13-2021].

¹²⁹⁸ See preamble and s 2 of the Bill.

¹²⁹⁹ Clause 1.

comments and public hearings).¹³⁰⁰ The objective is that in future only a petroleum right will be issued which will include both the exploration and production phases.¹³⁰¹ An application for such a right will require proof of the granting of an environmental authorisation and proof of an application for a water use license (per NWA).¹³⁰² Du Plessis and Nel¹³⁰³ state that framework legislation "aims to define overarching and generic principles in terms of which sectoral-specific legislation is embedded, as well as to enhance the co-operative ... governance amongst fragmented line ministries". In this sense framework legislation is mandated to manage across horizontal and vertical spheres of government. That is to say, legislation that are designed to operate in certain instances across and between national, provincial and local government spheres. This includes bridging different government departments at the horizontal and vertical spheres. The NEMA is the framework legislation on environmental matters in South Africa. It is the main statute designed to give effect to section 24 of the Constitution (i.e. the environmental right). As per its title the purpose of the NEMA is:

To provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance and procedures for co-ordinating environmental functions exercised by organs of state; to provide for certain aspects of the administration and enforcement of other environmental management laws; and to provide for matters connected therewith.¹³⁰⁴

Section 2 of NEMA lists a number of principles to be applied in the environmental context.¹³⁰⁵ Notably, these principles bind "the actions of all organs of state that may detrimentally affect the environment".¹³⁰⁶ Per NEMA, section 2 principles:

Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into account the effects

¹³⁰⁰ Some public consultations on the Bill have already taken place. See the press release by Parliament 19 February 2023 <https://www.parliament.gov.za/press-releases/media-statement-mineral-resources-and-energy-committee-concludes-first-round-public-hearings-upstream-petroleum-resources-development-bill-western-cape>.

¹³⁰¹ Clause 14(2).

¹³⁰² Clause 44(1)(d and g).

¹³⁰³ Du Plessis and Nel 2001 *SAJELP* 1-2.

¹³⁰⁴ Title of NEMA.

¹³⁰⁵ Section 37 of the MPRDA indicates that the section 2 principles of NEMA are applicable to all prospecting and mining operations.

¹³⁰⁶ Section 2 of NEMA.

of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option.¹³⁰⁷

and

There must be intergovernmental co-ordination and harmonisation of policies, legislation and actions relating to the environment.¹³⁰⁸

The NEMA further requires an environmental authorisation for listed or specified activities.¹³⁰⁹ The listed or specified activities are found in Listing Notices 1-3 of NEMA's Environmental Impact Assessment Regulations (EIA Regulations).¹³¹⁰ Activities listed in Notices 1 and 3 require a basic assessment while those listed in Notice 2 require a more comprehensive scoping and environmental impact report (S&EIR).¹³¹¹ UGD is listed in Listing Notice 2 and therefore would require a S&EIR report.¹³¹² This will require the applicant to appoint an environmental assessment practitioner, who has to ensure that several studies are conducted to determine the severity of the impacts a development may have (that will include impacts on water and food, amongst others).¹³¹³ How these impacts will be addressed need to be addressed in an Environmental Management Programme (EMPr).¹³¹⁴

In the case of *Earthlife Africa Johannesburg v Minister of Environmental Affairs*¹³¹⁵ the court required that as part of the environmental authorisation, a climate change impact assessment should be undertaken for a proposed coal-fired power station. Although the NEMA or its regulations did not specifically provide for this, the court read into section 240 and in interpreting South Africa's international obligations, that

¹³⁰⁷ Section 2(4)(b) of NEMA.

¹³⁰⁸ Section 2(4)(l) of NEMA.

¹³⁰⁹ Section 24 of NEMA deals with environmental authorisations.

¹³¹⁰ GN R983, 984 and 985 in GG 38282 of 4 December 2014, as amended, referred to as Listing Notices 1, 2 and 3.

¹³¹¹ See reg 1 of GN R982 in GG 38282 of 4 December 2014, as amended (referred to as GN R982). To conduct a BA process, reg of GN R983 will have to be followed, while in the case of scoping and an EIA, reg of GN R984 will have to be adhered to. The content of a BA is set out in Annexure I, while the scoping and EIA content is set out in Annexure II.

¹³¹² Listed activity 18, read with listed activity 20A, inserted by GN 517 in GG 44701 of 11 June 2021.

¹³¹³ Reg 12 of GN R982.

¹³¹⁴ Section 24N of NEMA read with Annexure I of GN R982.

¹³¹⁵ [2017] 2 All SA 519 (GP) para 52-56 and 78-91.

such assessment would be needed. The applicants in recent offshore exploration cases, argued the same.¹³¹⁶ The courts did not pronounce on this, however.

The issuing of reconnaissance permits and exploration rights for offshore exploration has been challenged in the court from December 2021 onwards.¹³¹⁷ The applicants applied for interdicts to prevent exploration activities on the South African east and west coasts.¹³¹⁸ The main points of contention include that the renewal of previous permits and rights would require the exploration companies to conduct an S&EIR under the new NEMA regulations,¹³¹⁹ that the public participation procedures were at fault,¹³²⁰ that cultural issues were not considered¹³²¹ and that climate change impacts should have been undertaken.¹³²² The applicants further argued that the S&EIR studies are flawed in that they do not consider the real impacts of such surveys on all marine life, and not only whales and dolphins. They also argued these studies were flawed.¹³²³ The court in three cases, granted interdicts against the reconnaissance permit and exploration rights,¹³²⁴ while the first court refused to do so, by applying the law as it stands.¹³²⁵ In future onshore gas exploration and production may face similar challenges.

In 2015, the Minister of Mineral Resources and Energy issued regulations to regulate onshore hydraulic fracturing.¹³²⁶ In 2019, the Supreme Court of Appeal declared the

¹³¹⁶ See *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* 2022 (6) SA 589 (ECMk) para 32-33.

¹³¹⁷ See Du Plessis and Franco *Litnet Akademies Weerdink* 22 Desember 2022.

¹³¹⁸ *Border Deep Sea Angling Association v Minister of Mineral Resources and Energy* (3865/2021) [2021] ZAECHC 111; *Sustaining The Wild Coast NPC v Minister of Mineral Resources and Energy* 2022 (2) SA 585 (ECG); *Adams v Minister of Mineral Resources and Energy* ((1306/22) [2022] ZAWCHC 24 (1 March 2022); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* 2022 (6) SA 589 (ECMk).

¹³¹⁹ 2021 *Border Deep Sea* case para 30-31; *Adams* case para 11,22,37,46 and 48; 2021 *Wild Coast* case para 44, 60 and 62; 2022 *Wild Coast* case para 31,33-34, 128-129.

¹³²⁰ *Adams* case para 46; 2021 *Wild Coast* case para 19,20 and 22; 2022 *Wild Coast* case para 90-91, 94 and 99.

¹³²¹ *Adams* case para 24, 38-39; 2022 *Wild Coast* case para 107, 112, 114-119.

¹³²² *Adams* case para 34; 2022 *Wild Coast* case para 124-125.

¹³²³ 2021 *Wild Coast* case para 44, 48, 58 and 62; 2022 *Wild Coast* case para 33, 34, 108 and 109; *Adams* case para 11, 13, 18, 25-26 and 33; 2021 *Wild Coast* case para 44, 48, 58 and 62.

¹³²⁴ *Adams* case para 50; 2021 *Wild Coast* case para 73, 77 and 82; 2022 *Wild Coast* case para 138.

¹³²⁵ 2021 *Border Deep Sea* case para 41-42.

¹³²⁶ GN R 466 in GG 38855 of 3 June 2015. Technical Regulations for Petroleum Exploration and Exploitation ("the Technical Regulations") under the MPRDA.

regulations unconstitutional as it had been improperly promulgated and were, therefore, invalid.¹³²⁷ In 2022, new hydraulic fracturing regulations issued in terms of the NEMA were published for comment.¹³²⁸ These measures relate to coordination between decision-making authorities, public participation, and environmental monitoring and will be applied in the discussion of the elements of the WEF nexus.¹³²⁹ In addition, the Minister of Forestry, Fisheries and Environment published for comment, the Minimum Information Requirements for the Submission of Applications for an Authorisation, Right, Permit or Licences for the Onshore Exploration of Oil and Gas Intending to Utilise Hydraulic Fracturing. Amongst others, it is meant to "facilitate the process of simultaneous application submissions" as well as "the process of simultaneous decision-making".¹³³⁰ Such decision-making may provide an opportunity for WEF nexus decision-making and will be discussed in the following chapter.

To assist the eventual transportation of gas, the DFFE drafted a Generic Environmental Management Programme for applications for an environmental authorisation in relation to the development or expansion of gas pipelines,¹³³¹ as well as the procedures that needs to be followed when such an application is made for a project within the Strategic Gas Pipeline Corridors or when a decision on an application is made.¹³³² The idea is to streamline the procedures for gas pipelines, most probably due to the possibility of UGD.

NEMAQA lists activities that result in atmospheric emissions, which have or may have a significant detrimental effect on the environment, including ecological, health, and socio-economic conditions.¹³³³ Those listed activities may not commence without an approved AEL.¹³³⁴ The application for an AEL does not follow the process in the EIA regulations – in short, before an application for AEL can be decided the EIA decision

¹³²⁷ *Minister of Mineral Resources v Stern and Others; Treasure the Karoo Action Group and Another v Department of Mineral Resources and Others* [2019] 3 All SA 684 (SCA) (4 July 2019) para 49-50.

¹³²⁸ GN 2273 in GG 47112 of 11 July 2022.

¹³²⁹ See Chapter 5.

¹³³⁰ GN 2264 in GG 46688 of 8 July 2022.

¹³³¹ GN 373 in GG 44481 of 23 April 2021.

¹³³² GN 411 in GG 44551 of 7 May 2021.

¹³³³ Section 21(1)(a) of NEMAQA.

¹³³⁴ Section 22 of NEMAQA.

that includes an air quality impact assessment report need to have been completed.¹³³⁵ The AEL licensing authority must make their decision within 60 days of the date on which the EIA decision was made.¹³³⁶ The NEMAQA further requires greenhouse gas reporting, which will be applicable to any UGD as methane gas may be released.¹³³⁷

Section 24K of NEMA provides for coordination between different organs of government in relation to an activity or activities that may require an environmental authorisation from more than one organ of government. In short, this section provides for written agreements between different organs of government. The aim of this is to avoid duplication in the procedures that are required for the different authorisations. Section 24L arranges for integrated environmental authorisations between NEMA and specific environmental management acts (SEMA).¹³³⁸ In this sense, NEMA and the relevant SEMAs provide for an integrated environmental management system. It would imply that the Minister of Mineral Resources and Energy would be able to issue an integrated authorisation for UGD.

4.7.2 Authorisations – water and waste

The *National Water Act* 36 of 1998 (NWA) seeks to ensure that the country's water resources are protected, used, developed, conserved, managed and controlled in a manner which takes into account relevant factors such as the meeting of the basic human needs of present and future generations.¹³³⁹ The NWA follows a holistic approach to managing all "water".¹³⁴⁰ This includes the allocation of water use via Catchment Management Agencies.¹³⁴¹ In terms of the water "reserve", per the NWA, water must be set aside to support basic human needs (water, energy, and food) and

¹³³⁵ Section 40(2)(c) of NEMAQA.

¹³³⁶ Section 40(3) of NEMAQA.

¹³³⁷ Section 43(1)(l) of NEMAQA, read with the greenhouse gas reporting regulations – GN 994 in GG 43712 of 11 September 2020.

¹³³⁸ Section 24(l) of NEMA. According to s 1 of NEMA the SEMAs include the *National Water Act* 36 of 2008 (NWA); *Environmental Conservation Act* 73 of 1989 (ECA); *National Environmental Management: Air Quality Act* 39 of 2004 (NEMAQA); *National Environmental Management: Waste Act*, 59 of 2008 (NEMWA); *National Environmental Management: Protected Areas Act* 57 of 2003 (NEMPA); and the *National Environmental Management: Biodiversity Act* 10 of 2004 (NEMBA), amongst others.

¹³³⁹ Section 2 NWA.

¹³⁴⁰ Section 3(3) NWA. The NWA recognises the scientific indivisibility of the water resource. It therefore includes all aspects of water resources.

¹³⁴¹ Section 8-11 NWA.

the environment.¹³⁴² Certain water uses, as specified in the Act, requires an application for and authorisation of a water licence (unless its use falls within one of the exceptions set out in the NWA).¹³⁴³ Section 21 of the NWA lists water uses that will trigger an application for a water use licence.¹³⁴⁴ In 2015, a notice was published declaring the exploration and production of onshore conventional gas as a controlled activity.¹³⁴⁵ Declared as such, an applicant for UGD must submit an application for a water use licence.¹³⁴⁶ In 2022, the Minister of Water and Sanitation published regulations on the exploration and production of onshore UGD.¹³⁴⁷

NEMWA lists activities that have or are likely to have a detrimental effect on the environment.¹³⁴⁸ Per the listed activities identified in Category A or B those activities may not be conducted without a WML. Category A listed activities requires submission of a BA report as per EIA regulations. Category B listed activities requires submission of scoping and EIA report (S&EIR) as per EIA regulations. UGD will trigger listed activity four, namely the disposal of hazardous waste to land that will require a S&EIR. The BA and EIA processes follow the procedures described in the NEMA and its regulations. The legislation and regulations are considered in relation to the WEF elements in Chapter 5.

4.7.3 Authorisations – energy

The *National Energy Act* 34 of 2008 (NEA) has a number of objectives that include, among other, ensuring the uninterrupted supply of energy; (b) the diversification of supply of energy and its sources; and the general facilitation of access to energy.¹³⁴⁹ The Act requires the Minister of Mineral Resources and Energy to publish an IEP that

¹³⁴² Section 16-18 NWA.

¹³⁴³ Chapter 4 of the NWA.

¹³⁴⁴ Section 40 of NWA.

¹³⁴⁵ GN 999 in GG 39299 of 16 October 2015 (GN 999).

¹³⁴⁶ Section 21(e), read with ss 37(1) and 38(1) of NWA, as well as with the Water Use License Application and Appeals Regulations, 2017 - GN R267 in GG 40713 of 24 March 2017.

¹³⁴⁷ GN 406 in GG 44545 of 7 May 2021 – Draft Regulations for the Use of Water for Exploration and Production of Onshore Naturally Occurring Hydrocarbons that Require Stimulation Including Hydraulic Fracturing and Underground Coal Gasification to Extract and any Activity Incidental Thereto that may Impact Detrimentally on the Water Resource, 2021 – for comment. Issued in terms of s 28(1)(g) of NWA read with GN 999.

¹³⁴⁸ Section 19 read with the List of Waste Management Activities that have, or are likely to have, a Detrimental Effect on the Environment - GN 921 in GG 37083 of 29 November 2013.

¹³⁴⁹ Section 2(a-b) and (i) of the NEA.

needs to be review annually.¹³⁵⁰ The Act further requires that the IEP consider the country's energy needs by analyzing energy consumption trends within different sectors of the economy.¹³⁵¹ Findings from this analysis are used to project future energy requirements. Latest development on the IEP took place on 28 April 2023. The President of South Africa initiated a proclamation whereby section 6 of the *National Energy Act* 34 of 2008 will come into operation on 1 April 2024.¹³⁵² Section 6 of the *National Energy Act* places a legislative obligation on the Minister of Mineral Resources and Energy to develop an IEP.

The *ERA* focuses on electricity supply (i.e. the trading and the generation, transmission or distribution of electricity).¹³⁵³ The Act states that its objects include the "sustainable ... development and operation of electricity supply infrastructure in South Africa" and the facilitation of "universal access to electricity".¹³⁵⁴ Any person that either generate, transmit or distribute electricity must apply for a license.¹³⁵⁵ The use of power stations that use gas to generate electricity will in future also have to apply for such a license from NERSA.

4.7.4 Authorisations – food

Except that food security may be a consideration in the BA and S&EIR processes,¹³⁵⁶ the *Conservation of Agriculture Resources Act* 43 of 1983 (CARA) is applicable. The CARA manages and regulates the use of South Africa's natural agricultural resources. In order to conserve the country's natural agricultural resources by maintaining the production potential of land, it specifically aims to promote the conservation of the soil, water resources and vegetation.¹³⁵⁷

The Minister may prescribe control measures (in the form of a prohibition or an obligation) to (i) prevent the salination or waterlogging of land and (ii) protect water

¹³⁵⁰ Section 6(1) of the NEA. For the IEP see para 4.5.3 above.

¹³⁵¹ See para 4.5.3 above for a discussion of the Plan.

¹³⁵² Proc No 118 of 2023.

¹³⁵³ Preamble of the *Electricity Regulation Act*.

¹³⁵⁴ Section 2(a) and (d) of the Act.

¹³⁵⁵ Section 19.

¹³⁵⁶ See para 4.7.1 and 4.7.2 above.

¹³⁵⁷ See preamble and s 3 of CARA.

courses and water resources.¹³⁵⁸ Further, the Minister is mandated to make regulations on "any matter which in terms of the Act is required or permitted to be prescribed or done by regulation, and, generally, with reference to any matter which he considers necessary or expedient to prescribe in order to achieve or to promote the objects of this Act".¹³⁵⁹ Despite the Act's focus on soil and water in relation to agriculture, it does not necessarily establish trade-offs between the use of the soil and water.

The protection of high potential agricultural land in the *Preservation and Development of Agricultural Land Bill*¹³⁶⁰ provides principles for the management of agricultural land and includes agricultural land evaluation and classification. It also provides for provincial agricultural sector plans and the declaration of protected agricultural areas.¹³⁶¹ In March 2023, the Bill served before the National Assembly.¹³⁶²

In 2017 the *Draft Regulation of Agricultural Land Holdings Bill, 2017* aims to provide for the establishment of a Land Commission that is mandated to establish a register of public and private ownership of agricultural land.¹³⁶³ The main objective of the Draft Bill is to provide for the redistribution of agricultural land to achieve redress to the results of past discrimination (apartheid) on access to agricultural land.¹³⁶⁴ Another objective of the Bill is the promotion of food security.¹³⁶⁵ The Bill has not yet been discussed at parliamentary committee level.¹³⁶⁶

Paragraph 4.6-4.7 described the regulatory framework applicable to UGD (in terms of government structures and cooperative government instruments). Preliminary findings include the existence of both weak and stronger WEF linkages and integration. Numerous sets of regulations and legislation are applicable to UGD. In some instances, there is proof of integration and co-ordination. For example, SPLUMA, the NEMA and

¹³⁵⁸ Section 6(1) and 6(2)(d)-(e) of CARA.

¹³⁵⁹ Section 29(1)(e) of CARA.

¹³⁶⁰ The *Preservation and Development of Agricultural Land Bill* [B8-2021].

¹³⁶¹ Preamble to Bill.

¹³⁶² Parliamentary Monitoring Group <https://pmg.org.za/bill/1018/>.

¹³⁶³ GG 40697 of 17 March 2017.

¹³⁶⁴ See preamble and clause 2 of the *Regulation of Agricultural Land Holdings Bill, 2017*.

¹³⁶⁵ Clause 2(c) of the *Regulation of Agricultural Land Holdings Bill 2017*.

¹³⁶⁶ Parliamentary Monitoring Group <https://pmg.org.za/bill/690/>.

other SEMAs, such as the NWA are aligned in that there is a recognition of integrative authorisations (across planning, environmental and water). This is in line with the aim of an integrated environmental system. The IGRFA aims to enhance coordination and integration across government levels by making use of a number of mechanisms in the form of coordinating forums. These include the President's Coordinating Council, the Cabinet Cluster Team, FOSAD, and IMCs. The Department of Planning, Monitoring and Evaluation provides oversight for strategic planning and the implementation of the NDP and the MTSF. The MTSF deals with improvement of services on water, energy and food production. While the MTSF does not directly refer to UGD it does indicate that exploration should be increasing. An Inter-Ministerial Committee on Sustainable Development Agendas oversees implementation of the SDGs. An application for UGD need to comply with the requirements set out in the MPRDA and NEMA. The MPRDA per section 37 and the NEMA per section 2 refer to one another in terms of decision-making. The 2022 hydraulic fracturing regulations issued in terms of the NEMA (published for comment) deals with coordination between decision-making authorities, public participation, and environmental monitoring. The Minimum Information Requirements for the Submission of Applications for an Authorisation, Right, Permit or Licences for the Onshore Exploration of Oil and Gas Intending to Utilise Hydraulic Fracturing is meant to "facilitate the process of simultaneous application submissions" as well as "the process of simultaneous decision-making". The *Upstream Petroleum Resources Development Bill* will in future only issue a petroleum right that include both the exploration and production phases. An application for such a right will require proof of the granting of an environmental authorisation and proof of an application for a water use license (per NWA). In other words, while some examples exists of an integrated environmental management system across water, energy and food, it remains fragmented.

The previous section identified and described the regulatory framework applicable to UGD in South Africa. This included South Africa's international and regional commitments on water, energy and food; South Africa's response to climate change via its adoption of the Paris Agreement; the Constitutional provisions applicable to water, energy, food and the environment; the overarching policy framework at a

general strategic level, a water strategic level, an energy strategic level and a food strategic level. This was followed by the government structure in South Africa, specifically the application of cooperative government instruments within and between the three spheres of government (national, provincial and municipal). An explanation of which legislation is generally applicable to an UGD authorisation(s). This included authorisations that are directly applicable to UGD and other authorisations specific to water, energy and food.

The following part of this chapter describes three empirical studies that straddle the WEF nexus and UGD in South Africa. By examining three sets of empirical data that cover different geographical, cultural and socio-economic realities, a number of conclusions can possibly be drawn on the extent of WEF nexus integration within UGD.

4.8 Empirical study on the WEF nexus and UGD

4.8.1 Introduction

Having referred to the legal framework for UGD in the first part of this chapter, the aim of this section is to state and synthesise the results from three empirical studies that are applicable to the WEF nexus and UGD in South Africa.¹³⁶⁷ The three empirical studies that straddle the WEF Nexus and UGD in South Africa are:

- Water-Energy-Food communities in South Africa: multi-actor nexus governance for social justice? (This work is based on the research supported wholly by the National Research Foundation (NRF) of South Africa and the Dutch Research Council (de Nederlandse Organisatie voor Wetenschappelijk Onderzoek - NWO) Project UID 129352);¹³⁶⁸ and
- Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and well-being in South Africa (Report to the Water Commission WRC Report No 2718/1/21 July 2021 Methner *et al* (eds));¹³⁶⁹ and

¹³⁶⁷ Chapter 1 indicated that the research methodology includes the use of empirical studies in relation to the WEF Nexus and UGD. See para 12 in Chapter 1.

¹³⁶⁸ Paragraph 12 in Chapter 1.

¹³⁶⁹ Paragraph 12 in Chapter 1.

- The Socio-Economic and Environmental Implications of Shale Gas Development in the Karoo, South Africa 2021 Julius Omokhudu Irene.¹³⁷⁰

4.8.2 *Water-Energy-Food communities in South Africa: multi-actor nexus governance for social justice?*

The NRF-NWO WEF-Nexus research group consists of senior academics, mid-level academics, post-doctoral fellows, doctoral and master students at Utrecht University, the University of Groningen, the North-West University and the University of Fort Hare. The research methodology is divided into three modules: Module 1 is based on household surveys in three study areas, namely the Matatiele Local Municipality, the Greater Taung Local Municipality and Majeng (restituted land¹³⁷¹) in the Magareng Local Municipality. The areas were chosen (purposive selection¹³⁷²) as they are all rural areas under traditional leadership and seemingly experience challenges in relation to energy, water and food. The Northern Cape and North-West areas are regarded as semi-desert areas similar to the Karoo area, while the Matatiele area is more mountainous and is situated on the eastern border of the Drakensberg Mountain range. It is in this last-mentioned area that the communities managed to withstand an application for exploration rights for UGD. The analysis of the data does not reflect the Matatiele data only, but also takes the Vaalharts and Northern Cape area into account, as the traditional authority areas are also threatened by the introduction of large-scale mining as well as solar farms.¹³⁷³ The traditional authorities are eager to

¹³⁷⁰ Para 12 in Chapter 1.

¹³⁷¹ Land claims were instituted in terms of the *Restitution of Land Rights Act* 22 of 1994 for land that was alienated through racially-based legislation after 27 June 2013. The Majeng community consists of small-scale farmers who lived in the Vaalharts irrigation area and who were dispossessed of their land. See One World Sustainable Investments "Majeng Integrated Development Planning: Business Plan" submitted to the Commission on Restitution of Land Rights: Regional Land Claims Commission Free State and Northern Cape (January 2011).

¹³⁷² The use of purpose sampling or selection is to achieve better or the best matching of the selection sample to the aims and objectives of the research. It is about intentional selection of people (individuals or groups) based on their ability to explain and interpret specific themes or concepts identified in a research aim. A purposive sample is the one whose characteristics are defined for a purpose that is relevant to the study. The intent of purposive sampling speaks to aspects of credibility, transferability, dependability and confirmability. These aspects are critical to the trustworthiness of the data and results. See Robinson "Purposive Sampling" 5243; Cambell *et al* 2020 *JRN* 652; Andrade 2021 *IJPM* 87; Maree and Pietersen "Sampling" 178.

¹³⁷³ On minerals and mining in the areas, see <https://www.mindat.org/loc-54265.html>. See e.g. also Tshikovha Environmental and Communication Consulting "Background information document for the proposed prospecting of various minerals in Farm Taung 894 HN within

introduce employment opportunities in their areas, as indicated later, since nearly three-quarters of the people living in the area have no income other than social grants.

The household survey questionnaires were developed by the post-doctoral fellows in the project.¹³⁷⁴ Annexure 1 contains the descriptives (questions) of the empirical study. The questionnaires were workshopped with the senior academics, non-governmental organisations (NGOs) working in the area, and other post-graduate students. The questionnaire was adapted several times. During March 2021, the research questions were tested via field workshops in the various areas. After the fieldshops the questionnaires were again adapted. The household surveys were conducted under the auspices and after training by Dr Saul Ngarava, a researcher at the Risk and Vulnerability Science Centre, at the University of Fort Hare.¹³⁷⁵ He trained ten ecochamps (young unemployed people, chosen by Environmental Rural Solutions, an NGO working in the Matatiele area) and 14 young unemployed people as well as four more experienced women in the Vaalharts area. These fieldworkers could speak the local languages of the communities and conducted surveys in the language preference of the household-heads. Some household members were prepared to conduct the household surveys either in English or Afrikaans, depending on the area. The three traditional leaders in the Greater Taung Local Municipality sent two young people from each of their areas, while the four women were chosen as they had prior experience assisting in empirical studies.¹³⁷⁶ Some of the researchers in the project at North-West University and University of Fort Hare also participated in conducting household surveys. Dr Ngarava identified the wards¹³⁷⁷ as well as the number of

Greater Taung Local Municipality under the Jurisdiction of Dr Ruth Segomotsi Mopatsi District Municipality in North West Province"(March 2016). The study was conducted on behalf of the project proponent the Batlaping ba ga Phuduhuchwana Community. See also the presentation of Kgosi Nyoko Motlhabane to the Parliament Committee on Mineral Resources 18 May 2010, available at <https://pmg.org.za>; Ruth Segomotsi Mompoti District Municipality NW District Development Model para 1 available at <https://www.cogta.gov.za/ddm/wp-content/uploads/2020/11/Dr-Ruth-Mompoti-October-2020.pdf>.

¹³⁷⁴ See Annex 1 for questions used in the study.

¹³⁷⁵ Now post-doctoral fellow at the Copernicus Institute, Utrecht University.

¹³⁷⁶ Undertaken by the Research Unit, Author, at the North-West University.

¹³⁷⁷ All local municipalities in South Africa are divided into wards, for the purpose of elections as well as for the appointment of ward councillors who provide feedback to the Municipal Council as to the needs of the community. See the *Local Government: Municipal Structures Act* 117 of 1998 and the *Local Government: Municipal Systems Act* 32 of 2000. See also <https://wazimap.co.za/> that provides data on the wards and the number of households in each ward.

household surveys that needed to be undertaken in each ward. The fieldworkers selected households that seemed to have some form of agricultural activity where it was apparent (i.e. convenience/availability household selection¹³⁷⁸). Otherwise, households were randomly selected in the wards as indicated by Dr Ngarava. There were 549 household surveys conducted in the Matatiele Local Municipal area (spread over eight wards), 556 in the Greater Taung Local Municipality (spread over 10 wards) and 79 in Majeng (that constitutes part of Ward 5). Not all of the questions are relevant to this study. However, the research outcomes clearly illustrate the household security regarding water, energy and food. To illustrate how water, energy and food security is perceived in South Africa, the relevant outcomes of the 2022 WEF Nexus questionnaire will be revealed. This section will refer to the combined information of the areas where the research was undertaken.

4.8.3 Data results of empirical study: Water-Energy-Food communities in South Africa: multi-actor nexus governance for social justice?

54% of the respondents were female and 46% male, from various ethnicities. 48.2% were predominantly seTswana speaking, 27.2% isiXhosa speaking and 18.8% seSotho speaking with other minority language speakers in the area. 36.5% were single, 30.9% married and 12.6% widowed. Their main income is social grants (69%) while 9.5% undertakes formal non-agricultural studies and 6.2% other informal activities. 41.6% had secondary education, while 40.8% had primary education only.¹³⁷⁹ 8.7% had no education at all. 74.4% of people are unemployed with only a few working in agriculture or in the informal sector. The main average age of the respondents are 56 years while the household head age average is 40 years. In terms of security of water, energy and food a number of graphs represent an interpretation of data accumulated. Household income calculated against household expenses on water, energy and food resources.

¹³⁷⁹ It is compulsory for children to attend school from the ages seven to fifteen years of age. See s 3(1) of the *South African Schools Act* 84 of 1996.

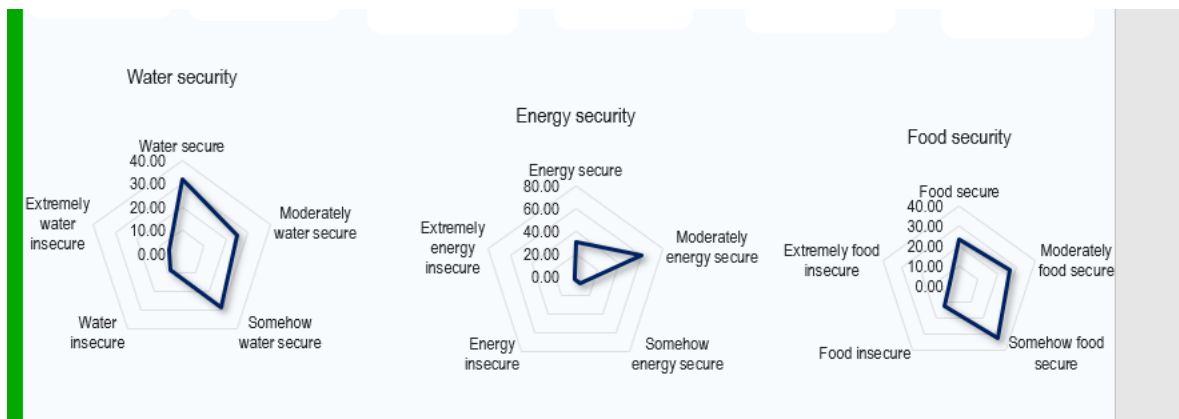


Figure 4-1: Household income calculated against household expenses on water, energy and food resources¹³⁸⁰



Figure 4-2: Energy security in terms of energy type use¹³⁸¹

Most of the respondents indicated that they receive electricity from the grid. This electricity is enough to use for lightning, water and heating as well as energy for cooking. Most of these respondents are, however, extremely energy insecure. In

¹³⁸⁰ Use of graph with permission of Dr Ngarava.

¹³⁸¹ Use of graph with permission of Dr Ngarava.

addition to electricity they mostly use firewood that they collect for energy purposes, mostly for water, heating and cooking.

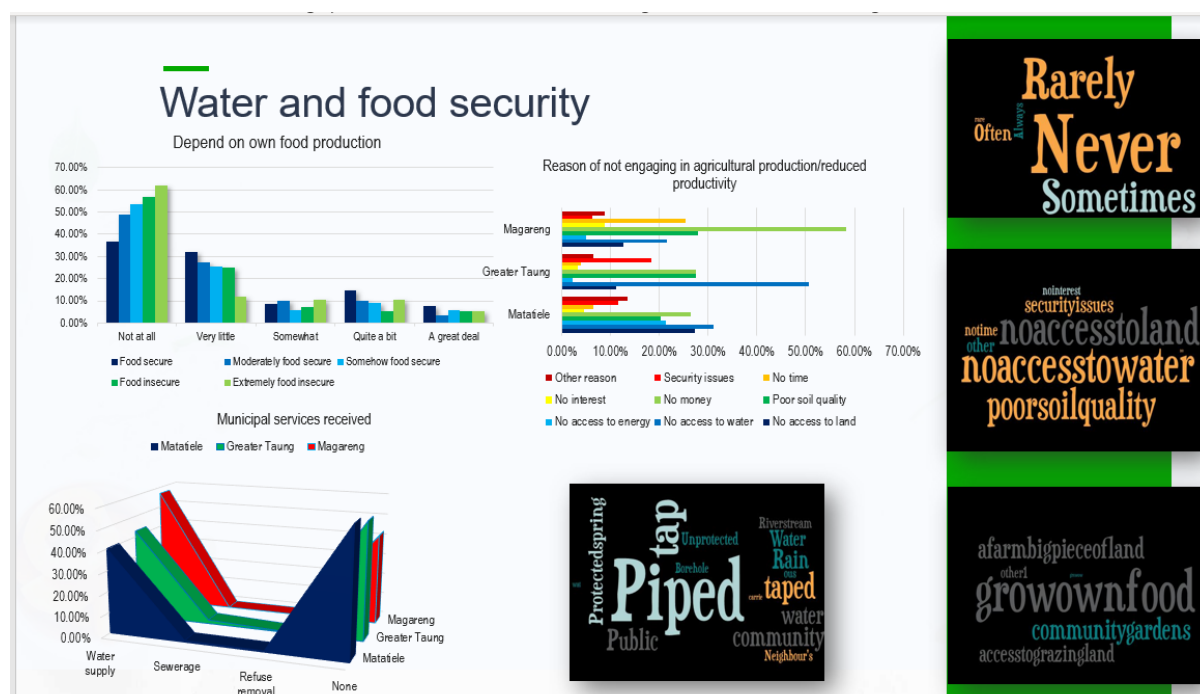


Figure 4-3: Water and food security in terms of own food production¹³⁸²

Most people buy their food (77%) and are not involved in agriculture (only 23%). Of those people that depend on their own food production, 39% is food secure, while about 61% indicated that they are food insecure. The respondents were asked why they are not involved in agriculture. In Magareng 60% of the people indicated that they have no money to be involved in agriculture while about 28% indicated that the soil is of poor quality. 22% indicated that they do not have access to water. In Greater Taung 51% of the people indicated that they have no access to water, and as a second choice indicated that the soil quality is poor and they have no money to participate in agriculture (28%). In Matatiele water scarcity was indicated as the main reason for lack of agricultural practices (33%), while lack of funding 27% and lack of access to

1382 Use of graph with permission of Dr Ngarava.

land 28% were also raised as reasons. 22% indicated that access to water was a problem.

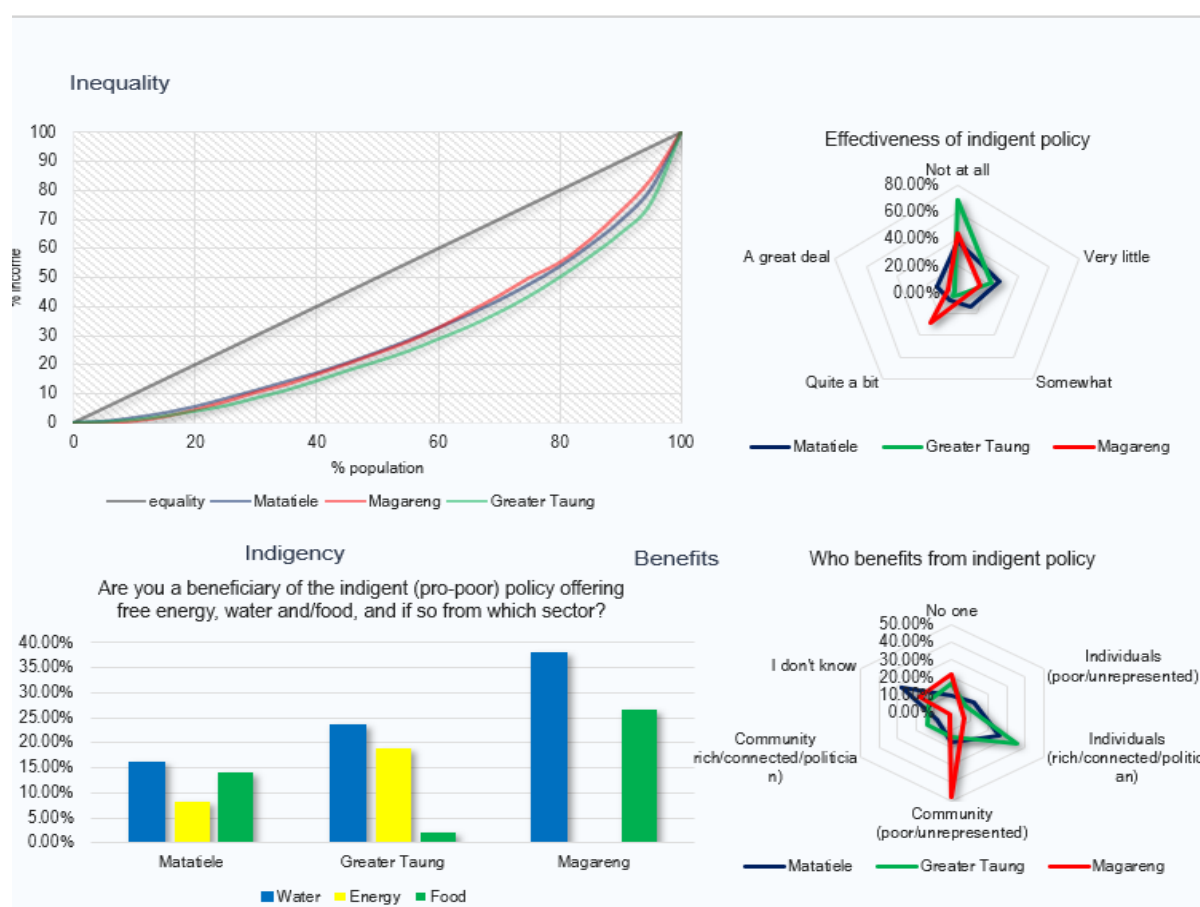


Figure 4-4: Effectiveness of indigent policy (water, energy and food)¹³⁸³

People may apply for assistance from the municipalities for water, energy and food in terms of its indigent policies. In Matatiele 16% of the respondents indicated that they receive free water from the municipality, about 8% free electricity and about 14% food assistance. In the Greater Taung 24% indicated that they receive free water, 18% free energy and only 2% free food. In Magareng about 39% indicated that they receive free water while 26% is dependent on free food from the soup kitchen that is run by members of the community. However, many people were unaware of these policies and that they could benefit from them (50%).

¹³⁸³ Use of graph with permission of Dr Ngarava.

StatsSA undertook a census in 2022 with questions pertaining to similar issues, namely water, energy and food.

At the national level the following data and statistics are relevant. There was an increase in the proportion of households with piped water. Almost half of households (48,4%) reported experiencing water interruptions for two or more consecutive days.¹³⁸⁴ In 2022, around 82,4% of households in the country had access to piped water either inside their dwelling or inside their yard.¹³⁸⁵ The proportion of households that accessed piped water off-site (from a water source outside the yard such as a neighbour or from a community stand) dropped from 17,9% in 2011 to 8,9% in 2022.¹³⁸⁶ Although the national picture regarding access to piped water shows improvement over the years there is a sizeable proportion of households in Eastern Cape (19,5%) with no access to piped water.¹³⁸⁷ The national average for households who experienced interruptions during the last 12 months is 48,4%. In the Eastern Cape this is 59,2%.¹³⁸⁸

There was a small decline in the number of households participating in agriculture across six of the nine provinces (from 2011 to 2022).¹³⁸⁹ The Eastern Cape province had some of the highest number of households participating in agriculture.¹³⁹⁰ Almost 2 million households reported participating in agriculture for household consumption only.¹³⁹¹ Most of the agricultural households were in KwaZulu-Natal (24,9%) and the Eastern Cape (20,7%).¹³⁹² This is reflected in that the Eastern Cape (247 902 or 25,8%) and KwaZulu-Natal (247 043 or 25,8%) reported the highest number of households involved in livestock and poultry production.¹³⁹³ Most of the households were involved in agriculture to produce 'only for own consumption' (1 988 825 or 80,7%) and 'mainly for own consumption with some sale' (189 371 or 7,7%).

¹³⁸⁴ StatsSA "Census 2022" xi.

¹³⁸⁵ StatsSA "Census 2022" 73.

¹³⁸⁶ StatsSA "Census 2022" 73.

¹³⁸⁷ StatsSA "Census 2022" 74.

¹³⁸⁸ StatsSA "Census 2022" 75.

¹³⁸⁹ StatsSA "Census 2022" xi.

¹³⁹⁰ StatsSA "Census 2022" xi.

¹³⁹¹ StatsSA "Census 2022" xi.

¹³⁹² StatsSA "Census 2022" 89.

¹³⁹³ StatsSA "Census 2022" 90.

Approximately 4,3% or 107 112 of agricultural households were producing 'only for sale'.¹³⁹⁴

The proportion of households using electricity as the main source of energy for lighting increased considerably from 58,1% in 1996 to 94,7% in 2022.¹³⁹⁵ The percentage of households using electricity for cooking increased from 47,4% in 1996 to 64,9% in 2022.¹³⁹⁶ The use of gas for cooking increased sharply between 2011-2022, with over 25,7% of the country using gas for cooking compared to the 3,5% in 2011. The upward trend in households using gas is noticeable. The extent of the percentage increase may be attributed to load shedding challenges the country has been facing during the census period 2011–2022.

The following data and statistics are applicable to the local municipalities of Laingsburg, Prince Albert and Beaufort West that make up the Central Karoo District Municipality (CKDM). This area is most likely to experience UGD in the future. This area is the geographical setting of the third empirical study discussed later in this chapter.¹³⁹⁷ The statistics on the CKDM is from the StatsSA Census 2022 Municipal Fact Sheet Report no 03-01-82.

In terms of the percentage of households with piped water on site (inside dwelling and in the yard), StatsSA indicates an improvement for all three municipalities over the 2011-2022 period:

- Laingsburg municipality 97,2% - 99,5%
- Prince Albert municipality 95,8% - 99,4%
- Beaufort West municipality 97,4% - 99,4%
- CKDM 97,1% - 99,4%

In terms of the percentage of households with electricity for lighting over the same period:

- Laingsburg municipality 79,4% – 92,3%

¹³⁹⁴ StatsSA "Census 2022" 92.

¹³⁹⁵ StatsSA "Census 2022" 78.

¹³⁹⁶ StatsSA "Census 2022" 78.

¹³⁹⁷ See para 4.8.7.

- Prince Albert municipality 86,4% - 97%
- Beaufort West municipality 92% – 97,3%
- CKDM 89,4% – 96,6%

The CKDM covers a total area of 38 852km². It stretches approximately 400km from its furthest south east point to its furthest north-west point. The semi desert conditions which prevail within the Central Karoo are a result of the harsh arid climate. The District consists of three local municipalities and they are Laingsburg Local Municipality, Prince Albert Local Municipality and Beaufort West Local Municipality. Some of the main towns in the district are Beaufort West, Klaarstroom, Laingsburg, Leeu Gamka, Matjiesfontein, Merweville, Murraysburg, Nelspoort, Prince Albert, Welgemoed. The CKDM accounts for a total population of 78,632. The CKDMs arid nature affects the viability of agriculture in the region. The area is very dependent on groundwater. Overgrazing has resulted in the degradation of large tracts of land and resulted in extensive soil erosion, with an associated decline in grazing potential and in water quality due to siltation. Agriculture is the largest employer in the CKDM. In 2019 the agriculture sector employed 8 220 employed people. This is 33.5% of total employment in the district municipality.

Beaufort West Local Municipality has the highest number of households with piped water inside the dwelling. It translates to 12 600 households or a share of 71.77%. The region with the lowest number of households with piped water inside the dwelling is Laingsburg with 1 970 or a share of 11.26%.

The CKDM had a total number of 1 210 (5.58%) households with electricity for lighting only, 19 700 (90.76%) households had electricity for lighting and other purposes and a total number of 794 (3.66%) households did not use electricity.

Only one project is listed in the DDM. This project relates to the UGD exploration that is being supported by the provincial government. While this project is listed there is no reference to any other projects/planning or development.

4.8.4 Governance findings of empirical study: Water-Energy-Food communities in South Africa: multi-actor nexus governance for social justice?

Various assumptions/findings can be made from the focus group discussions. At the focus group discussions in Kimberley (Northern Cape) in 2022, one participant indicated that agricultural production needs access to water. In the Vaalharts area, water is available but at a cost and that you have to pay water boards or water use associations for water use. Funding is needed for agricultural equipment and fuel. There are some projects where emerging farmers is assisted and trained in smart farmer programmes. The communal property association of Majeng also conducted a soil study which indicated that 973 ha of the 10 000 ha that was restituted can be used for irrigation. The Vaalharts Water Use Association also indicated that they are obliged to assist emerging farmers by addressing historical imbalances and they therefore may not cut off their water in the case of non-payment. While the Vaalharts Water Use Association provides raw water, it still needs to be cleaned for human consumption. In this regard, Sedibeng Water (now Magalies Water) is responsible for water services. The same applies to municipalities. In water allocation, the needs of people come first.

The participants also indicated that although it may be possible to address the agricultural part to ensure food security, the energy that needs to be available is not addressed in order to utilise the available water. It might be necessary to introduce trade-offs between the use of water, food production and food security and energy use.

New users compete for water that is already over-allocated. It is not certain how new entrants into agriculture would be able to access water. It is also indicated that small scale farmers, household gardens and holders of livestock do not need licencing for water use from rivers, dams or boreholes. Their activities would fall under a Schedule 1 water use as set out in the NWA. It was also indicated that groundwater is not always available and that people and livestock compete for access to ground water. Training would be necessary for new entrants on crop rotation and on the types of

crops that will be grown in the soil and in the area. Farmers should create forums to assist each other.

Sometimes the infrastructure is not working. However, if any farmer wants to farm commercially, the input and maintenance costs are very high. A farmer also has to consider the type of crop that it wants to plant, specifically in terms of water access. Commercial farming does not necessarily address food security on the ground. An option would be for the establishment of food gardens or communal gardens where vegetables could be planted. There is, however, a reluctance to work in such gardens on a voluntary basis.

The Mayor of the Magareng Local Municipality indicated that she would be interested to apply the WEF nexus concept and that cooperation between government spheres is necessary. One of the respondents indicated further that the local municipality is the service provider¹³⁹⁸ and that it cannot delegate its functions. It can therefore not transfer money to a community fund to, for example, buy fuel for their own pumps. It was stressed that "we cannot take management to water communities". A member of the communal property association raised the question whether they could not perhaps conclude service level agreements either with the municipality or Vaalharts Water Use Association to obtain potable water.

In the Majeng area, the municipality installed solar pumps to assist with the pumping of water and to move away from the necessity to provide diesel for pumping. Respondents complained that these pumps do not function if there is a few overcast days. They do not have batteries to save and or store the energy. In the Greater Taung Municipality in the Buxton area one respondent complained about the diesel polluting the water source making it impossible to use. In all the areas, the respondents raised issues of theft and vandalism of infrastructure. In this area, Magalies Water provides the diesel, but they need to be paid by the municipality. If they are not paid, then they cannot buy diesel and the communities go without water. During the fieldwork one respondent explained that the community sometimes have

¹³⁹⁸ In terms of s 19 of the *Water Services Act*, 108 of 1997 Municipalities may provide water services, or contract water services out to water services providers or enter into a joint venture with another water services institution.

to club together to buy diesel to pump the water. The representative of Magalies Water indicated that although there are boreholes they are overused and there is no time for the groundwater to recharge. At the Mahikeng (North West Province) focus group in 2022, it was indicated that a borehole was sunk to provide water to livestock. However, that borehole was taken over by the ward councillor with the permission of the community. The municipality uses the borehole for human consumption but there is now conflict with the farmers who do not have water for their livestock. There was neither proper consultation with all members of the community nor with the department of agriculture.

At the Kimberley workshop it was indicated that there should be more opportunities where government speak to the people. The groups must be mixed and should straddle government, youth, women, and people with disabilities. This is the only way to find out what the community needs. The involvement of communities is important as their view can contribute to the decision-making process. It was also indicated that "Communities should not become a political football". This will also be true in cases where UGD is planned.

At the Mahikeng focus group one of the attendees stressed the importance of the environment as such in the WEF nexus and that environmental matters should be taken into consideration. Officials from the Department of Human Settlements in the North-West Province referred to sustainable villages. They expressed the need that minimum standards are provided in terms of what land should be available for agriculture, what water can be used for what and what type of sustainable energy could be provided to the households. Minimum core units for such households and villages are needed.

At the Mahikeng focus group it was stated: "The challenge we experience is one of coordination. Each department tends to work on its own as their mandate is promulgated by law. I cannot work outside my mandate. If a new idea is introduced there is no interaction as each person is protecting one another, and that delays change and innovation". This also stressed the importance of cooperation between

different government departments especially when water, energy and food are relevant.

On the question on why officials do not break out of their silo's the response was that people fear change and sharing space. The politicians also interfere and projects are claimed by the politicians rather than to state that government provided the new development.

On the question what would they need to coordinate or to ensure a WEF nexus it was stated: "As people are looking at government, we look at the budget, we look at urban development and not global development". We do not consider the environment or the aspects that make up the environment or food security or infrastructure. We do not consider ecosystem services. It is one of the stumbling blocks".

An official of Human Settlements stated: "We need to provide integrated human settlements that is sustainable and viable". Planning should consider everything. If you have a new settlement, you need a clinic (different department), you need a school (different department), etcetera. One cannot give a house and 10 years later water. There is a need for integrated planning. The IGRFA can help but then the Act must be used. Nobody however takes responsibility for IGRFA. In the North West province, the Premier should bring everyone together to plan and ensure service delivery. This should be done in consultation with the communities".

There is conflict between the district, local municipalities and the traditional authorities. The communities are confused as to who should deliver services. They do not know whom to listen to. The councillors / ward councillor will say something and the traditional leader something else. The traditional authorities and councils should be clear as to their responsibilities. Not all decision-making is transparent.

Sometimes the councillor or the traditional leader may stall development. There is a need for consultation between the traditional leaders/authorities and the council. This conflict issue was also experience when the Taung Environmental Management Framework (EMF) was drafted.¹³⁹⁹ While SPLUMA gives the municipality the planning

¹³⁹⁹ PN 235 in PG 7818 of 31 October 2017.

authority the question remains whether SPLUMA can address the conflict between traditional leaders and its traditional council. This needs to be addressed somehow, possibly by changing the law.

One should not focus on one aspect only. If you focus on water only, then the allocated water may not be used – it could have been transferred to someone else. There is a need for a multi-stakeholder approach.

People and officials at all the workshops were uncertain what the role of catchment management agencies were. People were concerned that the banks of rivers are not protected. They were concerned about the pollution of water by industry and mines, which also stressed the importance of proper prior and informed consent in UGD matters.

Dr Jennifer Molwantwa, WRC at the Pretoria workshop (delivered paper) stressed that we have food insecurity, water resources are over-allocated and we are energy insecure as a result of Eskom. The different departments have different mandates and do not always see eye to eye. Water, energy and food are necessary for resilience and improved livelihoods. To address poverty and inequality a transformative approach of what the WEF nexus could be is needed.

Dr Molwantwa further indicates that "We need to know at what level to make the decisions. Should decisions be made at local or national level to manage the resources? There is a need for integrated resource management. Need to do more with less. The WEF nexus must take adaptation to climate change into account." She also links the WEF nexus to sustainable development.

Other inputs from the Pretoria workshop, entail that people are unaware of the existence of all these forums (CMAs, etcetera.) They are furthermore unaware of the tools that they can use. People have to split their time in getting water and wood. There is not time for meetings as time is spent to collect water and to cook or produce food for the family. There may be a need to leverage corporate partners to address the water, energy and food crisis. This will require developing trust between the

parties. If a project is funded then it should include the transfer of skills. In other words, this will enable the project to proceed beyond the initial funding.

Climate change force us to think holistically. For example, the DFFE takes more into account than merely the environment, as a development affects everything. There is a need to establish what the communities' needs are. In this sense, a bottom up approach rather than a top down approach should be followed. National policies do not always filter to the ground. A top down approach may result in the bringing of infrastructure that is not needed. This leads to vandalism and or corruption. From the adaptation fund you can provide funding and set up small NGOs and companies – small grants to set up the intervention communities need.

The climate change forums at provincial and local levels may be an opportunity to work together. In this respect, NGOs are involved. Per the general objective of the IGfRA we want the community and NGOs to report to the formal structures. The IDP is another forum that can be used to work together. Local municipalities do not have a mandate on climate change but the district municipality does. The local municipality can request the district municipality to budget to address municipality needs. According to a DFFE official, funds for WEF nexus implementation could be requested within the framework of climate change.

In the rural areas, the main concern is on water related aspects, particularly for farming irrigation because small scale farmers do not get support from the municipalities. The NGOs are also not supported by the municipality because they are seen as competition. The entry point should always be the community. The State created a dependency mentality. People should be involved. In this sense people should be empowered rather than to wait for government to act.

The participants further complained about clashing legal frameworks and unnecessary bureaucracy. Someone responded that South Africa has enough laws, policies and frameworks and what is actually needed is the technical and financial resources and general coordination to enable cooperative governance.

From the stakeholder mapping it was clear the officials themselves did not know who work with whom and who should report to whom.

The legal vehicles provide a mandate for a specific department. This may be an obstacle. One person explained: "for example, I have an agricultural project, but I have to fight with water, then with environment, then my land use (permission to occupy¹⁴⁰⁰ (PTO)) is not sufficient, or I am not near the electricity grid".

The WEF nexus approach should be flexible. It cannot be the same everywhere as each area differs from one another. There is a need for integrated aligned processes. One participant explained: "At this stage if you get one permit or authorisation, the other one had already expired and you therefore have to begin from scratch".

The national government (except COGTA) does not interact with municipalities and traditional authorities. National government speaks about delivering water, energy and food but the municipalities feel overburdened with all the additional and sometimes unfunded mandates. Although there is some interaction between departments on a quarterly basis (IGRFA) it is not clear what its actual mandate entails nor the workings thereof. Legislation therefore exists but there is a lack of understanding of the legislation. There are also too many new policies in the form of district development models. In this regard, there is a need for cross-sectoral implementation. A monitoring panel is required to make certain that all aspects are taken into account.

4.8.5 Preliminary conclusions

Municipalities have policies to assist destitute people with access to water, energy and food. This indicates that municipalities do recognise water, energy and food as key resources for human survival and development. However, this is negated by the fact that many people are not aware that they may qualify for assistance from the local municipality in the form of access to water, energy and food. It is clear from the study that access to water, energy and food is not readily available and that for most people

¹⁴⁰⁰ PTOs were issued to people in the former so-called homelands on communal land. It entails that a person may have a homestead and some land for agriculture. It was supposed to reflect African customary land rights. See in this regard Du Plessis and Pienaar 2010 *Fundamina* 73-90.

it is struggle for survival. The trade-offs between water, energy and food should not be taken within a silo-approach but rather in an integrated manner as is done with the planning of human settlements.

In relation to governance issues, the lack of integration in decision-making, the multiple structures and legislation seem to hamper development. The communities and government officials are not always aware of each other's mandates and also unaware of the possibilities of access to the climate change adaptation funds to assist them with improved access to water, energy and food. There is a need for integrated decision-making and a one-stop shop for authorisations. The bureaucracy and complex decision-making should be streamlined.

It is further clear that future decisions in relation to UGD that will have impacts on water and food, cannot be taken without the informed input of the community members.¹⁴⁰¹ People with insecure rights also struggle to access funding for development on the one hand, on the other hand, it may also hamper their say in how their land can be used, for example, for UGD. Developments should have a bottom up rather than a top down approach. When developments are approved, then skills transfer should take place to enable community members to also benefit from any development on their land. An enabling rather than a dependency environment should be created.

*4.8.6 Findings - Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and well-being in South Africa (Report to the Water Commission WRC Report No 2718/1/21 July 2021 Methner et al (eds))*¹⁴⁰²

The study by Methner *et al* "Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and well-being in South Africa"¹⁴⁰³ examines the WEF nexus approach in South Africa from a sustainable livelihoods framework.¹⁴⁰⁴ The main aim of the study is the provision of sustainable development outcomes for

¹⁴⁰¹ Also see para 5.5.below.

¹⁴⁰² Paragraph 12 in Chapter 1.

¹⁴⁰³ The study culminated in a report to the Water Commission, namely Methner *et al*/WRC Report No 2718/1/21 July 2021.

¹⁴⁰⁴ See para 12 in Chapter 1. Methner *et al*/WRC Report 3.

local households and communities.¹⁴⁰⁵ A number of case studies (spanning rural and urban communities) focuses on three geographical catchment areas that are experiencing major development pressures and resource competition. A mixed-method research approach (mixture of quantitative and qualitative methodologies) was used for the case studies. Findings from this empirical study are particularly useful in that they identify a number of WEF nexus nuances on the local community and household scale. This potentially has important implications for decision-making within governance and regulatory frameworks on development projects, including that of UGD.

The three catchments identified for the study are: Keiskamma (located in the Eastern Cape Province); uMngeni (located in Kwazulu-Natal province) and the Berg (located in the Western Cape). A number of communities (five in total) were identified as case studies within the three catchment areas, namely (i) Noordhoek (Berg River estuary), Pniel and Lanquedoc (upper Berg), (ii) Melani (upper Keiskamma) and Hamburg (Keiskamma River mouth) and (iii) Sobantu (mid-uMngeni) and Mpophomeni (upper uMngeni).¹⁴⁰⁶

The study recognises that context is critical in WEF nexus studies. This includes acknowledging the differences in geographical settings (physical location) and the differences in household demographic and economic realities.¹⁴⁰⁷ The study found great differences in the demographic and economic realities between different catchment areas. For example, households in the Berg mainly receives income from a combination of salaries or wages and have equal numbers of female and male headed households.¹⁴⁰⁸ In these households the head is generally employed and younger than 60 years old.¹⁴⁰⁹ This is in direct contrast to the households in the Keiskamma whom are chiefly supported by government grants (most households are not employed).¹⁴¹⁰ Further, Keiskamma "households are mostly headed by females (70%) and more than

¹⁴⁰⁵ Methner *et al* WRC Report 3.

¹⁴⁰⁶ Methner *et al* WRC Report 3.

¹⁴⁰⁷ Methner *et al* WRC Report 176-177.

¹⁴⁰⁸ Methner *et al* WRC Report 177.

¹⁴⁰⁹ Methner *et al* WRC Report 177.

¹⁴¹⁰ Methner *et al* WRC Report 177.

half are older than 60 years".¹⁴¹¹ A number of findings are specific to the different catchment areas and also within and between the different communities. The following paragraphs discuss some of them.

Hamburg is a rural setting where intermittent water supply negatively impacts on the local subsistence and small-scale farmers.¹⁴¹² Energy use is mainly electricity based "but supplemented by other energy sources such as gas, paraffin, manure and candles for" both cooking and lighting.¹⁴¹³ The community members buy gas in the form of 9 or 14 kilogram cylinders from nearby towns.¹⁴¹⁴ Transport of these gas cylinders take place either by the use of private transport or the use of minibus taxi.¹⁴¹⁵ An additional cost is therefore present in the transport of these gas cylinders.¹⁴¹⁶ The use of wood for cooking is common, however, the collecting of wood is problematic due to the forest areas around Hamburg having been declared conservation protected areas.¹⁴¹⁷ The community members involved in food producing activities all make use of rainwater tanks.¹⁴¹⁸ This confirms the vital role of water in the local food system. The water infrastructure is under-maintained and outdated and the result is local water outages even when water is available in the bulk supply system.¹⁴¹⁹ Additionally, energy outages (in the form of load shedding) negatively impacts the water supply system.¹⁴²⁰ Water pumps cannot function without electricity. During times of constraints in the bulk water supply system, community members engage in water trading activities (trading goods for water).¹⁴²¹ Local food production remains repressed by inadequate bulk water supply.¹⁴²² While own consumption and the trading of locally produced food is evident, community members visit retail outlets in nearby towns on either a weekly or monthly basis.¹⁴²³ This is not surprising since the impacts

¹⁴¹¹ Methner *et al* WRC Report 177.

¹⁴¹² Methner *et al* WRC Report 125.

¹⁴¹³ Methner *et al* WRC Report 125.

¹⁴¹⁴ Methner *et al* WRC Report 125.

¹⁴¹⁵ Methner *et al* WRC Report 125.

¹⁴¹⁶ Methner *et al* WRC Report 125.

¹⁴¹⁷ Methner *et al* WRC Report 125.

¹⁴¹⁸ Methner *et al* WRC Report 141.

¹⁴¹⁹ Methner *et al* WRC Report 143.

¹⁴²⁰ Methner *et al* WRC Report 143.

¹⁴²¹ Methner *et al* WRC Report 143.

¹⁴²² Methner *et al* WRC Report 143.

¹⁴²³ Towns such as Peddie and East London. Methner *et al* WRC Report 141.

from irregular water supply and constraints in the electricity supply system negatively impacts the ability of local subsistence and small-scale farmers to successfully engage in agriculture.¹⁴²⁴ Affordability, in the form of household income level is a main driver of WEF security or insecurity.¹⁴²⁵ This is also the case for households in Melani where households that could pay for water, energy and food have WEF security.¹⁴²⁶ In instances where households do not earn enough, trade-offs are made between water, energy and food purchases.¹⁴²⁷ In meeting water and energy demands via buying of water and energy, households in Hamburg and Melani have less food security.¹⁴²⁸ Water and energy competes with food for household income.¹⁴²⁹ In instances where energy needs cannot be met due to the lack of household income, it affects food security.¹⁴³⁰ This "occurs through compromised food selection choices and changes in cooking habits to accommodate low energy availability."¹⁴³¹

The uMngeni catchment consists of Sobantu and Mpophomeni. This catchment is poor with a substantial "number of households living under the poverty line".¹⁴³² Pension holders and government grants make up most of the income in this area.¹⁴³³ Many households in this area do not pay for basic water and energy services. Reasons for non-payment include poverty (unable to afford it) and an expectation that water and energy services should be provided free (from the government).¹⁴³⁴ This resulted in households engaging in illegal water and electricity connections to the energy grid and water supply system.¹⁴³⁵ In this way households save on water and energy expenses and therefore use their income on food.¹⁴³⁶

¹⁴²⁴ Methner *et al* WRC Report 125.

¹⁴²⁵ Methner *et al* WRC Report 174.

¹⁴²⁶ Methner *et al* WRC Report 174.

¹⁴²⁷ Methner *et al* WRC Report 174.

¹⁴²⁸ Methner *et al* WRC Report 174.

¹⁴²⁹ Methner *et al* WRC Report 174.

¹⁴³⁰ Methner *et al* WRC Report 174.

¹⁴³¹ Methner *et al* WRC Report 175.

¹⁴³² Methner *et al* WRC Report 175.

¹⁴³³ Methner *et al* WRC Report 175.

¹⁴³⁴ Methner *et al* WRC Report 175.

¹⁴³⁵ Methner *et al* WRC Report 175.

¹⁴³⁶ Methner *et al* WRC Report 175.

The upper Berg catchment consisting of Pniel and Lanquedoc have good water and energy service delivery.¹⁴³⁷ Pensioner-headed households make up around half of the Pniel community. While water and energy services are good, households are struggling to afford the services.¹⁴³⁸ Households make trade-offs in the form of substituting electricity for gas and growing food instead of buying food.¹⁴³⁹ The same is true for the households in Landquedoc and Noordhoek.¹⁴⁴⁰

The study¹⁴⁴¹ provides the following insights:

Across all the sites, water, energy and food are available to households, although not always reliable and the demand is often not met. Most households have an electrical connection and in most of the sites they are mostly energy secure. The use of additional sources of energy (such as gas, wood, manure and candles) take place when the electrical supply is interrupted or electricity is not available. Most households have access to a piped connection to a municipal supply of drinking water, either inside the dwelling or outside. Where this is not the case, alternative water sources such as groundwater and rainwater are important. Notably in these instances water security is as serious issue for households and a major factor is the time taken to collect water. Almost all households purchase their food at local formal and informal outlets. Home food gardening is more prevalent in some communities compared to others, depending on access to good quality land and water.¹⁴⁴²

Household income is directly linked to whether a household can afford water, energy and food, or not.¹⁴⁴³ This is notable in the higher level of water, energy and food insecurity found within households with only one pension, large households where the household head has a small income. In instances where income does not cover all WEF needs, community members use substitutions for more affordable options. This includes for example the use of wood, manure etc. for energy to cook and light.¹⁴⁴⁴ Pensions and social grants do not follow the annual rise in inflation and therefore households are becoming 'poorer' against rising water, energy and food process. The ability of households to afford water, energy and food are decreasing.¹⁴⁴⁵

¹⁴³⁷ Methner *et al* WRC Report 176.
¹⁴³⁸ Methner *et al* WRC Report 176.
¹⁴³⁹ Methner *et al* WRC Report 176.
¹⁴⁴⁰ Methner *et al* WRC Report 176.
¹⁴⁴¹ Methner *et al* WRC Report 176.
¹⁴⁴² Methner *et al* WRC Report 173.
¹⁴⁴³ Methner *et al* WRC Report 172.
¹⁴⁴⁴ Methner *et al* WRC Report 184.
¹⁴⁴⁵ Methner *et al* WRC Report 172.

Poor households make trade-offs between water, energy and food purchases.¹⁴⁴⁶ While "the nuances of these trade-offs are site specific", the purchasing of water remains essential and therefore trade-offs generally occur on energy and food.¹⁴⁴⁷

The WEF nexus approach is a useful concept for understanding and highlighting the consequences of sectoral silos and inadequate acknowledgement of trade-offs.¹⁴⁴⁸ Affordable alternative or supplementary energy sources such as renewable energy (solar) for household use could assist in addressing access to water, energy and food.¹⁴⁴⁹ The introduction of UGD within areas where communities are resource dependent and living off the land may have severe impacts on their access to water and food. Furthermore, these communities may also not necessarily benefit from the gas production on their land. It is therefore critical that WEF nexus linkages are identified and set within integrated decision-making frameworks on UGD.

4.8.7 "The Socio-Economic and Environmental Implications of Shale Gas Development in the Karoo, South Africa" 2021 Julius Omokhudu Irene¹⁴⁵⁰

This study used a mixed-method approach (utilising a combination of qualitative and quantitative methods) to explore the underlying factors shaping expert and public perception about shale gas development and to gain a better understanding of the reasons for support and opposition to UGD in South Africa.¹⁴⁵¹ The study used data collected from experts spread in different areas of the country and public participants from the four cultural groups across the Beaufort West area of the Central Karoo pertinent to this study.¹⁴⁵² The interview was directed to a sample of 26 experts with participants from policy makers, industry practitioners comprising of geologists, drilling, and reservoir engineers.¹⁴⁵³ In addition, 261 survey questionnaires were used

¹⁴⁴⁶ Methner *et al* WRC Report 172.

¹⁴⁴⁷ Methner *et al* WRC Report 172.

¹⁴⁴⁸ Methner *et al* WRC Report 184.

¹⁴⁴⁹ Methner *et al* WRC Report 181.

¹⁴⁵⁰ Para 12 in Chapter 1.

¹⁴⁵¹ Irene *Socio-Economic and Environmental Implications* 130.

¹⁴⁵² Irene *Socio-Economic and Environmental Implications* 173.

¹⁴⁵³ The 'expert' participants covered a broad range of professional and technical experiences related to oil and gas operations. 46% of the participants have 5 to 10 years' experience, 27% of the participants have 11 to 15 years' experience, 15% of the participants have experienced between 16 to 20 years and 12% of the participants have 21 to 30 years' experience. 69% of the participants are males while 31% are females, 19 % of the participants have age between

to sample public perception across the diverse social groups (Black, Coloured, Indian, and White) in the Karoo using a range of socio-demographic, beliefs, norms, and value considerations.¹⁴⁵⁴

The study used the environmental, economic and social elements (includes health aspects) of UGD as themes of sustainability in the form of possible risks and concerns.¹⁴⁵⁵ While the study by Irene aimed to present unique perspective regarding the similarity and differences in expert and public perception of UGD, some of the empirical data collected also has value for the WEF nexus study. It is of value and relevance to the WEF nexus as empirical data in the study by Irene focuses on water and agriculture (food) aspects linked to UGD (energy). The following paragraphs focus first on the results from the 26 expert grouping and then on the 261 public grouping.

The results from the empirical study on the 26 expert grouping indicates that in terms of perceived negative environmental impacts from UGD 19% listed water contamination, 23% listed excessive water withdrawal, 15.4% listed fugitive gas and air quality, 11.5% listed earthquakes, 15.4% listed ecological degradation (defined as fauna and flora), and 15.4% listed surface spills and land degradation.¹⁴⁵⁶ Notably, only 11.5% of the participants referred to possible negative health impacts from UGD.¹⁴⁵⁷

Water contamination having been identified as a key environmental issue, the respondents listed the potential sources of water contamination as follows: 57.7% identified biogenic sources, 23.1% identified integrity failure, and 19.2% identified surface spills.¹⁴⁵⁸

29 to 35 years, 19% between 36 to 40 years, 36% of the participants fell between 41 to 50 years old and 26% of the participant fell in the 51 to 60 years age group. See Irene *Socio-Economic and Environmental Implications* 139-140 and 173.

¹⁴⁵⁴ The demographic profile of the participants consists of: ages of 41 to 50 years old (28%), between 18 to 30 years old (25%), between 31 to 40 years old (23%), between 51 to 60 years old (14%) and people from 61 years and above (10%). Irene *Socio-Economic and Environmental Implications* 155 and 173.

¹⁴⁵⁵ Irene *Socio-Economic and Environmental Implications* 182.

¹⁴⁵⁶ Irene *Socio-Economic and Environmental Implications* 309.

¹⁴⁵⁷ Irene *Socio-Economic and Environmental Implications* 310.

¹⁴⁵⁸ Irene *Socio-Economic and Environmental Implications* 311.

In terms of resource governance and decision-making on UGD, 38.5% indicated a high level of trust while 61.5% indicated a low level of trust.¹⁴⁵⁹

On possible environmental benefits from UGD, 57.7% indicated a reduction in GHG emissions and the mitigation of local climate change,¹⁴⁶⁰ while 42.3% indicated that UGD has a much smaller footprint than that of coal.¹⁴⁶¹

All the participants (100%) indicated that UGD is the optimal bridge or transition fuel to more renewable energy sources.¹⁴⁶² All the participants (100%) indicated that their perception of UGD might change with the publishing of new empirical and industry evidence.¹⁴⁶³ On the choice of the energy type to be used, the following findings were made: 15.3% of the group supported coal, 15.3% supported nuclear, 15.3% conventional oil and gas, 19.1% unconventional gas and 35% renewables (solar and wind).¹⁴⁶⁴

36% of the 261 public grouping reacted to the question on whether UGD will reduce the country's carbon footprint that it would not, 26.1% provided a neutral answer, and 54.5% indicated that it would indeed lower the carbon footprint.¹⁴⁶⁵ On whether UGD will damage the local environment, the following results became apparent: 63.6% of the group indicated that it would not, 9.6% provided neutral answers, and 25.8% indicated that it would indeed damage the environment.¹⁴⁶⁶

On whether UGD could cause earthquakes and tremors results, 52.9% of the group responded that it would not, 26.1% provided neutral answers, and 21.1% indicated that yes it would cause earthquakes and tremors.¹⁴⁶⁷

On whether UGD could impact agriculture: 47.5% indicated that it would not, 16.1% provided neutral answers, and 36.4% confirmed that yes it would impact

¹⁴⁵⁹ Irene *Socio-Economic and Environmental Implications* 310.
¹⁴⁶⁰ Irene *Socio-Economic and Environmental Implications* 310.
¹⁴⁶¹ Irene *Socio-Economic and Environmental Implications* 310.
¹⁴⁶² Irene *Socio-Economic and Environmental Implications* 309.
¹⁴⁶³ Irene *Socio-Economic and Environmental Implications* 311.
¹⁴⁶⁴ Irene *Socio-Economic and Environmental Implications* 309.
¹⁴⁶⁵ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁶⁶ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁶⁷ Irene *Socio-Economic and Environmental Implications* - Appendix 9.

agriculture.¹⁴⁶⁸ On whether UGD could contaminate local water sources: 44.9% indicated that it would not, 17.2% provided neutral answers, and 37.9% indicated that UGD would indeed contaminate water resources.¹⁴⁶⁹ On whether UGD will harm ecosystems (defined in study to refer to wildlife and plants): 47.5% indicated that it would not, 13.8% were neutral, and 38.7% indicated that yes, it would harm ecosystems.¹⁴⁷⁰ On whether UGD will impact air quality: 3.5% indicated that it will not, 15.3% provided neutral answers, and 81.3% indicated that it will impact air quality.¹⁴⁷¹ On whether UGD will impact human health negatively: 25.3% indicated that it will not, 19.5% provided neutral answers, and 55.2% indicated that it will impact human health negatively.¹⁴⁷²

On whether UGD will keep South Africa tied to using fossil fuels, which contribute to climate change: 17.6% indicated that it would not, 33.3% provided neutral answers, and 49.1% indicated that yes it would keep the country tied to fossil fuels (with resultant contribution to climate change).¹⁴⁷³ On whether UGD should be viewed as a transition energy: 46% indicated it should not be seen as a transitional energy source, 19.5% provided neutral answer, and 34.5% indicated that UGD should indeed be viewed as a transitional energy source.¹⁴⁷⁴ On whether the South African government should rather invest in renewable/green energy: 12.3% indicated that no it should not, 17.2% were neutral, and 70.5% indicated that the government should indeed rather invest in renewable energy.¹⁴⁷⁵

The participants indicated the following as major concerns and or risks regarding UGD: water contamination 39.5%, air contamination 14.6%, threat to agriculture 3.1%, the impact on human health 21.1%, surface or land disruption 1.5%, global warming 5.0%, (the other risks identified are an increase in crime 7.7%, loss of landscape/sense of place 7.3%, and displacement/immigration influx 0.4%).¹⁴⁷⁶

¹⁴⁶⁸ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁶⁹ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁷⁰ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁷¹ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁷² Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁷³ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁷⁴ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁷⁵ Irene *Socio-Economic and Environmental Implications* - Appendix 9.
¹⁴⁷⁶ Irene *Socio-Economic and Environmental Implications* - Appendix 9.

Notably, 56% of the public group participants opposed UGD on four main grounds: contamination of groundwater by stray gas, excessive withdrawal of fresh water (used in the fracking process), release of fugitive methane to the atmosphere and the long-term impact on the Karoo ecosystem.¹⁴⁷⁷

A number of conclusions can be drawn. The study confirms the existence of interlinkages between water, energy and food (agriculture) within UGD. While the study did not refer to the WEF nexus directly, it does make the statement that environmental and social impacts from UGD are interrelated. This can also be conferred from both the 'expert' and the 'public' groupings answers to the perceived risks from UGD. The issues of water pollution, water extraction, methane leakage and air contamination with resultant increase of climate change, earthquakes and tremors, impacts on human health, animal and plant life, land surface impacts and impacts on agriculture featured prominently. Of particular interest is the view of both groups on whether UGD should be bypassed for renewable energy. This question also links with the issue of possible lock-in with fossil fuels. On the one hand, both groups indicated that UGD is a better option than coal because it is a bridging fuel and therefore will accelerate the transition to renewables. On the other hand, on the question whether the South African government should invest in renewable energy sources (solar and wind) both groups answered overwhelmingly in the positive. All the expert group participants (100%) indicated that the government should rather invest in renewables, while 70% of the public group favored investment in renewables. This is an important observation because it indicates that (i) both experts and the public view the impacts from UGD as unsustainable when compared to renewable options, and (ii) there is need for deeper research and understanding on renewable energy options vis-à-vis UGD. The bulk of data and research on UGD focuses on a comparison of UGD and coal. This needs to be expanded to include renewable options. For example, there is no clarity on whether local communities will actually benefit from UGD in the sense that gas from UGD will be linked to the national grid and many communities are not connected to the grid. In this case local communities will be paying the price (such as water, soil/agriculture/health) for the energy delivered to the city dweller. An

¹⁴⁷⁷ Irene *Socio-Economic and Environmental Implications* 180-181.

alternative that need to be researched includes the possibility of communities choosing locally produced solar energy instead of UGD. This speaks to aspects such as decision-making processes, transparency (community input and access to information) and distributive justice (such as the unfair distribution of risks and benefits among social groups) within the WEF nexus approach.

4.8.8 Possible limitations of empirical studies

Any collection of data via empirical methods are susceptible to a number of potential pitfalls. Broadly, this includes aspects of purposive sampling (i.e. who is included and who is excluded) and the interpretation of data. Empirical studies, like other methods, need to acknowledge and address aspects of credibility, transferability, dependability and confirmability of its findings. These aspects are critical to the trustworthiness of the data and results. Empirical studies, like other studies, cannot provide a complete and perfect representation of a reality or realities within different contexts. Empirical studies particularly, due to its reliance on purposive sampling and interpretation of data derived from those sample sets, should acknowledge potential limitations in this regard. The ideal was a fieldwork study that focused solely on UGD and WEF nexus governance aspects covering a wide geographical area earmarked for UGD in the Karoo and (ii) that included more stakeholders (government officials at national, provincial and local level, community members, farmers, farm workers, NGOs and civil society organisations).¹⁴⁷⁸ It must further be acknowledged that such a study will still be merely speculative, as UGD has not taken off yet. The empirical data collected for this study consists of a combination of three fieldwork studies that differ in scope and geographical location.¹⁴⁷⁹ The first study "Water-Energy-Food communities in South Africa: multi-actor nexus governance for social justice?" focused on governance aspects of the WEF nexus and while UGD was not its main focus, one of the study

¹⁴⁷⁸ This indeed was the intention of the fieldwork planning at the start of this thesis. However, the impact(s) of and restrictions due COVID19 during the 2020-2022 period made this not possible. The researcher, like others, also struggled with COVID19 symptoms during and post this period.

¹⁴⁷⁹ See Chapters 1.12 and 4. Water-Energy-Food communities in South Africa: multi-actor nexus governance for social justice?; Report to the Water Commission WRC Report No 2718/1/21 July 2021 Methner *et al* (eds) "Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and wellbeing in South Africa" 1-353; Irene *The socio-economic and environmental implications of shale gas development in the Karoo, South Africa* 1-311.

areas in the project, the Matatiele community in the Eastern Cape managed to prevent exploration for UGD.¹⁴⁸⁰ This makes this study relevant to the project. The second study "Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and well-being in South Africa" examines the WEF nexus approach in South Africa from a sustainable livelihoods framework. This study is useful in that it identifies a number of WEF nexus nuances on the local community and household scale. This potentially has important implications for decision-making within governance and regulatory frameworks on development projects, including that of UGD. The third study "The Socio-Economic and Environmental Implications of Shale Gas Development in the Karoo, South Africa" focused on UGD within the geographical area of the Karoo. While the study do not refer to the WEF nexus approach, a number of its findings are directly applicable to the WEF nexus within UGD. The three studies therefore straddle governance aspects of the WEF nexus within UGD in rural areas that are generally known to include and represent communities where difficult socio-economic conditions are the reality.¹⁴⁸¹

4.9 Conclusion

This Chapter provided a background description of the general realities of water, energy and food in South Africa. The description provides the dire state of people's access to water, energy and food. This was followed by an overview of the South African legal framework on water, energy and food as it relates to UGD.

UGD is regulated by different Acts and regulations, with some of them still in draft form. Figure 4.5 summarises the legal framework pertaining to UGD in South Africa.¹⁴⁸²

¹⁴⁸⁰ Environmental Justice Atlas <https://ejatlas.org/conflict/fracking-exploration-in-matatiele-south-africa>.

¹⁴⁸¹ Within this general statement on the socio-economic status of these communities it should be noted that different communities' socio-economic conditions are not homogeneous.

¹⁴⁸² It is impossible to list all the regulations and applicable legislation, but Figure 4.5 illustrates some of the complexity of the legal framework pertaining to UGD. Some of the legislation will also be referred to in Chapter 5.

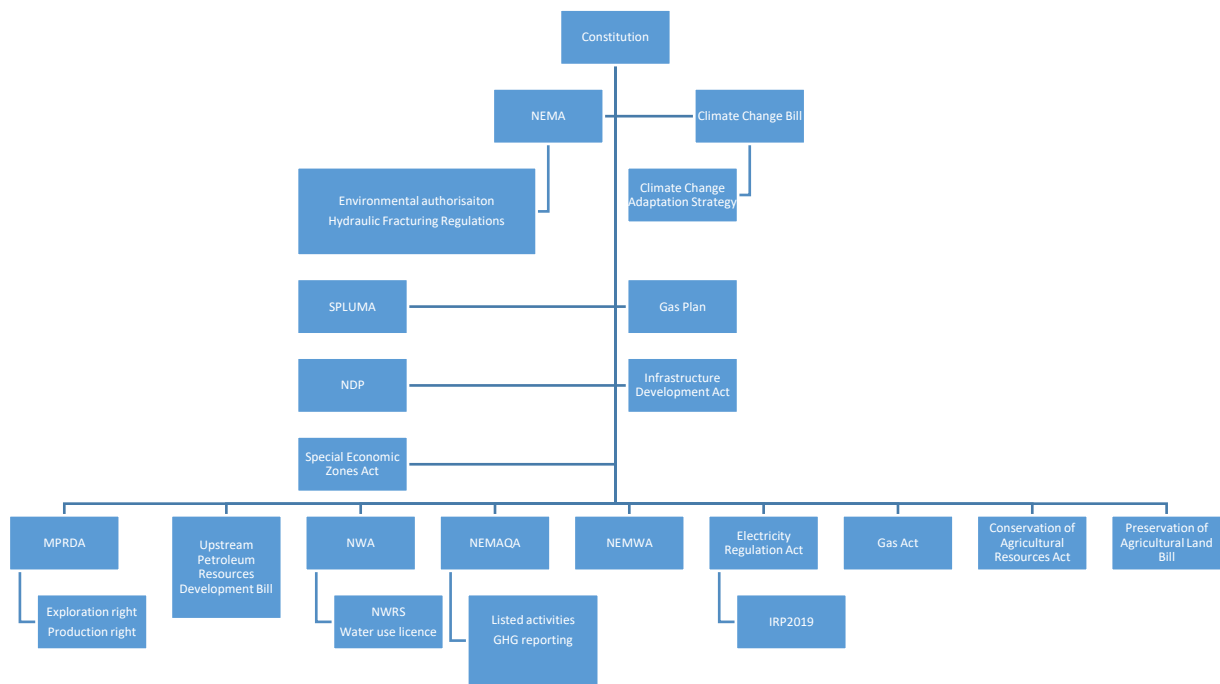


Figure 4-5: Legal framework pertaining to UGD

South Africa's plans, programmes and policies all favour development, with some of them specifically referring to gas and UGD. For a long period, a moratorium was placed on the development of UGD project, especially in the Karoo. Several iterations of hydraulic fracturing regulations saw the light, all of them challenged in court. The most recent regulations, issued in terms of the NEMA, are still in draft format. Currently the only legislation that regulates UGD specifically is the NEMA, that listed in 2021 hydraulic fracturing specifically as an activity for which an environmental authorisation will be needed. An applicant for a UGD project, will have to apply simultaneously for an exploration right and an environmental authorisation. It would be possible to combine the public participation process that will be needed. If there is change of land use, the necessary SPLUMA authorisations will have to be obtained.

In addition, the applicant will have to apply for a water use licence in terms of the NWA, as hydraulic fracturing is declared a controlled activity. As methane will be released and waste created, additional authorisations in terms of the NEMAQA and the NEMWA will be needed. This will be in addition to other legislation such as the *Hazardous Substances Act* 15 of 1973 that will regulated the control and storage of

the chemicals used in the hydraulic fracturing process.¹⁴⁸³ Furthermore, permission from the land owners (if communities with informal rights) might be needed, and agricultural legislation will apply in terms of the protection of high potential agricultural land as well as the protection of soil. Although the one environmental system was introduced to streamline environmental, mining and water authorisation, it is not done in relation to all authorisations that need to be obtained. The Department of Mineral Resources and Energy, the Department of Forestry, Fisheries and Environment, the Department of Water and Sanitation, the Department of Land Reform, Agriculture and Rural Development are all involved and may make different decisions from each other, still creating silo-based decision-making.

From the three empirical studies, it is clear that water, energy and food insecurity will have serious consequences for general sustainable development outcomes and ultimately for local communities and individual households, should UGD take place. For the most part, the costs of WEF nexus trade-offs are paid by the most vulnerable communities. These communities have limited means to influence higher levels of decision-making and also lack capacity to mediate or take advantage of changing WEF nexus dynamics. This includes WEF nexus dynamics generally and specifically within UGD. This includes the ability of local communities to be involved in the decision-making process on choice of energy source, for example UGD vis-a-vis renewables (solar/wind). Coordination and informed decision-making across government levels that includes input from local communities are key for water, energy and food security. The provision of basic services via the South African government is a key competent in determining access to water, energy and food. Related to this is the upkeep of infrastructure (water and energy supply systems).

The following chapter assesses the extent to which the South African regulatory framework that applies to UGD follows a nexus (integrated) approach to water, energy and food resource systems. This assessment is done by measuring the WEF nexus governance elements identified in Chapter three against the legal and regulatory

¹⁴⁸³ Due to the focus on water, energy and food, not all legislation pertaining to UGD was discussed in detail.

framework that are applicable on UGD. The assessment consists of checking whether the WEF nexus governance elements exist or are present in the regulatory framework.

CHAPTER 5: REGULATORY FRAMEWORK AND THE ELEMENTS OF WEF NEXUS GOVERNANCE

5.1 Introduction

In the previous chapter, the regulatory framework as it applies to UGD and water, energy and food, was discussed with reference to three empirical studies. This chapter aims to assess the extent to which the South African UGD regulatory framework follows a nexus (integrated) approach to water, energy and food resource systems. The assessment is done by testing the regulatory framework applicable to UGD (policy, legislation and case law) against the WEF nexus governance elements identified in Chapter three. Due to the scope of this study, it is not possible to discuss every single section or regulation that may be applicable to each element. The chapter focuses on the main trends and examples of WEF nexus governance elements that are apparent in the legislation.

The elements are examined as they appear in order below:

- Water, energy and food insecurity should be addressed with sustainable outcomes.
- Clear role and responsibilities of different government departments and spheres.
- Informed public participation.
- Integration of sources of information and information-gathering tools.
- Lifecycle approach.
- Flexible approaches making it possible to adapt or adjust when necessary.
- Inter-governmental cooperation and integrated decision-making.
- Integration on a policy and regulation level.
- Integration of multiple governance tools.
- The capacity to introduce new projects and programmes (training).
- Provision for strategic planning and reporting.
- Provision for monitoring and auditing.
- The interconnection of water, energy and food in a holistic perspective, taking into account inter-dependency, complexity and scale.

- Synergies and trade-offs amongst natural systems.
- The recognition of socio-ecological systems and the introduction of new technology.

Chapter 3 indicated that the level of WEF nexus integration within a regulatory framework can be described in terms of a spectrum from weak integration to strong integration.¹⁴⁸⁴ After completion of testing the nexus elements against the regulatory framework, the chapter concludes with a reflection on the extent to which these nexus elements are integrated into the South African legal framework.

5.2 Water, energy and food insecurity should be addressed with sustainable outcomes

The South African legislation on environmental and mining gives recognition to section 24 of the Constitution, sustainable development as well as to justifiable economic and social development.¹⁴⁸⁵ The NEMA that gives effect to section 24 of the Constitution includes sustainable development principles in section 2. Amongst others, it specifically states that environmental governance must be interlinked and that all elements of the environment should be considered when decisions that may impact on the environment, are made.¹⁴⁸⁶ The section 2 principles are applicable to all organs of state that make decisions impacting on the environment, therefore including decision-making as to whether UGD should be allowed. This is reiterated by the MPRDA that makes the section 2 NEMA principles directly applicable to mining, exploration and production activities.¹⁴⁸⁷ While the section 2 principles reflect on the social as well as the environmental context, it has in the past been criticised as being too anthropocentric as opposed to promoting ecological interests.¹⁴⁸⁸ This is similar to the criticism posed against the concept of sustainable development on an international level.¹⁴⁸⁹ The preamble of the NWA recognises that water is a scarce resource (water

¹⁴⁸⁴ See para 3.9 in Chapter 3. See also Peel "Regulation of the nexus" 201-202.

¹⁴⁸⁵ See e.g. preamble and ss 2, 23 and 24 NEMA, s 2 MPRDA, S 2 NEMAQA, s 2 NEMWA.

¹⁴⁸⁶ Section 2. See also Soyapi 2023 *SALJ* 453-457.

¹⁴⁸⁷ Section 37 MPRDA.

¹⁴⁸⁸ See e.g. Scholtz 2005 *TSAR* 69-85.

¹⁴⁸⁹ See e.g. Tladi 2004 *SAJELP* 17-29; Verschuuren 2006 *PER/PELJ* 208-261; Kotzé and French 2018 *Global Journal of Comparative Law* 5-36.

insecure) and it therefore has to be managed in a sustainable way.¹⁴⁹⁰ A main sustainable outcome is that human needs must be met as well as equitable access to water. In addition, the Act promotes the "efficient, sustainable and beneficial use of water in the public interest as well as to reduce and prevent water pollution".¹⁴⁹¹ Both the *National Environmental Management Waste Act* 59 of 2008 (NEMWA) and the *National Environmental Management Air Quality Act* 39 of 2004 (NEMAQA), amongst others, state that the measures introduced are specifically aimed at the health and well-being of people.¹⁴⁹²

In *Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province*¹⁴⁹³ (hereafter the *Fuel Retailers* case), the court via Justice Ngcobo stated that:

... development cannot subsist upon a deteriorating environmental base. Unlimited development is detrimental to the environment and the destruction of the environment is detrimental to development. Promotion of development requires the protection of the environment. Yet the environment cannot be protected if development does not pay attention to the costs of environmental destruction. The environment and development are thus inexorably linked.

Subsequently various other court decisions such as *HTF Developers*¹⁴⁹⁴ and the more recent South African Appeal court case of *Forestry South Africa v Minister of Human Settlements*¹⁴⁹⁵ confirm this. In the *Forestry* case the court emphasised the role that National Department of Water and Sanitation should play in terms of the NWA by stating that:

[t]he use of water is not simply an incident of private ownership. The Act proceeds from the following foundational principles: the government is the public trustee of

¹⁴⁹⁰ Preamble NWA.

¹⁴⁹¹ Preamble, s 2 and 19 of the NWA.

¹⁴⁹² Section 2(b) NEMAQA; s 2(a) NEMWA.

¹⁴⁹³ *Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province* 2007 (6) SA 4 (CC) para 44.

¹⁴⁹⁴ *HTF Developers v Minister of Environmental Affairs and Tourism* [2007] 4 All SA 1108 (SCA); 2007 (11) BCLR 1230 (SCA); 2007 (5) SA 438 (SCA).

¹⁴⁹⁵ *Forestry South Africa v Minister of Human Settlements, Water and Sanitation* (777/2022) and *Minister of Human Settlements, Water and Sanitation v Forestry South Africa* 824/2022 [2023] ZASCA 153 (15 November 2023). Also, see Feris 2010 *PELJ* 72-99 on the need for good environmental governance in light of sustainable development.

the nation's water resources; the Minister must ensure that water resources are protected and used in a sustainable and equitable manner in the public interest.

In *Endangered Wildlife Trust v Director-General, Department of Water and Sanitation*¹⁴⁹⁶ South Africa's Water Tribunal had to deal with an appeal against the issuing of a water-use licence to an underground coal mine. The Tribunal states that the area "has been previously disturbed by various anthropogenic activities ranging from crop cultivation, other forms of agriculture, tourism, and historical mining".¹⁴⁹⁷ The Tribunal needed to consider how the government should exercise their stewardship over water resources. The Tribunal illustrated the complexity of the balancing process as follows:¹⁴⁹⁸

In casu, at issue are water resources, the coal that lie in the belly of the earth, the flora and fauna that beautify the landscape, nourished by the rivers, rivulets, and wetlands in the area. Unflustered, all these natural resources and ecological processes that sustain them happen in harmonious equilibrium which the law and legal principles, superimposed by humans, purport to mimic and expect regulatory agencies to replicate. Alas, the mere process of living entails us disturbing this natural order in order to sustain life and livelihoods.

The Tribunal further acknowledges the socio-economic impact of coal-mining in the area as well as the creation of job opportunities for disadvantaged communities living in the area.¹⁴⁹⁹ The Tribunal indicates that socio-economic¹⁵⁰⁰ and ecological impacts¹⁵⁰¹ were considered in a balanced manner. The Tribunal states "while the environment and ecological sustainability are foundational to the notion of sustainable development – the NWA, NEMA and the Constitution require us to take an approach which integrates all these aspects without subjective linear focus on any one".¹⁵⁰² It is important to note that section 27 of the NWA specifically indicates that all these considerations should be taken into account when a water-use licence is to be issued.

¹⁴⁹⁶ (WT 03/17/MP) [2019] ZAWT 3 (22 May 2019).

¹⁴⁹⁷ (WT 03/17/MP) [2019] ZAWT 3 para 4.

¹⁴⁹⁸ (WT 03/17/MP) [2019] ZAWT 3 para 13.

¹⁴⁹⁹ (WT 03/17/MP) [2019] ZAWT 3 para 13.

¹⁵⁰⁰ (WT 03/17/MP) [2019] ZAWT 3 para 160, 160.1-160.9.

¹⁵⁰¹ (WT 03/17/MP) [2019] ZAWT 3 para 59-93.

¹⁵⁰² (WT 03/17/MP) [2019] ZAWT 3 para 160.5.I

Notably, the Tribunal indicated that one cannot stress one of the considerations at the cost of another.¹⁵⁰³

Sections 23 and 24 of the NEMA read with the EIA regulations expect of all environmental authorisation applicants, to indicate that they take all impacts that may have a significant impact on the socio-economic, cultural and ecological environment into account.¹⁵⁰⁴ However, it is doubtful whether the balancing takes place and all considerations are taken into account in all instances of decision-making. This is reflected in a number of cases where the allocation of water, energy and water authorisations are disputed.¹⁵⁰⁵ Section 240 of the NEMA requires a competent authority to take various criteria into account when making a decision to authorise a development. These criteria refer, amongst others, to pollution, environmental impact and environmental degradation as well as all the reports submitted to the relevant Department. The section does not specifically refer to the socio-economic and cultural environment specifically, but in terms of sections 2, and 23 read with section 24, this is implicit in the decision-making. These criteria also apply to the Minister of Mineral Resources and Energy when taking a decision to issue an environmental authorisation for UDG.¹⁵⁰⁶ In the case of *Earthlife Africa Johannesburg v Minister of Environmental Affairs*¹⁵⁰⁷ the court referred to a decision of the then Minister of Environmental Affairs whereby the Department was instructed to consider the impacts of climate change

¹⁵⁰³ See specifically s 27(1)(d) of NWA.

¹⁵⁰⁴ GN R982-985 in GG 38285 of 4 December 2014, as amended. To be read with s 1 of NEMA that defines the environment not only in an ecological manner. On the interpretation of the environment, see Nel and Alberts "Environmental Management and Environmental Law in South Africa" 3-11.

¹⁵⁰⁵ Also, see Murombo 2008 *PELJ* 105-136; Franco and Du Plessis 2023 *Litnet* 652-697. Also see case law where applicants argue that the NEMA and SEMAs apply to existing mining authorisations. The applicants do not always succeed in convincing the court that this is the case, see amongst others: *Global Environmental Trust v Tendele Coal Mining (Pty) Ltd* [2019] 1 All SA 176 (KZP); *Mining and Environmental Justice Community Network of South Africa v Uthaka Energy (Pty) Ltd* (11761/2021) [2021] ZAGPPHC 195 (30 March 2021); Trustees For The Time Being of *The Global Environmental Trust v Mfolozi Community Environmental Justice Organisation* (82865/2018) [2021] ZAGPPHC 262 (28 April 2021) and on gas exploration *Border Deep Sea Angling Association v Minister of Mineral Resources and Energy* (3865/2021) [2021] ZAECGHC 111 (3 Desember 2021); *Adams v Minister of Mineral Resources and Energy* (1306/22) [2022] ZAWCHC 24 (1 March 2022); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* 2022 (6) SA 589 (ECMk), *Sustaining The Wild Coast NPC v Minister of Mineral Resources and Energy* ([2022] 1 All SA 796 (ECG); 2022 (2) SA 585 (ECG).

¹⁵⁰⁶ Sections 1 and 24 NEMA.

¹⁵⁰⁷ [2017] 2 All SA 519 (GP) para 126.3.

before granting an environmental authorisation. Although section 24O of NEMA does not specifically make provisions for climate change considerations, the court read it into the criteria to consider environmental impacts.¹⁵⁰⁸

The Exploration Strategy for the Mining Industry of South Africa, 2022¹⁵⁰⁹ further recognises the importance of the balancing of social, economic and environmental interests,¹⁵¹⁰ although the overall trend in the document is towards more exploration and job creation, rather than protecting environmental interests.¹⁵¹¹ This is further evidenced by the South Africa's Exploration Implementation Plan, 2022¹⁵¹² that is specifically geared towards economic interests and that sees the environmental, spatial planning and proposed agricultural legislation as a threat towards mineral exploration.¹⁵¹³ The Strategy, however, speaks to energy security but less so to water and food security. As is apparent from the case dealing with gas exploration, water pollution and food security remain huge concerns.¹⁵¹⁴

¹⁵⁰⁸ [2017] 2 All SA 519 (GP) paras 78-91.

¹⁵⁰⁹ GN 2026 in *GG 46246* of 14 April 2022.

¹⁵¹⁰ Paragraph 2 states: "It is anchored on three critical pillars of sustainable development, namely, economic growth, social benefits, and environmental care through good governance".

¹⁵¹¹ The goal is stated in the preamble as "To attract mineral exploration investment, reignite mineral development, accelerate new mineral discoveries and encourage optimal utilisation of the South African mineral resources in line with the environmental, social, and corporate governance principles for sustainable growth and propel South Africa to a competitive position against other jurisdictions of comparable mineral endowment".

¹⁵¹² GN 2027 in *GG 46246* of 14 April 2022.

¹⁵¹³ Paragraph 2.3.1.1.6: "There exist policies and legislations [sic] across the government landscape that are seemingly incongruent with the intentions for sustainable prospecting activities, including but not limited to the following:

- Open-ended appeal and objection processes in the National Environmental Management Act (NEMA), which further extend the timeframes for prospecting;
- Application of Spatial Planning and Land Use Management Act (SPLUMA) as well as Protected Areas Act does not adequately consider mineral development requirements in their execution, especially in geological settings with the highest prospects;
- The Preservation and Development of Agricultural Land Bill presents a threat to the potential coexistence of mining and agriculture;
- Protracted timeframes in applications for water use licenses in terms of the National Water Act further undermine the development of advanced exploration that underpins bulk sampling to augment feasibility studies to enable transition of a prospecting right to a mining right".

¹⁵¹⁴ *Border Deep Sea Angling Association v Minister of Mineral Resources and Energy* (3865/2021) [2021] ZAECHC 111 (3 December 2021); *Adams v Minister of Mineral Resources and Energy* (1306/22) [2022] ZAWCHC 24 (1 March 2022); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* 2022 (6) SA 589 (ECMk), *Sustaining The Wild Coast NPC v Minister of Mineral Resources and Energy* ([2022] 1 All SA 796 (ECG); 2022 (2) SA 585 (ECG). Also, see Du Plessis 2023 *Litnet* 652-697.

Some integration is also seen in South Africa's report on the Sustainable Development Goals. The report is understandably fragmented as reporting is done in relation to the 16 goals. However, the reporting is grouped into social, economic and environmental goals as well as the governance-related tools.¹⁵¹⁵ The report acknowledges that these goals are interlinked and that they need to be balanced: "Economic growth without social inclusion at the expense of natural environment is as unwise as environmental protection at the expense of vulnerable groups and individuals".¹⁵¹⁶ Despite this, the newest reports indicate that South Africa has regressed on some of its commitments in relation to water, energy and food production.¹⁵¹⁷

It is, therefore, clear that the South African legislation and policy framework emphasize the integration of sustainable development regarding decision-making. This is also reiterated by the courts. The courts furthermore demand a careful balancing of the interests of sustainable development, to which the legislation aspires. The implementation of these considerations, however, may not always take place in practice. The pressure to recover the economy (also via UGD) as set out in the implementation plan, may hamper the progress made.¹⁵¹⁸

5.3 Life-cycle approach

Section 2 of the NEMA refers to a life-cycle approach¹⁵¹⁹ in that the "environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists through its life-cycle". This is reiterated in section 24E of the NEMA that states that every environmental authorisation must make provision for the ongoing management and monitoring of environmental impacts of the activity throughout the life-cycle of the activity.¹⁵²⁰ The environmental management programme¹⁵²¹ must accompany the environmental authorisation application. It is

¹⁵¹⁵ StatsSA "Sustainable Development Goals (SDGs) Country Report 2019".

¹⁵¹⁶ StatsSA "Sustainable Development Goals (SDGs) Country Report 2019" 3.

¹⁵¹⁷ Sustainable Development Report <https://dashboards.sdgindex.org/profiles/south-africa>. Also, see Viljoen and Qumbu 2020 *SAJELP* 39-61.

¹⁵¹⁸ Paragraph 1.

¹⁵¹⁹ Section 2(4)(e).

¹⁵²⁰ Section 24E(a).

¹⁵²¹ Section 24N NEMA read with regulation 23(4) and appendix 4 of GN R982 in GG 38282 of 4 December 2023, as amended.

especially applicable in the case of mining where environmental and health impacts should be addressed during the life-cycle of mining, exploration or production.

The repealed 2015 regulations for petroleum exploration and production referred to a life-cycle approach on a number of occasions.¹⁵²² In terms of risks due to environmental impacts, it required the gathering of information throughout the life of the relevant prospecting or mining rights.¹⁵²³ In terms of mine closure requirements, the regulations stipulated that the process for mine closure is a continuous process throughout the life of the mining operation.¹⁵²⁴ Mine residue in the form of stockpiles and deposits had to be characterised through the different phases of the life of said stockpiles and deposits.¹⁵²⁵ Well-integrity and well-examination were specifically linked to the life-cycle of the well.¹⁵²⁶ While not equaling a life-cycle approach, a number of references were made to the different phases of drilling and hydraulic fracturing.¹⁵²⁷ Notably, an environmental authorisation was required for each of the different phases of the process, namely (i) seismic survey (without hydraulic fracturing), (ii) hydraulic fracturing and (iii) the production phase. It can be argued that the emphasis on the different phases, both within the operational (drilling and hydraulic fracturing) and the general development phases strengthened the life-cycle approach.

In 2022 the Minister of Forestry, Fisheries and Environment published draft regulations pertaining to the exploration of onshore oil and gas, requiring hydraulic fracturing for comment.¹⁵²⁸ Similar to the 2015 regulations it is clearly stated that the environmental impacts associated with all phases of the project needs to be identified, assessed, avoided or managed.¹⁵²⁹ Furthermore, one of the aims of the regulations is to "set general and specific requirements for ongoing environmental monitoring of hydraulic

¹⁵²² Regulations for Petroleum Exploration and Production. See GN R466 in GG 38855 of 3 June 2015. Also, see Du Plessis 2015 *PELJ* 1440-1478. These regulations were repealed as the Supreme Court of Appeal found that only the Minister of Forestry, Fisheries and Environment may issue the regulations and not the Minister of Mineral Resources and Energy – see *Minister of Mineral Resources v Stern; Treasure the Karoo Action Group v Department of Mineral Resources* [2019] 3 All SA 684 (SCA) para 48.

¹⁵²³ Section 56(b).

¹⁵²⁴ Section 56(a).

¹⁵²⁵ Section 73(2)(b)(i)(gg) and 73(3)(a)(i) and 73(5)(c).

¹⁵²⁶ Section 84 and 107(3).

¹⁵²⁷ Section 5(1)(g); 7(1)(h-i); 51(b)(i-ii); 118(2); 122(1); 127(2); and 131(1).

¹⁵²⁸ GN 2273 in GG 47112 of 11 July 2022.

¹⁵²⁹ Regulation 2(c).

fracturing and production operations".¹⁵³⁰ The use of potable water other than for drinking or domestic use is prohibited and water should be recycled if used in the hydraulic fracturing process. It may further not be disposed of into surface watercourses or injected into used wells.¹⁵³¹ The applicant or holder of an exploration or production right must further assess, monitor and manage the environmental impacts (measured against the initial baseline assessment¹⁵³²) during the operational phase of the project, as well as during the decommissioning and closure phases of the project.¹⁵³³ During the operational phase, the holder of the exploration or production rights will have to comply with prescribed standards.¹⁵³⁴ Although the previous regulations focused more on a life-cycle approach, the draft regulations endeavoured to do the same. The draft regulations include various measures for the control of water but do not refer to the impact of the regulations on food production, for example. However, this would have been assessed during the initial environmental impact assessment phase.

5.4 Clear role and responsibilities of different government departments and spheres

While the roles and responsibilities of the different government departments are clear per their respective mandates and within their own sectoral areas as per the prescribed legislation, the opposite is true in instances of conflict. For example, a specific role is prescribed for the national, provincial and local governments in the SEMAs. If a municipality, for example, prescribes standards for air quality management, then those standards must correlate with the national and relevant provincial standards.¹⁵³⁵ While it is clear who should do what, it is not so clear when the requirement is outside the specific department's mandate or when there is conflict regarding this. There is no

¹⁵³⁰ Regulation 2(3).

¹⁵³¹ Regulation 4 that also refers to various other prohibited practices in relation to the disposal and storage of water. Regulation 5 also prohibits certain areas from hydraulic fracturing, e.g. two kilometers from a strategic watercourse or a thermal or cold spring.

¹⁵³² Regulations 6(b) and 7. A monitoring plan must be submitted at the commencement of the project and for the next 24 months the monitoring results must be submitted to the Department of Mineral Resources and Energy – reg 7(2)-(3), (5)-(9).

¹⁵³³ Regulation 6.

¹⁵³⁴ Regulation 8, 9-10 and appendix 1.

¹⁵³⁵ Sections 8-11 NEMAQA. The National Ambient Air Quality Standards were e.g. published in GN 1210 in GG 32816 of 24 December 2009.

integrated decision-making here. In some instances, a municipality or a department may only be a commenting authority, while in other instances integrated decision-making may have to take place.¹⁵³⁶

The *Climate Change Bill* has the clearest provisions in this regard. It specifically states that the aim of the eventual Act will be to provide a coordinated and integrated response to climate change.¹⁵³⁷ All policies will have to be aligned to ensure that the risks of climate change are addressed.¹⁵³⁸ Various forums are established at a provincial and municipal level to coordinate the climate change response,¹⁵³⁹ with a presidential climate commission with oversight responsibilities.¹⁵⁴⁰ These forums may further establish intergovernmental support committees in terms of the *Intergovernmental Relations Framework Act* 13 of 2005.

The introduction of the one environmental system had, as one of its aims, to provide a clear role for the DFFE, the DMRE and the DWS.¹⁵⁴¹ The idea was that the applications for environmental, mining and water-use authorisations should be aligned. The roles and responsibilities of the different departments and timelines should be coordinated. The Minister of Mineral Resources and Energy is the main decision-maker on exploration and production rights as well as environmental authorisations, atmospheric emission and waste management licences.¹⁵⁴² Where the roles of the Minister of Mineral Resources and Energy vis-à-vis the other Departments were not clear it gave rise to conflict. In the case of *Mineral Sands Resources (Pty) Ltd v Magistrate for the District of Vredendal, Kroutz*¹⁵⁴³ the environmental

¹⁵³⁶ Also see the *Maccsand* cases indicating that the applicant for mining (pre 2014) cannot rely on the mining authorisation only, but has to obtain all other authorisations (e.g. environmental and planning). See *Maccsand (Pty) Ltd v City of Cape Town* (2012 (4) SA 181 (CC); 2012 (7) BCLR 690 (CC); *Maccsand (Pty) Ltd v City of Cape Town* 2011 (6) SA 633 (SCA); [2011] 4 All SA 601 (SCA); *City of Cape Town v Maccsand (Pty) Ltd* 2010 (6) SA 63 (WCC); [2011] 1 All SA 506 (WCC).

¹⁵³⁷ Clause 2(a).

¹⁵³⁸ Regulation 7.

¹⁵³⁹ Climate change response is dealt with in Chapter 3 of the Bill.

¹⁵⁴⁰ Clauses 8-11.

¹⁵⁴¹ Section 50A NEMA, s 163A NWA and various amendments to the MPRDA via the *Mineral and Petroleum Resources Development Amendment Act* 49 of 2008 as well as amendments via the *National Environmental Laws Amendment Act* 62 of 2008 and subsequent amendments, including the most recent the *National Environmental Laws Amendment Act* 2 of 2022.

¹⁵⁴² Section 40(3A) NEMAQA; ss 1 and 24 NEMA.

¹⁵⁴³ [2017] 2 All SA 599 (WCC).

management inspectors entered on mining land with a warrant issued by the Magistrate for the District Vredendal. The court, however, found that the mineral resource environmental inspectors had the mandate to investigate transgressions on mining land and not the environmental management inspectors.¹⁵⁴⁴ The court dealt in detail with the separate mandates of the mining, environmental and water inspectors, indicating that the one environmental system provided specific roles for each Department in this regard.¹⁵⁴⁵ This case illustrates that the mandates of the different departments in relation to mining are not that clear and similar jurisdictional disputes may arise once UGD takes place.

5.5 Informed public participation

The principle of public participation is a key characteristic of South Africa's constitutional democracy. It is most probably the best-developed of all principles in South African law. Section 196 of the Constitution lists a number of values and principles applicable to public administration.¹⁵⁴⁶ Particular reference is made to the need for public participation in policy-making and in the legislative processes.¹⁵⁴⁷ Numerous court decisions¹⁵⁴⁸ confirm the important role that public participation plays within the country's participatory democracy whereby individuals or institutions have an opportunity to take part in decisions that affect them.¹⁵⁴⁹ The numerous case law

¹⁵⁴⁴ Designated in terms of s 31BB NEMA.

¹⁵⁴⁵ Paras 42-122.

¹⁵⁴⁶ Section 196 of the Constitution.

¹⁵⁴⁷ Section 196(1)(e) and 72 of the Constitution. Any act or by-law that did not follow an adequate public participation process before its passing into law may be declared unconstitutional.

¹⁵⁴⁸ *Doctors for Life International v Speaker of the National Assembly* 2006 (6) SA 416 (CC); *Bengwenyama Minerals (Pty) Ltd v Genorah Resources (Pty) Ltd* (2011 (4) SA 113 (CC); *Matatiele Municipality v President of the RSA* 2007 (6) SA 477 (CC); *Earthlife Africa (Cape Town) v Director General Department of Environmental Affairs and Tourism* 2005 (3) SA 156 (C); *Balenj v Minister of Mineral Resources* 2019 (2) SA 453 (GP); *Maledu v Itereleng Bakgatla Mineral Resources (Pty) Limited* 2019 (2) SA 1 (CC); *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* [2022] 1 AII SA 796 (ECG); *Adams v Minister of Mineral Resources and Energy* (1306/22) [2022] ZAWCHC 24 (1 March 2022); *Sustaining The Wild Coast NPC v Minister of Mineral Resources and Energy* [2022] 4 AII SA 533 (ECG); *Mfololozzi Community Environmental Justice Organisations v Tendele Coal Mining (Pty) Ltd* 2023 JDR 2537 (KZP).

¹⁵⁴⁹ De Vos and Freedman *South African Constitutional Law in Context* 124; Chenwi 2011 *SAPL* 155. In this vein the court in *Doctors for Life International v Speaker of the National Assembly* 2006 (6) SA 416 (CC) at para 227 states: "Public involvement in our country has ancient origins and continues to be a strongly creative characteristic of our democracy. We have developed a rich culture of *imbizo*, *lekgotla*, *bosberaad*, and *indaba*. Hardly a day goes by without the holding of consultations and public participation involving all 'stakeholders', 'role-players' and

on public participation is, however, also a barometer of the many instances of non-compliance with the requirement of public participation.¹⁵⁵⁰

Du Plessis¹⁵⁵¹ posits that mere community engagement does not equal actual public participation. Public participation is the vehicle through which community interests such as their perception and understanding of impacts emanating from UGD such as trade-offs between water, energy and food need to be accounted for.¹⁵⁵² In this manner, public participation plays a vital role within decision-making processes on UGD.¹⁵⁵³ Public participation strongly links with procedural rights of communities such as the right to access to information and to just administrative action.¹⁵⁵⁴ The existence of these rights advocates communities' access to information and results of social and environmental impact assessments on UGD. Without access to information and results of social and environmental impact assessments on UGD, communities will not be able to understand and assess those impacts.¹⁵⁵⁵ In the same vein, experts, such as toxicologists and epidemiologists cannot conduct research without access to data and information on likely impacts emanating from UGD.¹⁵⁵⁶ This includes impacts such as the likely trade-offs between water, energy and food.

The principle of public participation is also important in WEF nexus issues within UGD development. A number of statutes, such as the MPRDA, the *Local Government: Municipal Systems Act* 32 of 2000, the NEMA, and several SEMAs specifically provide for consultation and public participation.¹⁵⁵⁷ Reference is also made to how the draft amendments to the Mineral and Petroleum Regulations¹⁵⁵⁸ (hereafter the Draft

'interested parties', whether in the public sector or the private sphere. The principle of consultation and involvement has become a distinctive part of our national ethos".

¹⁵⁵⁰ One of the more recent examples is that of the *Traditional Khoi-San Leadership Act* 3 of 2019 (TKLA) that got struck down by the Constitutional court due to the National Assembly and provincial legislatures failing to facilitate reasonable public participation (due to inadequate notice, lack of pre-hearing education, and limited accessibility to meetings). See *Mogale v the Speaker of the National Assembly* (CCT 73/22) [2023] ZACC 14.

¹⁵⁵¹ Du Plessis "Governance of hydraulic fracturing" 123.

¹⁵⁵² Du Plessis "Governance of hydraulic fracturing" 123.

¹⁵⁵³ Du Plessis "Governance of hydraulic fracturing" 123.

¹⁵⁵⁴ Du Plessis "Governance of hydraulic fracturing" 123.

¹⁵⁵⁵ Du Plessis "Governance of hydraulic fracturing" 123.

¹⁵⁵⁶ Du Plessis "Governance of hydraulic fracturing" 123.

¹⁵⁵⁷ Section 10 of the MPRDA; ss 16-22 of the LGMSA, s 24 NEMA (environmental authorisations); s 57 of the NEMAQA and s 32(1)(d) of the NEMPA.

¹⁵⁵⁸ GN R1554 in GG 42870 of 28 November 2019.

Amendments) and the *Upstream Petroleum Resources Development Bill* (hereafter the Bill) incorporate public participation. While these two are yet to be implemented, (statutory) they do provide an indication of how the principle of public participation and its associated elements such as interested and affected parties (hereafter I&APs), are likely to be defined.

For example, per section 10(1) of the MPRDA, the Regional Manager must, after accepting an application for a prospecting right, mining right or mining permit, make known that a named application has been received and must request interested parties to submit comments.¹⁵⁵⁹ The Regional Manager must, in terms of section 10(1)(a) and 10(1)(b) of the Act,¹⁵⁶⁰ notify the applicant in writing of the prospecting right, mining right or mining permit, to (i) submit an environmental management plan and (ii) notify and consult with I&APs and submit the result thereof to the relevant Department.

The NEMA, being the environmental framework legislation, addresses (among other aspects) how potential impacts emanating from listed or specified activities within the EIA regulations, must be considered, assessed and reported to enable the responsible authority to make an informed decision on the granting of an environmental authorisation. Section 24(1)(a) and (c) of NEMA states that:

Every applicant must comply with the requirements prescribed in terms of this Act in relation to ... any procedure relating to public consultation and information gathering.¹⁵⁶¹

Section 24(4)(a)(v) of NEMA deals with public participation.¹⁵⁶² This section states that an application for an environmental authorisation must ensure public participation procedure(s) to include all IAPs.¹⁵⁶³ Public participation is defined in the NEMA as a process by which potential IAPs are given opportunity to comment, or raise issues relevant to the environmental application.¹⁵⁶⁴ IAPs in turn are defined to include (i) any person, group of persons, or organisation, interested in or affected by a listed or

¹⁵⁵⁹ *Bengwenyama* case paras 32 and 62.

¹⁵⁶⁰ Read with s 16(4)(b) of the Act.

¹⁵⁶¹ Section 24(1)(a) and (c) of NEMA.

¹⁵⁶² Also read Du Plessis 2008 *PELJ* 170-200; Murombo 2008 *PELJ* 105-136.

¹⁵⁶³ Section 24(4)(a)(v).

¹⁵⁶⁴ Section 1.

related activity, and (ii) any organ of state that may have jurisdiction over any aspect of the activity.¹⁵⁶⁵ The importance of public participation is also confirmed as a general objective of integrated environmental management.¹⁵⁶⁶ The specific section refers to adequate and appropriate opportunity for public participation.¹⁵⁶⁷ Further, section (2)(4)(f) of the NEMA states that the contribution of all I&APs in environmental governance must be promoted, namely

... the participation of all interested and affected parties in environmental governance must be promoted, and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation, and participation by vulnerable and disadvantaged persons must be ensured.¹⁵⁶⁸

Several of the SEMAs specifically provide for consultation and public participation. The NEMAQA, for example, specifies that before any power in terms of the Act can be exercised, it must be announced in the *Government Gazette*.¹⁵⁶⁹ A similar provision is included in the *Climate Change Bill*.¹⁵⁷⁰ It must also be published in a national newspaper or a regional newspaper if the power would only affect one region.

The draft amendments to the MPRDA Regulations define "interested and affected parties" as:

... a natural or juristic person or an association of persons with a direct interest in the proposed or existing operation or who may be affected by the proposed or existing operation.¹⁵⁷¹

It continues to state that "interested and affected parties":

... include but are not limited to; (i) Host Communities, (ii) Landowners (Traditional and Title Deed owners), (iii) Traditional Authority, (iv) Land Claimants, (v) Lawful land occupier, (vi) Holders of informal rights, (vii) the Department of Agriculture, Land Reform and Rural Development, (viii) Any other person (including on adjacent and non-adjacent properties) whose socioeconomic conditions may be directly affected by the proposed prospecting or mining operation, (ix) the Local Municipality,

¹⁵⁶⁵ Section 1 and 24(4)(a)(v).

¹⁵⁶⁶ Section 23(2)(d).

¹⁵⁶⁷ Section 23(2)(d).

¹⁵⁶⁸ Section (2)(4)(f) of the NEMA.

¹⁵⁶⁹ Section 57.

¹⁵⁷⁰ Clause 29.

¹⁵⁷¹ Regulation 1(b) of the Draft Amendments to the Mineral and Petroleum Regulations, 2019 GN R1554 in GG 42870 of 28 November 2019.

and (x) the relevant Government Departments, agencies and institutions responsible for the various aspects of the environment and for infrastructure which may be affected by the proposed project.¹⁵⁷²

Thus, per the Draft Amendments a wide interpretation is applied to I&APs to include numerous interest groups. What constitutes "meaningful consultation" per the Draft MPRDA Regulations:

... means that the applicant, has in good faith engaged the landowner, lawful occupier or interested and affected party in respect of the land subject to the application about the impact the prospecting or mining activities would have to his right of use of the land by availing all the information pertaining to the proposed activities enabling these parties to make an informed decision regarding the impact of the proposed activities.¹⁵⁷³

Chenwi¹⁵⁷⁴ argues that meaningful engagement is about supporting social transformation via the realisation of socio-economic rights and this augments democratic accountability.¹⁵⁷⁵ Meaningful engagement ensures that development is relevant to local needs and conditions.¹⁵⁷⁶ It provides communities a say in development activities that impact their lives and livelihoods.¹⁵⁷⁷ In this sense, meaningful consultation occurs when communities, individuals and the government engage in a process of talking and listening to one another while being aware that any engagement is context sensitive.¹⁵⁷⁸

Clause 19 of the Climate Change Bill addresses consultation with I&APs, stating:

The Petroleum Agency must, within 14 days from the date of acceptance of an application lodged in terms of section 15, 16, or 38 (a) make known, in the prescribed manner, that an application for a reconnaissance permit or petroleum right has been accepted in respect of the block or blocks in question; (b) call upon interested and affected persons to submit their comments and objections regarding the application, within 30 days from the date of the notice, to the Petroleum Agency.¹⁵⁷⁹

¹⁵⁷² Regulation 1(b)(i)-(x) of the Draft Amendments to the Mineral and Petroleum Regulations, 2019 GN R1554 in GG 42870 of 28 November 2019.

¹⁵⁷³ Regulation 1(c) of the Draft Amendments.

¹⁵⁷⁴ Chenwi 2011 *SAPL* 156.

¹⁵⁷⁵ Chenwi 2011 *SAPL* 156.

¹⁵⁷⁶ Chenwi 2011 *SAPL* 155.

¹⁵⁷⁷ Chenwi 2011 *SAPL* 155.

¹⁵⁷⁸ Chenwi 2011 *SAPL* 129.

¹⁵⁷⁹ Clause 19(1)(a)-(b) of the Bill.

Further, section 35(5)(c) of the same Bill, the Petroleum Agency must consult with I&APs as required per clause 19.¹⁵⁸⁰

As an example, as opposed to the mining legislation, the *National Environmental Management: Protected Areas Act* 57 of 2003 (NEMPA) requires a process of public participation.¹⁵⁸¹ This entails the identification of relevant owners of land, persons whose right in land may be affected, and members of the public such as interested parties.¹⁵⁸² Objections and feedback from interested and affected parties must be included (in the consideration of publishing a notice on declaration).¹⁵⁸³ NEMPA states that management plans must contain procedures for public participation.¹⁵⁸⁴ This specifically includes owners of land, local communities and interested parties.¹⁵⁸⁵

On receiving an application to conduct commercial prospecting, mining, exploration, production or related activities in a protected area, the NEMPA states that the Minister must, among others, take into account: "reports, information, studies conducted and consultation done for the EIA per the requirements of Chapter 5 of NEMA".¹⁵⁸⁶ While the original section 48(4) directly refers to the interest of local communities, the amended section does not.¹⁵⁸⁷ Instead section 48(5) refers to "any information, reports, studies conducted or consultation done" for the EIA per the requirements of Chapter 5 of NEMA.¹⁵⁸⁸ This can be interpreted to include the interests of local communities. This is due to its reference to the section 2 principles of NEMA, specifically section 2(4)(g) that requires decisions to take into account the interests and needs of IAPs, such as local communities.

The LGMSA requires local government structures to facilitate public participation within a system of participatory governance.¹⁵⁸⁹ This is relevant to the WEF nexus because

¹⁵⁸⁰ Section 35(5)(c) of the Bill.

¹⁵⁸¹ Section 32(1)(d).

¹⁵⁸² Section 33(1-2).

¹⁵⁸³ Section 33(4).

¹⁵⁸⁴ Section 41(2)(e).

¹⁵⁸⁵ Section 41(2)(e).

¹⁵⁸⁶ Section 48(5)(a)(i, ii and iv). As added by s 40 of the *National Environmental Management Laws Amendment Act* 2 of 2022.

¹⁵⁸⁷ Substituted section 48(4).

¹⁵⁸⁸ Section 48(5)(a)(ii).

¹⁵⁸⁹ Section 16(1).

a number of local government structures such as council and ward committee meetings set the platform where the development, implementation and review of IDPs take place.¹⁵⁹⁰ Additionally, section 17 of the LGMSA stipulates a list of specific mechanisms, processes and procedures for community participation as it relates to (i) petitions and complaints lodged by the local community, (ii) general notification and public comment procedures, (iii) public meetings and hearings, (iv) consultative sessions with local community organisations (including traditional authorities), and (v) reporting back to the local community.¹⁵⁹¹ Notably, the municipality (local government) must take note of the special needs of members of the local community in terms of the level of literacy, language preferences, disabilities, women and any other disadvantaged groups.¹⁵⁹² Section 21 of the LGMSA stipulates the requirements in the case of official communication via the media to the local community.¹⁵⁹³ This includes communication in terms of any other applicable legislation,¹⁵⁹⁴ as well as the requirement to publish the notice in the local newspaper or newspapers of the area, and radio broadcasting the notice in the relevant area. The notice must be in the language or languages preferred and used in the area, a copy of the notice must be displayed at the municipal offices, and a staff member of the municipality must provide reasonable assistance to members of the community who cannot read or write.¹⁵⁹⁵

In *Bengwenyama Minerals (Pty) Ltd v Genorah Resources (Pty) Ltd*¹⁵⁹⁶ (hereafter the *Bengwenyama* case) the court dealt with a review on the granting of a prospecting right. The question before the court was whether proper consultation had taken place between the mining company and the community.¹⁵⁹⁷ The court examined a number of sections within the MPRDA. In terms of section 10(1) of the MPRDA, the Regional Manager must, after accepting an application for a prospecting right, make known that the application has been received and must request interested parties to submit

¹⁵⁹⁰ Section 16(1).
¹⁵⁹¹ Section 17(2).
¹⁵⁹² Section 17(3) and 18(2)(a).
¹⁵⁹³ Section 21.
¹⁵⁹⁴ Section 21(1).
¹⁵⁹⁵ Section 21(1-5).
¹⁵⁹⁶ 2011 (4) SA 113 (CC).
¹⁵⁹⁷ Paragraph 26.

comments.¹⁵⁹⁸ The Regional Manager must¹⁵⁹⁹ notify the applicant of the prospecting right, in writing, to (i) submit and environmental management plan and (ii) notify and consult with I&APs and submit the result thereof to the relevant Department.¹⁶⁰⁰ The court states that the granting and execution of a prospecting right will have significant impact on the use and enjoyment of land and this directly impacts the rights and interests of I&APs.¹⁶⁰¹ It is therefore imperative to consult with I&APs.¹⁶⁰² The court indicates that the purpose of consultation is to find out "whether an accommodation of sorts can be reached" that acknowledges the impact of prospecting "on the land owner's right to use his land".¹⁶⁰³ While the Act does not require the parties to agree on this (potential impacts on land use), it does expect parties to engage in good faith to attempt reaching some form of agreement.¹⁶⁰⁴ By referring to *Matatiele Municipality v President of the RSA*¹⁶⁰⁵ (hereafter the *Matatiele* case) the court confirms that the concept of consultation in good faith is well-established in South African law.¹⁶⁰⁶ Accordingly, the court acknowledges that landowners need information to enable them to make informed decisions.¹⁶⁰⁷ The provision of necessary information is part of the purpose of public participation and consultation.¹⁶⁰⁸ The consultation process and its result are integral in considering whether the granting of a prospecting right is procedurally fair.¹⁶⁰⁹

In *Earthlife Africa (Cape Town) v Director General Department of Environmental Affairs and Tourism*¹⁶¹⁰ (hereafter the *Earthlife* case), the court made a number of findings on public participation and access to information. This case was based mainly on the regulations prescribing the procedures for the preparation and consideration of environmental impact reports in terms of the *Environmental Conservation Act 73* of

¹⁵⁹⁸ *Bengwenyama* case paras 32 and 62.

¹⁵⁹⁹ In terms of section 10(1)(a) and 10(1)(b) of the Act, read with s 16(4)(b) of the MRPDA.

¹⁶⁰⁰ *Bengwenyama* case para 33. Previously the Department of Mineral Resources, now the Department of Mineral Resources and Energy (DMRE).

¹⁶⁰¹ *Bengwenyama* case para 63.

¹⁶⁰² *Bengwenyama* case para 63.

¹⁶⁰³ *Bengwenyama* case para 65.

¹⁶⁰⁴ *Bengwenyama* case para 65.

¹⁶⁰⁵ 2007 (6) SA 477 (CC) para 66.

¹⁶⁰⁶ *Bengwenyama* case para 65.

¹⁶⁰⁷ *Bengwenyama* case para 66.

¹⁶⁰⁸ *Bengwenyama* case para 66.

¹⁶⁰⁹ *Bengwenyama* case para 66.

¹⁶¹⁰ 2005 (3) SA 156 (C).

1989 (ECA), the predecessor of NEMA.¹⁶¹¹ The court refers to EIA regulation 3(1)(f), namely, "to ensure that all interested parties ... are given the opportunity to participate in all the relevant procedures contemplated in these regulations".¹⁶¹² The court emphasises that public participation is not limited to a specific phase of the EIA process but encompasses all phases thereof.¹⁶¹³ The purpose of public participation is to provide an interested party an opportunity to have a say in the decision-making process.¹⁶¹⁴ In this way, the court indicates that the approach to procedural fairness in respect of public participation should be "generous" and not legalistic.¹⁶¹⁵ The court found that the public participation process was flawed because interested parties were not included in all material phases of the EIA process.¹⁶¹⁶

The court in *Baleni v Minister of Mineral Resources*¹⁶¹⁷ (hereafter the *Baleni* case) dealt with the issue of the "level" of public participation that is required before the granting of a mineral right.¹⁶¹⁸ The court examined what the difference between "consent" and "consultation" within public participation entails.¹⁶¹⁹ The court agrees with the *Bengwenyama* judgement, namely that although "consultation" does not require the reaching of an agreement between the landowner and mining company), it does require active participation in so far as the granting of a prospecting or mining right will likely impact the landowner's right on land use.¹⁶²⁰ In this way consultation is "a process of consensus seeking that may not necessarily result in agreement".¹⁶²¹ The court indicates that "consultation" is reserved for I&APs and that this grouping includes landowners.¹⁶²² This differs from "consent" that is reserved for "communities". Per the MPRDA a "community" is defined as:

¹⁶¹¹ EIA regulations. GN R1183 in GG 18261 of 5 September 1997, as amended. The ECA has largely been replaced by the NEMA (and other SEMAs).

¹⁶¹² *Earthlife* case para 23.

¹⁶¹³ *Earthlife* case para 98.

¹⁶¹⁴ *Earthlife* case para 105.

¹⁶¹⁵ *Earthlife* case para 98.

¹⁶¹⁶ *Earthlife* case para 113.

¹⁶¹⁷ 2019 (2) SA 453 (GP).

¹⁶¹⁸ *Baleni* case para 32.

¹⁶¹⁹ *Baleni* case para 32.

¹⁶²⁰ *Baleni* case para 45.

¹⁶²¹ *Baleni* case para 45 as it refers to the *Bengwenyama* case.

¹⁶²² *Baleni* case para 74.

.. a group of historically disadvantaged persons with interest or rights in a particular area of land on which the members have or exercise communal rights in terms of an agreement, custom or law: Provided that, where as a consequence of the provisions of this act, negotiations or consultations with the community is required, the community shall include the members or part of the community directly affected by mining on land occupied by such members or part of the community.¹⁶²³

Special protection in the form of "consent" as opposed to mere consultation is therefore ascribed to communities.¹⁶²⁴ This speaks to the greater interests of communities with rights in land.¹⁶²⁵ The court continues to motivate this finding by relying on international law, such as the *Convention on the Elimination of All Forms of Racial Discrimination*, that provides communities the right to accept or refuse their free, prior and informed consent to any mining development that will significantly affect them.¹⁶²⁶ For example:

The Committee is conscious of the fact that in many regions of the world indigenous peoples have been, and are still being, discriminated against and deprived of their human rights and fundamental freedoms and in particular that they have lost their land and resources to colonists, commercial companies and State enterprises.¹⁶²⁷

Another applicable example that the court refers to is that of the *International Covenant on Civil and Political Rights* (hereafter the ICCPR) that dealt with a case where an indigenous community (Aymara) was deprived of access to water without prior consent. In this matter the Human Rights Committee stated that it:

... considers that participation in the decision-making process must be effective, which requires not mere consultation but the free, prior and informed consent of the members of the community.¹⁶²⁸

Although there is no expressive provision on free, prior and informed consent within the *African Charter on Humans and Peoples' Rights*, both the Commission on Human and People's Rights and the African Court on Human and People's Rights have

¹⁶²³ *Baleni* case para 66 quotes the definition of "communities" per the MPRDA as amended GN 437 in GG 32151 of 21 April 2009.

¹⁶²⁴ *Baleni* case para 74.

¹⁶²⁵ *Baleni* case para 74 refers to ss 10 and 23(2A) of the MPRDA.

¹⁶²⁶ *Baleni* case para 78.

¹⁶²⁷ *Baleni* case para 78 refers to the *General Recommendation No 23: Indigenous Peoples issued in terms of the Convention on the Elimination of All Forms of Racial Discrimination*.

¹⁶²⁸ *Baleni* case para 81 refers to the *Angela Poma Poma v Peru* case CCPR/C/95/D/1457/2006 that served before the Human Rights Commission in terms of the (ICCPR).

indicated that "no decisions may be made about people's land without their free, prior and informed consent".¹⁶²⁹ The court concludes by confirming the requirement of prior communal consent in instances where land is held on a communal basis.¹⁶³⁰

The South African Human Rights Commission (hereafter the SAHRC) welcomed the findings of the *Baleni* case on meaningful participation.¹⁶³¹ It indicates in its National Investigative Hearing Report on the Underlying Socio-economic Challenges of Mining-affected Communities¹⁶³² (hereafter SAHRC Report) in South Africa that many mining rights issues in South Africa were done without adequate and meaningful participation and consultation.¹⁶³³ The SAHRC emphasises the importance of access of information to communities.¹⁶³⁴ In this context, representative and inclusive platforms are key within any public participation process.¹⁶³⁵ In terms of community consent the SAHRC states that:

... community consent implies that a decision made by the community must be free from any form of manipulation, coercion, or pressure; prior to the commencement of the activity; and with full, detailed and accurate information on the nature and scope of the proposed mining activity.¹⁶³⁶

In the case of *Maledu v Itereleng Bakgatla Mineral Resources (Pty) Limited*¹⁶³⁷ (hereafter the *Maledu* case) the court dealt with issues of consultation and consent in the granting of a mining right in terms of the MPRDA.¹⁶³⁸ Section 10(1) of the MPRDA requires that the Regional Manager must, after accepting an application for a mining right, make it publicly known and invite all interested and affected persons to submit their comments.¹⁶³⁹ Comments and objections received to the mining right application, must, in terms of section 10(2) of the MPRDA, be referred to the Regional Mining

¹⁶²⁹ *Baleni* case para 82.

¹⁶³⁰ *Baleni* case para 83.

¹⁶³¹ SAHRC statement on 26 November 2018.

¹⁶³² SAHRC "National Hearing on the Underlying Socio-economic Challenges of Mining-affected Communities in South Africa" (August 2018).

¹⁶³³ Sections 10(1), 10(2) and 16(4)(b) MPRDA - SAHRC Report 29, 42.

¹⁶³⁴ SAHRC Report 68.

¹⁶³⁵ SAHRC Report 92.

¹⁶³⁶ SAHRC Report 64.

¹⁶³⁷ 2019 (2) SA 1 (CC).

¹⁶³⁸ *Maledu* case para 77.

¹⁶³⁹ *Maledu* case para 77.

Development and Environmental Committee for consideration.¹⁶⁴⁰ The person applying for a mining permit (after being accepted by the Regional Manager) must consult with the landowners, lawful occupiers and any interested and affected persons.¹⁶⁴¹ In addition, the result of the consultation must be included in the environmental reports.¹⁶⁴² The court refers to and quotes sections of the *Bengwenyama* case on (i) the purpose of consultation between parties and (ii) the need for negotiating between parties for some form of agreement in good faith.¹⁶⁴³ The court emphasises that:

... in instances where land is held on a communal basis, affected parties must be given sufficient notice of and be afforded a reasonable opportunity to participate, either in person or through representatives, at any meeting where a decision to dispose of their rights to land is to be taken. And this decision can competently be taken only with the support of the majority of the affected persons having interests in or rights to the land concerned, and who are present at such a meeting.¹⁶⁴⁴

The court hereby confirms that the MPRDA requires proper consultation between the parties.

The importance of public participation is also confirmed in an appeal decision on 21 July 2020 by the Water Tribunal.¹⁶⁴⁵ In this matter, the Water Tribunal set aside a water use licence (WUL) that was granted in terms of section 27 of the NWA to a coal-fired producer (ACWA).¹⁶⁴⁶ The Tribunal confirmed that a party could not rely on a public participation process that had already taken place (i) for another authorisation (namely an environmental authorisation vis-à-vis a WUL) and (ii) that had taken place some six to seven years previously.¹⁶⁴⁷ Notably, the Tribunal indicated that the process for a WUL and for an environmental authorisation is not an integrated process and hence the information within the respective public participation documents (WUL application and environmental authorisation) do not contain the same information

¹⁶⁴⁰ *Maledu* case para 77.

¹⁶⁴¹ Section 16(4)(b) MPRDA.

¹⁶⁴² *Maledu* case para 77.

¹⁶⁴³ *Maledu* case para 78-79.

¹⁶⁴⁴ *Maledu* case para 97.

¹⁶⁴⁵ *The Trustees of the Groundwork Trust v Acting Director-General: Department of Water and Sanitation and ACWA Power, Khanyisa Thermal Power Station (RF) Pty Ltd* (Water Tribunal WT02/18 MP) (hereafter the Water Tribunal).

¹⁶⁴⁶ *Water Tribunal* para 120.

¹⁶⁴⁷ *Water Tribunal* para 138, 140.

available to I&APs.¹⁶⁴⁸ Further, the information provided within the environmental authorisation process preceded the WUL application with some six to seven years.¹⁶⁴⁹ This is problematic because such data is old and therefore does not represent the ever-changing physical environment.¹⁶⁵⁰ The six-year time span is also relevant in the identification of I&APs because during this time it is likely that new or additional I&APs have come to be.¹⁶⁵¹ In short, I&APs cannot make informed decisions and provide comments that are relevant to the WUL within a public participation process based on (i) old data and (ii) based on different information sets and that (iii) omits to identify new I&APs.¹⁶⁵² The decision to grant a WUL was therefore flawed. The Tribunal indicated that a new public participation process is required to rectify the shortcomings of the earlier one.¹⁶⁵³

In the *Border Deep Sea Angling Association v Minister of Mineral Resources and Energy* (hereafter the *Shell* case) an application was made for an interdict prohibiting the use of seismic surveys, which in turn are based on the renewal of an existing exploration right. While the court in this case indicated its reservation on the public participation process following upon the granting of the exploration right, it made no ruling on it.¹⁶⁵⁴ This decision was, however, overturned in two subsequent cases namely, the 2021 *Wild Coast* case¹⁶⁵⁵ and the 2022 *Wild Coast* case.¹⁶⁵⁶

The court in the 2021 *Wild Coast* case (followed from the interdict application in the *Shell* case) confirms the importance of following a proper public participation process.¹⁶⁵⁷ The court stated that although formal procedure was followed in the placing of notices in four newspapers inviting I&APs to register to be part of the consultation process, the two languages used in the notices (English and Afrikaans)

¹⁶⁴⁸ *Water Tribunal* para 138.

¹⁶⁴⁹ *Water Tribunal* para 138.

¹⁶⁵⁰ *Water Tribunal* para 138.

¹⁶⁵¹ *Water Tribunal* para 140.

¹⁶⁵² *Water Tribunal* para 138, 140.

¹⁶⁵³ *Water Tribunal* para 146.

¹⁶⁵⁴ *Shell* case para 29-30. Specifically, the process whereby I&APs were identified.

¹⁶⁵⁵ *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* [2022] 1 All SA 796 (ECG) (hereafter the 2021 *Wild Coast* case).

¹⁶⁵⁶ *Sustaining the Wild Coast NPC v Minister of Mineral Resources and Energy* [2022] 4 All SA 533 (ECG) (hereafter the 2022 *Wild Coast* case).

¹⁶⁵⁷ 2021 *Wild Coast* case para 33-34.

were not the language common to the area.¹⁶⁵⁸ Local languages used by the community in the geographical area are isiZulu and isiXhosa and therefore, the notices should also have been published in those languages.¹⁶⁵⁹ General illiteracy and the use of non-local languages require a different and more inclusive approach to public participation.¹⁶⁶⁰ The court indicated that other forms of notices could or should have been employed such as local radio and newspapers that use isiZulu and isiXhosa languages.¹⁶⁶¹ The local villages, communities and traditional communities had therefore not been properly informed of the consultation process.¹⁶⁶² In addition, the court also ruled that consultation with Kings or traditional leaders of the communities does not constitute proper public participation.¹⁶⁶³ Specifically, it cannot be assumed that Kings speak for all of their subjects.¹⁶⁶⁴ The communities within the geographical area (amaMpondo aseQaukeni) impacted by the exploration right (including seismic surveys) do not fall under the jurisdiction of the Kings and hence consultation with those monarchs do not constitute valid public participation.¹⁶⁶⁵ It is also trite that communities have different customary law rules.¹⁶⁶⁶ The Amadiba community, for example, apply strict rules on consultation whereby consensus-seeking within the community is customary.¹⁶⁶⁷ In other words, top-down decision-making is not part of their customary rules.¹⁶⁶⁸

The 2022 *Wild coast* case ensued from the 2021 case as it dealt with Part B of the interdict application. Based on the same facts the court had to make a ruling on whether the granting of the exploration right (based on the earlier granting of renewal thereof) was lawful. The court referred to previous case law on public participation in terms of the MPRDA (such as the *Bengwenyama* case discussed above). Notably the court confirmed that although the *Bengwenyama* case dealt with public participation

¹⁶⁵⁸ 2021 *Wild Coast* case para 22.
¹⁶⁵⁹ 2021 *Wild Coast* case para 22.
¹⁶⁶⁰ 2021 *Wild Coast* case para 21-22.
¹⁶⁶¹ 2021 *Wild Coast* case para 22.
¹⁶⁶² 2021 *Wild Coast* case para 21-22.
¹⁶⁶³ 2021 *Wild Coast* case para 33-35
¹⁶⁶⁴ 2021 *Wild Coast* case para 25 and 26.
¹⁶⁶⁵ 2021 *Wild Coast* case para 26.
¹⁶⁶⁶ 2021 *Wild Coast* case para 26.
¹⁶⁶⁷ 2021 *Wild Coast* case para 25.
¹⁶⁶⁸ 2021 *Wild Coast* case para 25.

within the context of a prospecting right, the findings could certainly also be applied in other instances, such as an application for an exploration right.¹⁶⁶⁹ The court also provided a description of what a community entails, namely:

For purposes of MPRDA, a community means a group of historically disadvantaged persons with interests or rights in the particular area of land on which the members have or exercise communal rights in terms of an agreement, custom or law: this provided that, where as a consequence of the provisions of this Act, negotiations or consultations with the community is required, the community shall include the members or part of the community directly affected by mining on land occupied by such members or part of the community.¹⁶⁷⁰

Confirming much of the findings of the 2021 case, the 2022 case stresses the shortcomings of the public participation process. These shortcomings include (i) relying on Kings or monarchs who cannot make decisions for their communities without their consensus, (ii) the use of languages not used in the region (including illiteracy and not using local radio stations and local newspapers in local languages), (iii) assuming that community members have access to digital devices (mobile phones, computers) and access to the internet (rural areas), and (iv) not noting that many of the communities did not attend the consultation meetings (this should have raised a red flag to the party leading the consultation process).¹⁶⁷¹

The two rulings made in the 2021 and the 2022 Wild Coast cases confirm that the public participation process should not merely be a tick-box exercise that follows formalistic procedures.¹⁶⁷² A more concerted effort is required to (i) identify all I&APs and (ii) to understand different community aspects in the public participation process.

In *Adams v Minister of Mineral Resources and Energy*¹⁶⁷³ (hereafter the *Adams* case) the court dealt with consultation within the context of an application for a reconnaissance permit.¹⁶⁷⁴ The designated agency on accepting the application is required to notify the applicant in writing to:

¹⁶⁶⁹ 2022 *Wild Coast* case para 98.

¹⁶⁷⁰ 2022 *Wild Coast* case para 93.

¹⁶⁷¹ 2022 *Wild Coast* case para 92, 99, 100, 101.

¹⁶⁷² 2022 *Wild Coast* case para 30.

¹⁶⁷³ *Adams v Minister of Mineral Resources and Energy* (1306/22) [2022] ZAWCHC 24.

¹⁶⁷⁴ Section 74(4)(a) MPRDA.

... consult in the prescribed manner with the landowner, lawful occupier and any interested and affected party and include the result of the consultation in the relevant environmental reports required in terms of Chapter 5 of the National Environmental Act, 1998.¹⁶⁷⁵

The court declared that the consultation process was flawed because the communities and individuals were not properly included in the process.¹⁶⁷⁶ The court stated that proper inclusion of I&APs in this instance required (i) the use of community and commercial radio stations and print media, (ii) the use of the IsiXhosa, English and Afrikaans languages, and (iii) the calling of community meetings.¹⁶⁷⁷ The court also referred to section 24(1)(a) of the NEMA that deals with environmental authorisations that states "[e]very applicant must comply with the requirements prescribed in terms of this Act in relation to ... any procedure relating to public consultation and information gathering".¹⁶⁷⁸

In terms of information-gathering, the court stress the importance of meaningful consultation, particularly in so far as meaningful consultation will identify and address a number of potential community aspects (such as spiritual connection(s) to the geographical area and its resources).¹⁶⁷⁹ Adequate and appropriate consultation within the environmental impact assessment is therefore key in providing the decision-maker with valuable information needed to make a well-informed decision.¹⁶⁸⁰

The legislation as well as the case-law therefore indicates that public participation is clearly recognised and if not properly conducted, the courts are empowered to enforce the participation measures.

5.6 Integration of sources of information and information-gathering tools

Informed decision-making is key to good governance and decisions can only be informed if decision-makers have ready access to accurate, relevant, current and

¹⁶⁷⁵ *Adams* case para 6.

¹⁶⁷⁶ *Adams* case para 14.

¹⁶⁷⁷ *Adams* case para 14.

¹⁶⁷⁸ *Adams* case para 20.

¹⁶⁷⁹ *Adams* case para 35, 48.

¹⁶⁸⁰ *Adams* case para 48.

complete information.¹⁶⁸¹ Access to information is vital for public participation because it enables the public to obtain knowledge about the decision-making process, the relevant facts and the decision to be taken.¹⁶⁸² Without access to information, public participation becomes impossible.¹⁶⁸³ Public participation can only be achieved if IAPs are given access to information.

Section 32 of the Constitution deals with the right of access to information. It states that all people in South Africa (including non-nationals) "have the right of access to any information (i) held by the State and (ii) held by another person that is required for the exercise or protection of any rights".¹⁶⁸⁴ Section 32 further requires that national legislation be enacted to give effect to the right of access to information.¹⁶⁸⁵ The *Promotion of Access to Information Act* 2 of 2000 (PAIA) is the result of the named constitutional requirement. In terms of PAIA people can request information from public and private bodies.¹⁶⁸⁶ A person requesting information must follow the procedures as prescribed in the Act.¹⁶⁸⁷

Section 2(4)(k) of the NEMA (being part of a set of environmental management principles) states that decisions on the environment must be taken in an open and transparent way. Access to information must be provided in accordance with the law.¹⁶⁸⁸ This NEMA principle therefore confirms the vital link between access to information and open and transparent decision-making. The court in *Trustees for the time being of the Biowatch Trust v Registrar, Genetic Resources* (hereafter the *Biowatch* case) dealt with a request for access to information in terms of section 32(1) of the Constitution and the now repealed section 31(1) of the NEMA. The court confirmed that state departments and its agencies should respond adequately to requests of access to information.¹⁶⁸⁹ The court also went on to state that section 32

¹⁶⁸¹ The National Framework for Air Quality Management para 5.2.

¹⁶⁸² Van Bekhoven 2016 *National Taiwan University Law Review* 231.

¹⁶⁸³ Sisilana *Public participation and environmental law* 40-42; 55.

¹⁶⁸⁴ Section 32 of the Constitution.

¹⁶⁸⁵ Section 32(2) of the Constitution. The importance of access to information is also confirmed in s 195(1)(g) of the Constitution. Per s 195(1)(g) the transparency of public administration relies on the provision of timely, accessible and accurate information to the public.

¹⁶⁸⁶ PAIA is enforced by the Information Regulator.

¹⁶⁸⁷ Regulations published in terms of PAIA. See GN R757 in GG 45057 of 27 August 2021.

¹⁶⁸⁸ Section 2(4)(k).

¹⁶⁸⁹ *Biowatch* case para 45.

of the Constitution was intended to encourage the facilitation of transparent and accountable government.¹⁶⁹⁰ Access to information is now regulated via the *Promotion of Access to Information Act 2 of 2000* (PAIA).

The court in *Occupiers of 51 Olivia Road, Berea Township and 197 Main Street Johannesburg v City of Johannesburg* (hereafter the *Occupiers* case) confirmed that the right of access to information in terms of section 32(1) of the Constitution and PAIA placed a duty on the State to engage in a meaningful manner with communities affected.¹⁶⁹¹ Meaningful engagement is qualified as a two-way process between government (departments and its agencies) and the communities involved and therefore access to information is vital for enabling the mentioned two-way process.¹⁶⁹²

The court in *Earthlife* focused on the importance of access to information within the public participation process.¹⁶⁹³ The court confirmed that without access to relevant information, affected parties could not make meaningful representations within the public participation process.¹⁶⁹⁴ This does not mean that an interested party necessarily has a right to all information and material held.¹⁶⁹⁵ Rather, interested parties have a right to information and material that are sufficient to understand the "gist" or substance of a case.¹⁶⁹⁶ In *Company Secretary of Arcelormittal South Africa v Vaal Environmental Justice Alliance*¹⁶⁹⁷, the respondent, requested information from Arcelormittal, which the company refused. The court enforced the respondent's right of access to information and stated that "[c]orporations operating within our borders, whether local or international, must be left in no doubt that in relation to the environment in circumstances such as those under discussion, there is no room for secrecy and that constitutional values will be enforced".¹⁶⁹⁸

¹⁶⁹⁰ *Biowatch* case para 4.

¹⁶⁹¹ *Occupiers* case para 53.

¹⁶⁹² *Occupiers* case para 53.

¹⁶⁹³ *Earthlife* case para 76. For a discussion on public participation see para 5.4 in this chapter.

¹⁶⁹⁴ *Earthlife* case para 76.

¹⁶⁹⁵ *Earthlife* case para 75.

¹⁶⁹⁶ *Earthlife* case para 75.

¹⁶⁹⁷ 2015 (1) SA 515 (SCA); [2015] 1 All SA 261 (SCA). Also see *Biowatch Trust v Registrar, Genetic Resources* 2009 (6) SA 232 (CC).

¹⁶⁹⁸ Paragraph 82.

On informed decision-making, the 2017 *National Framework for Air Quality Management* states that it:

... is fundamental to good governance and decisions can only be informed if decision-shapers and decision-makers have ready access to accurate, relevant, current and complete information. Constructive participation in, and implementation of, air quality management matters are also dependent on the same information.¹⁶⁹⁹

As indicated in Chapter 3 above,¹⁷⁰⁰ the same need applies to the WEF nexus. The Department of Forestry, Fisheries and Environment has several databases with information pertaining to environmental authorisations and the environment in general,¹⁷⁰¹ air quality emission applications,¹⁷⁰² and water use applications.¹⁷⁰³ Similarly, mining applications have to be submitted on SAMRAD.¹⁷⁰⁴ Exploration and production applications made to PASA need to be submitted on the Oil and Gas Application Portal.¹⁷⁰⁵ In addition to this South Africa submits reports in terms of the requirements of the Convention on Biodiversity (hereafter CBD),¹⁷⁰⁶ reports to the UNFCCC,¹⁷⁰⁷ as well as South Africa's progress on the SDGs (and formerly MDGs).¹⁷⁰⁸

¹⁶⁹⁹ The National Framework for Air Quality Management para 5.2.

¹⁷⁰⁰ See Chapter 3 para 3.9.

¹⁷⁰¹ See, for example, Environmental Geographical Information Systems (E-GIS) <https://egis.environment.gov.za/>; National Environmental Web-based Screening Tool <https://screening.environment.gov.za/screeningtool/index.html#/pages/welcome>; Protected Areas Register https://egis.environment.gov.za/protected_areas_register; SAGERS South African Greenhouse Gas Emissions Reporting System <https://ghgreporting-public.environment.gov.za/GHGLanding/SAGERSHome.html>; South African Mineral Resources Administration System (SAMRAD) <https://www.dmr.gov.za/samrad-online-system>; Petroleum Agency of South Africa Geotechnical Data https://geoportal.petroileumagencyrsa.com/Storefront/Viewer/index_map.html; PASA Geoportal <https://petroileumagencyrsa.com/index.php/maps>.

¹⁷⁰² South African Air Quality Information System (SAAQIS) <https://saaqis.environment.gov.za/>.

¹⁷⁰³ Electronic Water Use License Application and Authorisation System (e-wulaas) <http://www.dwa.gov.za/ewulaasprod/house.aspx>.

¹⁷⁰⁴ South African Mineral Resources Administration System (SAMRAD) <https://www.dmr.gov.za/samrad-online-system>.

¹⁷⁰⁵ <https://geoportal.petroileumagencyrsa.com/PortalPASA/CustomHtml.aspx?PageID=d7f3f61d-4689-4280-a59a-b865f002dd60>.

¹⁷⁰⁶ <https://www.cbd.int/countries/?country=za>.

¹⁷⁰⁷ GHG. See e.g. the Draft South Africa's First Nationally Determined Contribution under the Paris Agreement Updated in 2021 that was published for comment – https://www.dffe.gov.za/sites/default/files/reports/draftnationallydeterminedcontributions_2021updated.pdf.

¹⁷⁰⁸ South Africa's most recent scores are available here <https://dashboards.sdgindex.org/profiles/south-africa>. Also see Statssa "Sustainable Development Goals: Country report 2019" http://www.statssa.gov.za/MDG/SDGs_Country_Report_2019_South_Africa.pdf.

While it can be argued that reporting on the SDGs follows some level of information integration it is not true for the rest where reporting remains mainly sector-specific.

In terms of access to information, different phases of the WEF nexus assessment require different kinds of information and data. What is required is solid and precise representation(s) of complexity. Typically, WEF nexus information and data needs straddle temporal and spatial levels across water, energy and food resource systems. While data are needed to foster expert dialogue on best solutions within the WEF nexus, it (data and information) is often not readily available to support integrated qualitative assessments. While the previous versions of hydraulic fracturing regulations provided for access to information, especially regarding the substances added to ensure hydraulic fracturing,¹⁷⁰⁹ the new draft regulations make it an obligation of the holder of the right to report in the post-hydraulic fracturing report what the fluid composition as well as the chemical composition of gases is.¹⁷¹⁰ A reading of the case law predicts that the courts will enforce openness and transparency especially if people's health and well-being and the environment may be impacted upon.

5.7 Flexible approaches, i.e. being able to adapt or adjust when necessary

While environmental legislation in the form of the NEMA,¹⁷¹¹ the NWA¹⁷¹² and the MPRDA¹⁷¹³ provide that authorisations may be revised, adjusted or amended when the circumstances change, it largely remains a discretionary function. Notably such discretion must take place within the respective mandates, otherwise, it will likely be taken on administrative review.¹⁷¹⁴ In this respect section 6(2)(a) of the *Promotion of*

¹⁷⁰⁹ See Du Plessis 2015 *PELJ*.

¹⁷¹⁰ Appendix 2 and 3.

¹⁷¹¹ Section 24N(6).

¹⁷¹² Section 28.

¹⁷¹³ Sections 46, 47, 81 and 85.

¹⁷¹⁴ See e.g. *McDonald v Minister of Minerals and Energy* 2007 (3) SA 642 (C) and *Nature's Choice Properties (Alrode) (Pty) Ltd v Ekurhuleni Metropolitan Municipality* (487/08) 2009 ZASCA.

Administrative Justice Act 3 of 2000 (PAJA) deals with grounds for review to include (i) unauthorised action and (ii) unauthorised delegation of power.¹⁷¹⁵

The dynamic nature of socio-ecological systems infers non-linear impacts and therefore the need for a regulatory framework that responds to change and uncertainty by having adaptive and reflexive qualities.

It can be concluded that while the South African legislation proposes a flexible approach and an ability to adjust when necessary it does not really provide for adaptive capacity as socio-ecological systems and intertwined complex adaptive systems.¹⁷¹⁶

5.8 Inter-governmental cooperation and integrated decision-making

The South African government system is built on the concept of cooperative government as set out in Chapter 3 of the Constitution.¹⁷¹⁷ The principles of cooperative government include that all spheres of government and organs of state must "secure the well-being of the people of the Republic",¹⁷¹⁸ "provide transparent, accountable and coherent government",¹⁷¹⁹ and cooperate with each other.¹⁷²⁰ Cooperation entails, amongst others, that they should assist and support each other, inform each other of matters of common interest (e.g. WEF-related issues), and adhere to agreed procedures. If there is a dispute, the government departments or spheres must take all steps to resolve the conflict.¹⁷²¹ The *Intergovernmental Relations Framework Act 13 of 2005* gives effect to the Constitution.¹⁷²² The Act allows for

¹⁷¹⁵ For example see *McDonald v Minister of Minerals and Energy* 2007 (3) SA 642 (C) and *Nature's Choice Properties (Alrode) (Pty) Ltd v Ekurhuleni Metropolitan Municipality* (487/08) 2009 ZASCA.

¹⁷¹⁶ See Chapter 3.9.

¹⁷¹⁷ *Certification of the Constitution of the Republic of South Africa, 1996* 1996 (4) SA 744 (CC); 1996 (10) BCLR 1253 (CC) paras 287-282.

¹⁷¹⁸ Section 41(1)(b) Constitution.

¹⁷¹⁹ Section 41(1)(c) Constitution.

¹⁷²⁰ Section 41(1)(h) Constitution.

¹⁷²¹ Section 41(3) read with s 41(1)(h)(vi) that states that government must avoid litigating against each other. However, in recent years government was obligated to act against municipalities that do not conform to their constitutional mandate. See e.g. *Member of the Executive Council for Local Government, Environmental Affairs and Development and Development Planning, Western Cape Province v Knysna Municipality* [2023] 3 All SA 531 (WCC).

¹⁷²² Section 41(2) Constitution.

forums of cooperative governance between different spheres of government, as well as in the same sphere of government. It also allows for the appointment of joint technical committees. The Minister published "The Intergovernmental Dispute Prevention and Settlement: Practice Guide: Guidelines for Effective Conflict Management"¹⁷²³ as well as "Implementation Protocol Guidelines and Guidelines for Managing Joint Programmes"¹⁷²⁴ in the *Government Gazette*. Joint programmes include:

- (a) Programmes that require a cross-departmental involvement in the planning, budgeting and delivery of services.
- (b) A number of departments are often responsible for a specific aspect of the programme, but none is responsible for it in its entirety.
- (c) Programmes that require integration rather than mere coordination.

In principle, any programme that wants to achieve WEF nexus governance would fall under the scope of these guidelines. That means that the different role players within government will have to agree on an Implementation Protocol.¹⁷²⁵ Chapter 2 of GN 696 of 2007 provides further guidelines as how to set up the Protocol, for example, by conducting initial scoping studies.

Several of the sector-specific legislation also provides for cooperative governance. It is stated as one of the section 2 NEMA principles.¹⁷²⁶ NEMA further more allows the Minister to establish advisory committees to assist her in her decision-making.¹⁷²⁷ One such committee is the Committee for Environmental Coordination that consists of the directors-general of different government departments with activities that may impact on the environment.¹⁷²⁸ Such a committee could also be used to discuss or decide on how to implement WEF nexus decision-making. During the application for authorisation process, the Ministers responsible for environment and mining may

¹⁷²³ GN 491 in GG 29845 of 26 April 2007.

¹⁷²⁴ GN 696 in GG 30140 of 3 August 2007 in terms of Chapter 3 of the Act.

¹⁷²⁵ Reg 2-3 of GN 696 in GG 30140 of 3 August 2007. An example of the contents of the protocol is to be found in reg 4.

¹⁷²⁶ Section 2(4)(l)-(m) NEMA.

¹⁷²⁷ Section 3A NEMA.

¹⁷²⁸ Also see Du Plessis 2008 *SAPL* 87-110. The Committee was established pre the amendment of the NEMA by *National Environmental Management Amendment Act* 44 of 2008.

furthermore consult with any other organ of state to ensure alignment of the requirements of the applications as well as to avoid duplication.¹⁷²⁹ The Minister may conclude a written agreement with such organ(s) of state.¹⁷³⁰ The competent authority and "any other authority empowered under a specific environmental management Act may agree to issue an integrated environmental authorisation".¹⁷³¹ It is already possible to integrate an environmental authorisation with a WUL, as the NWA is regarded as a SEMA.¹⁷³² It is not necessarily done. Energy authorisations, however, fall under the scope of NERSA, and not the Minister of Mineral Resources and Energy. In order to cooperate within the WEF, other measures will have to be employed. That being said, within the scope of UGD, it would be possible to integrate, again in principle, the exploration or production right with the environmental authorisation.

NEMA, in addition, provides a framework for conflict resolution on difference or disagreements regarding the protection of the environment.¹⁷³³ The Minister, MEC or Municipal Council may refer difference or disagreement issues for mediation or conciliation.¹⁷³⁴ Referral of such an issue for conciliation must be directed to either the Director-General or an appointed conciliator.¹⁷³⁵ Notably, anyone may request the Minister, MEC or Municipal Council to (i) call for a public meeting with IAPs and (ii) appoint a facilitator to conduct said meeting with the aim of reaching an agreement.¹⁷³⁶ A report from the conciliator detailing the result from a conciliation process must be made available to the public.¹⁷³⁷ This includes (i) information on the agreement reached or (ii) where an agreement could not be reached, then the recommendations and reason therefore.¹⁷³⁸

The proposed regulations pertaining to the exploration and production of onshore oil and gas requiring hydraulic fracturing¹⁷³⁹ issued in terms of the MPRDA, state as its

¹⁷²⁹ Section 24K(1) NEMA.

¹⁷³⁰ Section 24K(2) NEMA.

¹⁷³¹ Section 24L(1) NEMA.

¹⁷³² Section 1 NEMA.

¹⁷³³ Section 17.

¹⁷³⁴ Section 17(1)(a-b).

¹⁷³⁵ Section 17(1)(b)(i).

¹⁷³⁶ Section 17(2).

¹⁷³⁷ Section 18(7).

¹⁷³⁸ Section 18(7)(b-d).

¹⁷³⁹ GN 2273 in GG 47112 of 11 July 2022.

goal to give effect to coordination between the different departments when the baseline monitoring takes place, for "environmental assessments, ... and environmental monitoring for the heritage resources permit, water use licence, environmental authorisation" and the exploration and production right through minimum information requirements. The timeframes for the applications for the different authorisations should be coordinated as well as the decision-making and the conditions set in the authorisations.¹⁷⁴⁰ The draft regulations furthermore ensure that the Minister of Water and Sanitation is involved in various stages of the hydraulic fracturing process in relation to water quality and possible water pollution.¹⁷⁴¹

Another measure that provides for cooperative governance is the *Disaster Management Act* 57 of 2002 that provides for the establishment of disaster management centers at the different spheres of government. These centers must ensure a coordinated response to disasters, address emergency preparedness and also mitigate the impacts of the disaster. The Act defines a disaster as including damage to the environment.¹⁷⁴²

The NEMPA requires consultation between all the national departments, provincial departments, and the local government (local municipality) likely to be affected by a notice on the declaration of a nature reserve or protected environment.¹⁷⁴³ The Act provides for co-management of an area in the form of an agreement between the management authority, another organ of state, a local community, an individual or another party.¹⁷⁴⁴

As the title of the *Marine Spatial Planning Act* 16 of 2008 indicates, its focus is on marine spatial planning and therefore not specifically applicable to onshore UGD. The Act does however incorporate a number of relevant WEF nexus elements and is therefore relevant to this study. There is no explicit reason why the workings of this

¹⁷⁴⁰ Regulations 2(f) and 6(h).

¹⁷⁴¹ E.g. regulations 16 and 20. Appendix 2 sets out the information that the holder of the right must compile as a post hydraulic fracturing report and to be submitted to the Minister of Water and Sanitation.

¹⁷⁴² Section 1.

¹⁷⁴³ Section 32(1)(a-b).

¹⁷⁴⁴ Section 42(1)(a). The management plan may include other development activities within and adjacent to the protected area in terms of the applicable IDF. See S 41(3)(a).

Act cannot be used a marker on onshore spatial planning. It makes provision for a number of committees across a number of government departments. It has a national working group that consists of officials nominated from government departments that include energy, environmental affairs, mineral resources, fisheries, planning; monitoring and evaluation, science and technology, rural development and land affairs.¹⁷⁴⁵ The working group is responsible for developing a draft spatial planning framework by taking into account relevant factors.¹⁷⁴⁶ These factors are numerous and include, among others, spatial data of different sector users, compatible and incompatible uses, synergies among compatible users, analysis of emerging uses, environmental change impacts, current uses, activities and pressures for change, future uses and potential for all sectors, shared environmental, social, cultural and economic values.¹⁷⁴⁷ The working group is required to make a recommendation to the Directors-General Committee on ways to resolve user conflicts and trade-offs.¹⁷⁴⁸ The Directors-General Committee consists of Directors-General from the same departments that make up the national working group.¹⁷⁴⁹ This committee is required to consider the spatial planning framework (including possible recommendations) received from the working group.¹⁷⁵⁰ After consideration of the spatial planning framework, the Directors-General Committee is required to approve and refer it to the Ministerial Committee.¹⁷⁵¹ The Ministerial Committee mirrors the government departments found within the working group and the Directors-General Committee.¹⁷⁵² Notably, the Ministerial Committee must ensure cooperation between the different sector departments and resolve user conflicts and trade-offs.¹⁷⁵³ This is a good example where cooperative government is expressly provided for.

Similar structures are to be found in the *Climate Change Bill*. One of the objectives of the Bill is "to - (a) provide for a coordinated and integrated response by the economy

¹⁷⁴⁵ Section 9(1)(a).
¹⁷⁴⁶ Section 9(2)(a).
¹⁷⁴⁷ Section 9(2)(b)(i-xvii).
¹⁷⁴⁸ Section 9(3)(b).
¹⁷⁴⁹ Section 10(1).
¹⁷⁵⁰ Section 10(6)(a).
¹⁷⁵¹ Section 10(6)(a).
¹⁷⁵² Section 10(1).
¹⁷⁵³ Section 6(a-b).

and society to climate change and its impacts in accordance with the principles of cooperative governance".¹⁷⁵⁴ In order to achieve this the Bill aims to establish various forums such as Provincial Forums on Climate Change,¹⁷⁵⁵ Municipal Forums on Climate Change,¹⁷⁵⁶ and formalising the Presidential Commission on Climate Change.¹⁷⁵⁷ The provincial and municipal forums must coordinate climate change responses in their areas of jurisdiction while the Commission advises the President on long-term adaptation and mitigation as well as monitoring and evaluating government's achievement of its own goals.¹⁷⁵⁸

The object of CARA is the conservation of the country's natural agricultural resources. Emphasis is on maintaining the agricultural production potential of land. Article 3 of CARA states that "the objects of the Act are to provide for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land, by the combatting and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants". Natural agricultural resources per the Act includes the soil, the water sources and the vegetation.¹⁷⁵⁹ The Minister may establish a conservation committee to assist with the (i) promotion of conservation of natural agricultural resources and (ii) provision of advice.¹⁷⁶⁰ The Minister is responsible for selecting members of the conservation committee. Members of the conservation committee are selected based on their knowledge of and interest in the conservation of the natural agricultural resources. The members consist of two land users selected by the Minister and at least three additional members that are nominated by the farmers' association, farmers' union or district agricultural union (as the case may be for the specific area).¹⁷⁶¹ This points to the inclusion of people in the form of land

¹⁷⁵⁴ Clause 2(a).

¹⁷⁵⁵ Clause 8.

¹⁷⁵⁶ Clause 9.

¹⁷⁵⁷ Clause 10.

¹⁷⁵⁸ Clause 11.

¹⁷⁵⁹ Section 1.

¹⁷⁶⁰ Section 15(1-2).

¹⁷⁶¹ Section 15(3)(a-b).

users who have practical everyday knowledge of possible water, energy and food interconnections and trade-offs.

In order to assist the multiple conservation committees within any region, the Minister may also establish a regional conservation committee.¹⁷⁶² Members of the regional conservation committee are appointed by the Minister and while it consists of a regional director, an officer of the department and two representatives from each particular area within the region (i.e. a subregion of that region) it also allows for one representative of each provincial agricultural union (from the area that forms part of the region concerned).¹⁷⁶³ The presence of representative(s) from a provincial agricultural union within a regional conservation committee, confirms, as is the case with conservation committees, the inclusion of people who have practical everyday knowledge of possible water, energy and food interconnections and trade-offs.

In terms of section 17 of CARA, an advisory board, namely the Conservation Advisory Board, advises the Minister on any matter that are applicable to achieving the objectives of the Act or any matter which the Minister may deem necessary.¹⁷⁶⁴ The members of the advisory board are appointed by the Minister and include, among others, an officer from the DFFE.¹⁷⁶⁵ This points to possible cooperation between the departments of agriculture and DFFE.

There are various additional inter-governmental structures to ensure cooperative governance.¹⁷⁶⁶ On the executive level cabinet cluster-committees and on provincial level there is, for example, a MINMEC on environment.¹⁷⁶⁷ On the administrative or departmental level, Directors-General Cabinet Cluster Committees, and on provincial level MINTEC: Environment. In the case of air quality, specific, additional committees ensure cooperative governance, namely the National Provincial Air Quality Officer Forum and the Municipal Air Quality Officer Forum, which all culminate in an Annual

¹⁷⁶² Section 16(1).

¹⁷⁶³ Section 16(3)(a).

¹⁷⁶⁴ Section 17.

¹⁷⁶⁵ Section 17(3)(a)(1-iv).

¹⁷⁶⁶ Also, see Du Plessis 2008 *SAPR/PL* 87-110; Du Plessis (ed) *Environmental Law and Local Government in South Africa* Chapter 11.

¹⁷⁶⁷ 2017 National Framework for Air Quality Management para 4.4.

National Air Quality Governance Lekgotla.¹⁷⁶⁸ Similar structures or the same structures could be used to also consider matters related to water, energy and food, or optionally their scope of work could be broadened.

The Constitution and various Acts provide for cooperative government and cooperative governance. This concept is well entrenched in South African law. There is not currently a joint committee or forum that specifically focuses on the WEF nexus and less so in relation to UGD. If WEF nexus governance is to be introduced in South Africa, the only way will be so that government and organs of state, work together (also with the private sector) to achieve this.

5.9 Integration on a policy and regulation level

An example of integration on a policy and regulation level is the action plan to address the energy crisis in the country that also specifically relates to UGD.¹⁷⁶⁹ The plan "Confronting the Energy Crisis: An Action Plan to End Load Shedding" indicates that it will, among other interventions, accelerate procurement of new energy capacity from gas, namely some 3000 MW (both onshore and off-shore gas).¹⁷⁷⁰ The action plan establishes a dedicated National Energy Crisis Committee (NECOM) that straddles all government departments and includes the departments responsible for water, energy and the environment.¹⁷⁷¹ The inclusion of all government departments seems to imply that they are required to work together and coordinate their efforts to procure energy capacity from gas.

An update on the "Energy Action Plan" was published in January 2023 and from this, it is clear that the authorisation process for energy projects (including gas) has been streamlined to include:

¹⁷⁶⁸ 2017 National Framework for Air Quality Management para 4.4 and figure 2.

¹⁷⁶⁹ See President Ramaphosa's address to the nation on 25 July 2022 and the subsequent publishing of the plan "Confronting the Energy Crisis: An Action Plan to End Load Shedding". https://www.gov.za/sites/default/files/gcis_document/202207/confronting-energy-crisisan-action-plan-end-load-shedding.pdf.

¹⁷⁷⁰ Confronting the Energy Crisis at 4 and 10.

¹⁷⁷¹ Confronting the Energy Crisis at 10.

- exempting transmission infrastructure development from obtaining an environmental authorisation in areas where the environmental impact is low;
- reducing the timeframes of environmental authorisations for projects on energy that are identified and gazetted as Strategic Infrastructure Projects; and
- reducing the time frame for land-use authorisations of energy projects.¹⁷⁷²

Although these actions (above) point to coordination between some of the government departments, there is little, if any, evidence that water and food (agriculture) are linked to energy.

Another example can be found in the NCCR-WP that states "an effective response to climate change requires national policy to ensure a coordinated, coherent, efficient and effective response to the global challenge of climate change".¹⁷⁷³ This implies that water, energy and food policies need to acknowledge the need for integrated policies and planning in relation to one other, but also in relation to climate change.¹⁷⁷⁴ The *Climate Change Bill* foresees that the Minister will publish a National Adaptation Strategy and Plan,¹⁷⁷⁵ to provide "an integrated and coordinated approach" that includes all spheres of government as well as the private sector, non-governmental organisations and communities.¹⁷⁷⁶

The NDP acknowledges that climate change (in the form of droughts and flooding) has the potential to reduce food production (food security) and the availability of potable water (water security).¹⁷⁷⁷ It does not seem to include energy security within the ambit of climate change risks. The National Planning Commission declared its willingness to assist the Department of Energy to achieve more holistic and integrated

¹⁷⁷² Energy Action Plan - Six Month Update: January 2023 at 3.

¹⁷⁷³ Paragraph 1.

¹⁷⁷⁴ Paragraph 5 where the mainstreaming of climate change into all policies and planning is proposed.

¹⁷⁷⁵ Clause 18.

¹⁷⁷⁶ Clause 18(4)(e).

¹⁷⁷⁷ NDP 33.

policy outcomes.¹⁷⁷⁸ This is based on the recognition that cross-cutting issues (spatial planning, governance, regulation, linkages to water, infrastructure and socio-economic and environmental impacts) need to be addressed.¹⁷⁷⁹ The Commission indicated its value in this regard as a potential facilitator between relevant stakeholders.¹⁷⁸⁰ While this points to a willingness (at last from the Commission) for policy integration, there are no further details (how, when, stakeholders involved, etcetera) on named policy integration.

The National Policy on Food and Nutrition Security, 2013 states that food security:¹⁷⁸¹

...requires well-managed inter-sectoral co-ordination, and the genuine integration of existing policies and programmes in health, education, and environmental protection, as well as in agrarian reform and agricultural development.

While the need for coordination and integration is clearly indicated in South African policies, no direct link has been made to water and energy specifically.

5.10 Integration of multiple governance tools

The integration of multiple governance tools is relevant in integrated environmental management.¹⁷⁸² South African environmental legislation includes numerous environmental management tools. Various typologies can be followed to categorise these tools.¹⁷⁸³ Nel, Du Plessis and Du Plessis developed a structure for governing-based local environmental governance instrumentation that can also apply to UGD. These include command and control-based instruments, incentive and disincentive-based instruments, agreement-based instruments and civil-based instruments.¹⁷⁸⁴ Command and control instruments in relation to UGD would, for example, include

¹⁷⁷⁸ NDP 174.

¹⁷⁷⁹ NDP 174.

¹⁷⁸⁰ NDP 174.

¹⁷⁸¹ Section 4 NPFNS.

¹⁷⁸² See Nel and Alberts "Environmental management and environmental law in South Africa" 1-55; Nel, Du Plessis and Du Plessis "Instruments for local environmental governance" Chapter 3; Du Plessis and Nel "Driving compliance to and enforcement of South African legislation" 259-285; Kidd, Retief and Alberts "Integrated environmental assessment and management" 1213-1277.

¹⁷⁸³ See Nel and Alberts "Environmental management and environmental law in South Africa" Chapter 1; Nel, Du Plessis and Du Plessis "Instruments for local environmental governance" Chapter 3.

¹⁷⁸⁴ Nel, Du Plessis and Du Plessis "Instruments for local environmental governance" para 3.4.3.

offences and fines,¹⁷⁸⁵ the appointment of environmental mineral inspectors,¹⁷⁸⁶ the issuing of directives,¹⁷⁸⁷ compliance notices,¹⁷⁸⁸ inspections,¹⁷⁸⁹ reporting,¹⁷⁹⁰ monitoring¹⁷⁹¹ and auditing¹⁷⁹² as well the award of damages in case of a spill or pollution.¹⁷⁹³

Incentive based instruments will, for example, refer to tax incentives for the installation of renewable energy and the rehabilitation of land,¹⁷⁹⁴ while disincentives could include the waste discharge system fees¹⁷⁹⁵ and carbon tax.¹⁷⁹⁶

Agreement-based instruments include, for example, environmental cooperation agreements, whereby government and industry or a private person can come to an agreement to improve on the standards laid down by law and set measurable targets to fulfil the undertaking, as well as to include procedures for monitoring, reporting and independent verification.¹⁷⁹⁷ The agreement must also set out the penalties for non-compliance.¹⁷⁹⁸ It would be possible, for example, in the case of UGD to compose such an agreement to indicate that all aspects related to the WEF nexus, will be adhered to. The MPRDA makes provision for technical cooperation agreements that could be composed to assist in the search for, for example, gas fields.¹⁷⁹⁹ The agreements are

¹⁷⁸⁵ E.g. s 151 NWA, ss 49A and 49B NEMA and 98 and 99 MRDA, and the proposed hydraulic fracturing regulations - reg 23-24 GN 2273 in GG 47112 of 11 July 2022.

¹⁷⁸⁶ Section 31BB NEMA.

¹⁷⁸⁷ See e.g. S 28 NEMA, s 19 NWA, s 45 MRPDA.

¹⁷⁸⁸ Sections 31L-31N NEMA. Also, see Feris 2006 *PELJ* 52-70.

¹⁷⁸⁹ E.g. Reg 8 GN 2273 in GG 47112 of 11 July 2022.

¹⁷⁹⁰ E.g. Reg 9(4) GN 2273 in GG 47112 of 11 July 2022 (reporting on the gas well).

¹⁷⁹¹ E.g. Reg 7(3) and (6) of GN 2273 in GG 47112 of 11 July 2022 – requires continuing monitoring of impacts against the baseline report and reg 20 post-decommissioning monitoring.

¹⁷⁹² See e.g. GN R982 in GG 38282 of 4 December 2014, as amended.

¹⁷⁹³ See e.g. s 32 NEMA and s 153 NWA.

¹⁷⁹⁴ See e.g. ss 12B (relate to renewable energy), 12B (pipelines), 12L (energy efficiency savings), 12R and 12S (special economic zones), 15 and 15A (mining), 26B (taxation of oil and gas companies), 37B (deductions in respect of environmental expenditure), 37C (deductions in respect of environmental conservation and maintenance) *Income Tax Act* 58 of 1962.

¹⁷⁹⁵ GN 1353 in GG 20615 of 12 November 1999. Also see Pegram, Weston and Reddy 2014 *Water Practice and Technology* (2014) 125–134; Kotzé and Bosman 2006 *Obiter* 128-145.

¹⁷⁹⁶ See *Carbon Tax Act* 15 of 2019 that will apply to the potential emission of methane gas by UGD.

¹⁷⁹⁷ Section 35 NEMA, also see Fischer "Environmental management co-operative agreements: a contribution to pollution prevention in South Africa"; Scholtz 2004 *SAJELP* 183-194.

¹⁷⁹⁸ Section 35(3)(d) NEMA.

¹⁷⁹⁹ Section 76 MRPDA.

followed by a technical cooperation permit, signifying that they are approved by government.

In the case of civil-based instruments a distinction can be made between structural instruments, procedural instruments and rights-based instruments. Structural instruments provide for cooperation between government departments as well as between government and the public.¹⁸⁰⁰ Procedural instruments relate to public participation,¹⁸⁰¹ civil action and private prosecution,¹⁸⁰² alternative dispute resolution,¹⁸⁰³ as well as access to information.¹⁸⁰⁴

It is not only necessary that legislation integrate various environmental management instruments, but it is also necessary to investigate if these instruments investigate water-energy and food-related issues integrally. In order to do so, some of the policy and environmental instruments, not referred to earlier, will be provided as examples.

The NEMAQA recognises that air quality may lead to ecological degradation and therefore measures should be implemented to protect air quality.¹⁸⁰⁵ The 2017 National Framework for Air Quality Management accordingly stated that a holistic approach is necessary, as air pollution does not know boundaries. It affects people at a local, regional and even at an international level.¹⁸⁰⁶ It may have an impact on soil, water quality and people's health too.¹⁸⁰⁷ The Framework suggests different technical tools that could achieve integrated air quality management. Section 21 of the NEMAQA allows the Minister to list activities that cause air pollution or emissions that may impact on the "environment, including health, social, economic and ecological

¹⁸⁰⁰ See para 5.8 on cooperative government instruments.

¹⁸⁰¹ See para 5.5 above.

¹⁸⁰² Section 33 NEMA, also see *Uzani Environmental Advocacy CC v BP Southern Africa (Pty) Ltd* [2019] 2 All SA 881 (GP); 2019 (5) SA 275 (GP); Rantlo and Viljoen 2020 *Impact Assessment and Project Appraisal* 441-445.

¹⁸⁰³ Sections 17-22 NEMA (conciliation, arbitration, investigation, commissions); also see Couzens and Dent 2006 *PELJ* 1-51.

¹⁸⁰⁴ Section 32 Constitution and PAIA. See para 5.6 above.

¹⁸⁰⁵ Section 2(a)(i)-(ii) NEMAQA.

¹⁸⁰⁶ 2017 National Framework for Air Quality Management in the Republic of South Africa - GN 1144 in GG 41996 of 28 October 2022 para 2.2.1 and 2.2.3.

¹⁸⁰⁷ Government of Canada <https://www.canada.ca/en/environment-climate-change/services/air-pollution/quality-environment-economy/ecosystem/effects-soil-water.html>; Fisher "Air Pollution and Development in Africa: Impacts on Health, the Economy and Human Capital" 18.

conditions, or cultural heritage".¹⁸⁰⁸ The listed activities also include the applicable norms and standards.¹⁸⁰⁹ The applicant for the licence must do an atmospheric impact assessment that takes all of these issues into account¹⁸¹⁰ – therefore ensuring some form of integrated decision-making, similar to the NEMA authorisation.¹⁸¹¹ The NEMAQA makes specifically the section 2 NEMA principles and its section 24 applicable to atmospheric emission licences.¹⁸¹²

Section 2 of the *National Energy Act* 34 of 2008 refers to a number of objectives of the act. Notably it states that the objectives of the act to: "provide for certain ... health and environment matters that pertain to energy".¹⁸¹³ This objective is elaborated on in section 4 of the act where it states:

The Minister may, after consultation with the Minister of Trade and Industry, the Minister of Labour and the Minister of Environmental Affairs and Tourism, adopt measures not contemplated in any other legislation, to minimise the negative ... health and environmental impacts of energy carriers.¹⁸¹⁴

Health and environmental matters necessarily include air quality, water quality and the availability of water resources. Air quality is directly linked to climate change impacts. Water quality and water availability in turn are linked to climate change. The reference to water and food in section 4 of the Act is indirect at best. Further, the objective of minimising negative health and environmental impacts emanating from energy carriers, is not compulsory.¹⁸¹⁵ Per the wording of section 4, "[t]he Minister may after consultation" ... confirms the optional status of this objective. In addition, while section 4 refers to optional consultation between a number of government departments, only the Department of Forestry, Fisheries and the Environment deals

¹⁸⁰⁸ Section 39(b)-(c) read with 36(6)-(7) NEMAQA; also see 2017 National Framework for Air Quality Management para 3.2.1.

¹⁸⁰⁹ Listed Activities and Associated Minimum Emission Standards Identified in terms of s 21 of the *National Environmental Management: Air Quality Act* 39 of 2004 - GN 893 in GG 37054 of 22 November 2013.

¹⁸¹⁰ Regulations Prescribing the Format of the Atmospheric Impact Report - GN 747 in GG 36904 of 11 October 2013.

¹⁸¹¹ See paras 4.6- 4.7.

¹⁸¹² Sections 38(2), 39(d) and 40 make section 24 of the NEMA applicable to the NEMAQA and therefore its regulations that follow a more integrated approach to the environment, including the socio-economic and cultural environment.

¹⁸¹³ Section 2(h).

¹⁸¹⁴ Section 4.

¹⁸¹⁵ Section 4.

with water and air quality aspects. Notably, there is no reference to agriculture and or food security. Section 5 refers to measures that must be used to secure access of energy. These measures must take account of health and environmental impacts.¹⁸¹⁶ Section 6 states that the IEP must account for the environment.¹⁸¹⁷ Further, the IEP must take into account plans relating to water and air quality including GHG mitigation.¹⁸¹⁸ Further, the IEP must inform and be informed by plans from all sectors whose plans impact on or are impacted by the IEP.¹⁸¹⁹ This points to the inclusion of water and food/agriculture sectors. The development of the IEP must take into account environmental and health impacts.¹⁸²⁰ The IEP must also account for the "developmental requirements" of the Southern African region.¹⁸²¹ This arguably includes agriculture and therefore food security.

5.11 Provision for strategic planning and reporting

The *Climate Change Bill*'s National Adaptation Strategy and Plan referred to above, is the most ambitious cooperative strategy and plan thus far. It could be considered to also include matters related to the WEF nexus, as Departments also have to include Sector Adaptation Strategy and Plans.¹⁸²² The strategy and plans should identify areas that are subject to climate change risks and vulnerability, ecosystems and communities as well as the mechanisms of how this will be addressed. The Departments are listed in Schedule 2 of the Bill and include amongst others, Agriculture; Forestry, Fisheries and Environment; Energy; Health; Human Settlements; Science and Technology; and Water and Sanitation. While all of the plans and strategies should in principle, also have to relate to each other, there is no express provision for this to be done. There might be a need to add the departments related to water, energy and food as this at least should ensure that there is a WEF nexus.

¹⁸¹⁶ Section 5(2)(a).
¹⁸¹⁷ Section 6(2)(g).
¹⁸¹⁸ Section 6(3)(a).
¹⁸¹⁹ Section 6(3)(b).
¹⁸²⁰ Section 6(4)(e).
¹⁸²¹ Section 6(4)(f).
¹⁸²² Clause 19.

There are strategic documents for almost every department and sector. The aim of strategic planning is to plan for the future. However, it is not clear whether these documents link and coordinate with one another. For example, the NDP states that in order to deal with cross-cutting issues (such as spatial planning, institutional capacity, governance, regulation, and linkages to water, infrastructure, social, economic and environmental impacts), the country's approach to energy planning needs to become more holistic and integrated.¹⁸²³ However, apart from the Commission's availability to act as facilitator between stakeholders, there are no further details on provision for strategic planning. The NDP's guiding principles on environmental sustainability and an equitable transition to a low-carbon economy confirm the need for strategic planning by way of a systemic approach that is responsive to risk by being able to identify and manage trade-offs.¹⁸²⁴

The NDP refers to the need to improve policy coordination.¹⁸²⁵ This resulted in a number of consultations on policy coordination issues within government departments during 2017-2018.¹⁸²⁶ Findings from these consultations indicated that policy-making in national government departments lacked a central policy-coordinating mechanism.¹⁸²⁷ This resulted in the National Policy Development Framework (NPDF) that aims to guide all government departments on policy coordination (across national, provincial and local government spheres).¹⁸²⁸ The NPDF recognises that by following a de-centralised approach to policy making, the different national government departments and their branches and or directorates are making their own policy.¹⁸²⁹ This is problematic because it leads to a lack of policy coordination as well as contradictions (i.e. duplication and complexity).¹⁸³⁰

¹⁸²³ NDP 174.

¹⁸²⁴ NDP 200.

¹⁸²⁵ NDP at 212-213.

¹⁸²⁶ NPDF at 6.

¹⁸²⁷ NPDF at 6.

¹⁸²⁸ The NPDF was approved by Cabinet on 2 September 2020. It is to be reviewed in the fifth year of implementation.

¹⁸²⁹ NPDF at 6.

¹⁸³⁰ NPDF at 6.

5.12 The capacity to introduce new projects and programmes (training)

The legislation does not necessarily address this aspect specifically. However, any new project or programme may be subject to a strategic environmental assessment¹⁸³¹ as was done in the case of UGD in the Karoo.¹⁸³² If the new project falls under the scope of any of the listed activities of the NEMA, NEMAQA and NEMWA, a basic assessment or an EIA will have to be undertaken. According to the NEMA regulations, one of the things that an environmental assessment practitioner has to report on is the use of alternative methods and technologies. The environmental assessment practitioner must indicate which alternative technologies are available and what their potential impact would be. This has, however, become a tick-list exercise more than a weighing-up or comparing of alternatives.

The 2007 *National Industrial Policy Framework* acknowledges the need for innovation and technology, but it does not further elaborate in this regard.¹⁸³³ The *Framework* refers to the role that non-traditional agricultural and mining activities could play in this regard.¹⁸³⁴ It is, however, not clear if the non-traditional mining activities refer to UGD. It also does not refer to the possible impacts of industrialisation.

The Framework was followed by reiterations of implementation plans, with the most recent the *Industrial Policy Action Plan IPAP 2016/17 – 2018/19* (referred to as IPAP2019).¹⁸³⁵ IPAP2019 refers to IPAP2016¹⁸³⁶ that emphasises beneficiation and resource diversification and specifically "to strengthen the *vital economic linkages between the primary agriculture, mining and manufacturing sectors of the economy* in order to secure greater downstream beneficiation and maximise upstream linkages".¹⁸³⁷ The IPAP2016 was based on (i) gas-based industrialisation, whereby LNG will be imported from international markets (includes, the importation of gas from

¹⁸³¹ Section 1 read with s 24(5)(bA)(ii) NEMA.

¹⁸³² See para 3.9. Also see Humby "Environmental assessment of shale gas" 86-117.

¹⁸³³ Paragraph 14.

¹⁸³⁴ Paragraph 1.1.7.

¹⁸³⁵ Department of Trade and Industry "Industrial Policy Action Plan IPAP 2016/17 – 2018/19" (IPAP 2019).

¹⁸³⁶ Department of Trade and Industry "Industrial Policy Action Plan 2015" (IPAP 2016).

¹⁸³⁷ IPAP 2019 at 6, 12-14.

Mozambique) and (ii) the projection that South Africa will be able to supply its own gas in the long-term.¹⁸³⁸

The IPAP2019 states:

(if this proves to be both commercially and ecologically viable), leveraging the very large indicative reserves of shale gas in the Karoo basin to transform South Africa into a significant producer of natural gas in its own right – with enormous potential effects for industrialisation.¹⁸³⁹

The Department of Trade and Industry continues with this vision in IPAP2019.¹⁸⁴⁰ New mechanisms and ways had to be found to introduce new infrastructure. The *Special Economic Zones Act* 16 of 2014 and the *Infrastructure Development Act* 23 of 2014¹⁸⁴¹ can be regarded as such measures.

The concept of special economic zones has at its core to address spatial apartheid and to "agri-park development and industrial revitalisation" and regional economic clusters.¹⁸⁴² The *Special Economic Zones Act* targets special economic activities and introduces several tax incentives.¹⁸⁴³ The aims of special economic zones¹⁸⁴⁴ include, amongst others, to develop infrastructure that can support certain industrial activities.¹⁸⁴⁵ This links to IPAP2019 that indicates that the exploration of gas may achieve this. Another aim is to enable the beneficiation of South Africa's natural resources, which include gas.¹⁸⁴⁶ It is also foreseen that special economic zones will promote regional development and generate new and innovative economic activities.¹⁸⁴⁷ The idea is to bring economic and social benefits to the people living in or near these special economic zones; in this technology and a skills-transfer must take place.¹⁸⁴⁸ The Act indicates the cooperation of the DFFE and labour departments

¹⁸³⁸ IPAP 2016 at 128.

¹⁸³⁹ IPAP 2019 at 7.

¹⁸⁴⁰ IPAP 2019 at 36-38.

¹⁸⁴¹ Also see 5.12.

¹⁸⁴² IPAP 2019 at 5-6, 30.

¹⁸⁴³ SA Government <https://www.gov.za/faq/finance-business/what-special-economic-zone-south-africa-and-how-can-it-benefit-my-business>.

¹⁸⁴⁴ Designation takes place in terms of ss 23-30.

¹⁸⁴⁵ Section 4.

¹⁸⁴⁶ Section 4(2)(e).

¹⁸⁴⁷ Section 4(2)(g).

¹⁸⁴⁸ Section 4(2)(h).

but it does not refer to the specific departments responsible, whether mining, agriculture or water.¹⁸⁴⁹ It states that the implementation protocol may provide for a one-stop shop for authorisations.¹⁸⁵⁰ The Department of Trade and Industry already introduced such an Energy-One Stop Shop portal for energy applications.¹⁸⁵¹ This is in line with the Presidential Energy Action Plan.¹⁸⁵²

The designation of some of these special economic zones is not without controversy. The recent Musina-Makhado Special Economic Zone,¹⁸⁵³ for example, is challenged in court in relation to its environmental authorisation process.¹⁸⁵⁴ Some allegations regarding corruption were also raised in the press.¹⁸⁵⁵ It seems that more oversight is necessary when new projects and programmes are introduced.

The *Infrastructure Development Act* as stated before,¹⁸⁵⁶ provides for the introduction of strategically integrated projects of social and economic importance,¹⁸⁵⁷ which according to Schedule 1 may include pipelines (also gas pipelines) and "installations for harnessing any source of energy" (which may imply reference to UGD).

As hydraulic fracturing has so many potential impacts,¹⁸⁵⁸ perhaps consideration should be given to a one-stop shop for UGD developments, taking into account all the relevant government department and spheres that would have to issue authorisations, ranging from agriculture, water and sanitation, environment, forestry and fisheries, to

¹⁸⁴⁹ Section 22.

¹⁸⁵⁰ Section 22(2). Also see Le Roux 2016 *Journal of Economic and Financial Sciences* 749-768; Parliamentary Monitoring Group <https://pmg.org.za/committee-meeting/29805/>; Mackay *Engineering News* 27 October 2023; Kotzé *et al* 2007 *SAJELP* 53-82.

¹⁸⁵¹ InvestSA <http://energyoss.gov.za/>.

¹⁸⁵² The Presidency Republic of South Africa "Confronting the Energy Crisis: An Action Plan to end Load Shedding" (2019), stating that a "number of measures are already in place to accelerate these projects, including:

- Embedded generation projects have been declared as Strategic Infrastructure Projects (SIPs), shortening the timeframes for environmental authorisations, water use licenses and other requirements.
- The Department of Forestry, Fisheries and the Environment has declared 11 Renewable Energy Development Zones where strategic environmental assessments have already been undertaken".

¹⁸⁵³ GN 1324 in GG 41287 of 1 Dec 2017.

¹⁸⁵⁴ Karrim *Daily Maverick* 2 February 2023.

¹⁸⁵⁵ Sole *AmaBhungane* 7 April 2020; Sole *AmaBhungane* 8 April 2020; Sole *Amabungane* 9 April 2020; *AmaBhungane Reporter Amabungane* 18 November 2021.

¹⁸⁵⁶ See 5.12.

¹⁸⁵⁷ Section 7.

¹⁸⁵⁸ See 2.4.1-2.4.5.

labour, and health. UGD can be regarded as new technology in the South African context,¹⁸⁵⁹ as would any of the other projects that the Departments of Trade and Industry and Science, Innovation and Technology envisaged. Measures should be taken to ensure an open and transparent process to ensure WEF nexus decision-making, as well as to avoid possible corruption.¹⁸⁶⁰ In order for this to happen an inter-governmental implementation protocol could be agreed upon.¹⁸⁶¹

5.13 Provision for monitoring and auditing

While several Acts specifically require reporting (compliance), they are sector-specific only and do not necessarily allow for different departmental participation. For example, the holder of an exploration or production right will in future, in terms of the draft hydraulic fracturing regulations, have to report on the wells to both the Department of Mineral Resources and Energy as well as to the Department of Water and Sanitation.¹⁸⁶² In terms of the proposed regulations, the applicant has to compile a baseline study of all the environmental qualities before he or she embarks on UGD. The holder of the right must continuously monitor the environmental impacts against the baseline study and post-decommissioning monitoring must take place.¹⁸⁶³

In the case of renewal applications for mining, exploration and production authorisations, the applicant must report on its compliance with the environmental conditions as well as the content of the EMPr.¹⁸⁶⁴ Furthermore, the authorisation holders must provide monthly reports on their mining activities as well as their finances.¹⁸⁶⁵ This reporting will be over-and-above that required by section 24Q of the NEMA. In terms of this section in order to ensure compliance with the conditions in the environmental authorisation and to determine whether the existing EMPr is still adequate to deal with the environmental impacts of the activity, the holder of the

¹⁸⁵⁹ See 2.3.3.

¹⁸⁶⁰ Commission of Enquiry into State Capture <https://www.statecapture.org.za/site/information/reports>.

¹⁸⁶¹ See also 5.8 on cooperative governance above.

¹⁸⁶² E.g. Reg 9(4) GN 2273 in GG 47112 of 11 July 2022 (reporting on the gas well).

¹⁸⁶³ E.g. Reg 7(3) and (6) of GN 2273 in GG 47112 of 11 July 2022 – requires continuing monitoring of impacts against the baseline report and reg 20 post-decommissioning monitoring.

¹⁸⁶⁴ See ss 18, 24, 24, 41, 81 and 85 MPRDA.

¹⁸⁶⁵ Section 28 MPRDA.

environmental authorisation will have to monitor and audit its compliance and performance as prescribed in the authorisation.¹⁸⁶⁶ The independent audit report must be submitted to the relevant department on an annual basis.¹⁸⁶⁷ The EMPr can be amended but must be subjected to a public participation process.¹⁸⁶⁸ If the EMPr therefore regulates UGD impacts on water and food production, simultaneous reporting will take place. There is, however, no prescribed integrated reporting required.

South African legislation therefore provides for monitoring and auditing but the execution thereof is still sector-specific.

5.14 The interconnection of water, energy and food in a holistic perspective, taking into account inter-dependency, complexity and scale

South African legislation does not specifically provide for measures investigating the interconnection of water, energy and food in a holistic perspective, taking into account their inter-dependence, complexity and scale. Some of the legislation, however, refers to an ecosystem-approach.¹⁸⁶⁹ The definition of environment in NEMA,¹⁸⁷⁰ includes water, land and the atmosphere as well as micro-organisms, animal and plant life. It recognises their interaction and their possible impact on human health and well-being. Section 24 of the Constitution in addition refers to "ecologically sustainable development" rather than to sustainable development as such.¹⁸⁷¹

The *Marine Spatial Planning Act* 16 of 2018 is the first Act that refers to an ecological approach, despite its focus to determine the possibilities for the economic exploitation of the ocean. It states as one of its principles "the advancement of an ecosystem and earth system approach to ocean management which focuses on maintaining

¹⁸⁶⁶ Section 24Q read with s 24N(7)(d) NEMA.

¹⁸⁶⁷ Regulation 34 of GN R982 in GG 38282 of 4 December 2014, as amended.

¹⁸⁶⁸ Regulation 34 of GN R982 in GG 38282 of 4 December 2014, as amended.

¹⁸⁶⁹ Section 1 NEMA defines an ecosystem as "a dynamic system of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit."

¹⁸⁷⁰ Section 1.

¹⁸⁷¹ Also see Rotondo *et al* 2022 *Sci Rep* 12 18513 and Soyapi 2023 *SALJ* 453-457.

ecosystem structure and functioning within a marine area".¹⁸⁷² The principles have to be considered in light of the precautionary approach.¹⁸⁷³ The section 2 principles of NEMA also refer to the precautionary approach,¹⁸⁷⁴ as well as that the disturbance of ecosystems and biological diversity be avoided.¹⁸⁷⁵ The precautionary principle speaks of "a risk-averse and cautious approach being applied, which takes into account the limits of current knowledge about the consequences of decisions and actions".¹⁸⁷⁶ It specifically states that "the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised".¹⁸⁷⁷ In the case of the use of non-renewable resources (such as UGD) the consequences of their use should be considered.¹⁸⁷⁸ Simultaneously, the principles put people and their interests at the forefront.¹⁸⁷⁹

The National Spatial Development Framework¹⁸⁸⁰ (hereafter NSDF) seems to acknowledge the complexity and scale of trade-offs between water, energy and food security, taking the impact of climate change into account.¹⁸⁸¹ The NSDF further acknowledges the existing institutional weaknesses to ensure integrated decision-making.¹⁸⁸² They include, for example, the silo-based approach still followed in the national sphere including the "country losing control over its resources", and is unable "to implement plans and frameworks that are in the national interest, rather than those that are in the interests of private investors or foreign countries".¹⁸⁸³ With regard to the natural resource base the NSDF notes that the following is important:

- Placing a far greater focus on, creating a much greater awareness of, and introducing a far greater quantification of our natural resource base, to enable and enhance the sustainable use and protection of critical natural resources;

¹⁸⁷² Section 5(1)(d).

¹⁸⁷³ Section 5(1).

¹⁸⁷⁴ Section 2(4)(a)(vii).

¹⁸⁷⁵ Section 2(4)(a)(i).

¹⁸⁷⁶ Section 2(4)(a)(vii).

¹⁸⁷⁷ Section 2(4)(a)(vi).

¹⁸⁷⁸ Section 2(4)(a)(v).

¹⁸⁷⁹ Section 2(2).

¹⁸⁸⁰ Gen Notice 1594 in GG 47999 of 1 February 2023.

¹⁸⁸¹ NSDF paras 3.5-3.6, 162.

¹⁸⁸² Paragraph 3.10.

¹⁸⁸³ Paragraph 3.10.

- Making a clearer distinction between the ecological and economic value of natural resources, and pursuing a far greater interest in and understanding of future trends and risks in natural resource use; and
- Identifying and earmarking broad categories of (1) high-value agricultural land for national food security and agrarian reform, and (2) environmentally-significant areas for the provision and use of essential ecosystem services.

The legislation and policy documents state that decision-making must take scientific terms into account. For example, the NSDF refers to "ecological infrastructure" as the "naturally functioning ecosystems that generate or deliver valuable services to people, for example, water catchments, wetlands, riparian zones, coastal dunes, kelp beds and/or spawning grounds. Ecological infrastructure consists of a network of interconnected structural elements in the landscape and seascape". It makes reference to food security, resilience, ecosystems, strategic water resource areas and stressed catchments, amongst others. No decision can, however, be made in relation to these concepts, if the decision-making is not science-based.

This requirement for decision-making to be based on science is also confirmed in *Endangered Wildlife Trust v Director-General, Department of Water and Sanitation*¹⁸⁸⁴ where the South African Water Tribunal indicated that the precautionary principle needs to be considered in light of scientific evidence.¹⁸⁸⁵ The court in the *Fuel Retailers* case also confirmed this indicating that the precautionary principle:

... is especially important in the light of ... NEMA which ... specifically requires the investigation of the potential impact, including cumulative effects, of the proposed development on the environment and socio-economic conditions, and the assessment of the significance of that potential impact.¹⁸⁸⁶

In the *Shell* case, the court emphasised the important role that scientific proof plays in environmental governance:

There is an increasing global concern about the environment in which we live, and for all creatures, small and great. [...] These issues include the interplay between law and science, the manner and extent to which scientific proof is sourced and

¹⁸⁸⁴ (WT 03/17/MP) [2019] ZAWT 3 (22 May 2019).

¹⁸⁸⁵ Paragraphs 158, 158.1-158.12.

¹⁸⁸⁶ Paragraph 81.

canvassed, and the mode of judicial assessment in urgent environmental-related matters brought in the public interest.¹⁸⁸⁷

While the need for scientific proof in environmental governance per the examples above, confirms the existence and or acknowledgement of a general inherent complexity, it is not so clear whether this includes aspects of inter-dependency and scale (both temporal and spatial) specifically to the WEF nexus.¹⁸⁸⁸

5.15 Synergies and trade-offs amongst natural systems

The NSDF specifically recognises the trade-offs between water, energy and food security:¹⁸⁸⁹

Currently, the complicated trade-offs between water, food and energy security in these areas (and the knock-on effects in other places) are largely playing out in an ad hoc way. It is, however, not due to lack of awareness and concern, as numerous national and province-focused plans refer (and have referred) to the challenge. The problem is that not much has been done to date, with urgent engagement being required with regard to the ... trade-offs [in specific catchment management areas].

In stating this, the NSDF specifically also refers to the catchment areas where the mining and energy sector competes with the agricultural sector for water. UGD will in future also have a significant impact on water, competing with agriculture amongst others in the Karoo, a water-stressed area.¹⁸⁹⁰

Although section 24O of the NEMA does not specifically refer to trade-offs, the relevant minister must consult with all government departments or organs of state that may have an interest in the proposed activity. He or she must furthermore consider all environmental impacts that the proposed activity may have on the environment, which also includes socio-economic considerations (e.g. access to energy and agriculture/livelihoods). As indicated by the *Fuel Retailers* case, economic, social and

¹⁸⁸⁷ *Border Deep Sea Angling Association v Minister of Mineral Resources and Energy* (3865/2021) [2021] ZAECHC 111 (3 December 2021) para 41.

¹⁸⁸⁸ See 2.4.8 and 2.5 on spatial and temporal scales applicable to UGD impacts. See 3.6. - 3.9. on WEF nexus complexity, including spatial and temporal scales.

¹⁸⁸⁹ NSDF para 5.7.4.1.

¹⁸⁹⁰ See 2.4.6.

environmental considerations should be balanced.¹⁸⁹¹ It does not necessarily happen in this manner.

The legislation does not address trade-offs within water, energy and food production. One exception may be the NWA where a reserve determination must be made before a water use licence can be issued. The reserve refers to the quantity and quality of the water required for current and future human consumption, as well as the water needed "to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource".¹⁸⁹² The Minister must ensure that adequate allowance is made to each of the component of the reserve and must take the different classes of the water source into account.¹⁸⁹³

The NDP acknowledges that there are, in the form of water allocation, trade-offs between water, industrial use (energy), agriculture (food), and conservation, which in turn have social and environmental consequences/impacts.¹⁸⁹⁴ While not explicitly referring to the WEF nexus this can certainly be interpreted as recognising trade-offs between water, energy and food. Notably, by including social and environmental impacts within the ambit of trade-offs, an argument can be made that the NDP is moving closer to recognising a socio-ecological systems approach.

While the NCCAS¹⁸⁹⁵ focuses mainly on adaptation measures, it does acknowledge that adaptation and mitigation can in some instances be either (i) mutually supportive (synergies) or (ii) contradictory (trade-offs).¹⁸⁹⁶ The idea or concept of trade-offs between water, energy and food, therefore exists in the policy and legislation, although not always clearly spelled out. In relation to UGD there will be a need to specifically acknowledge these trades-offs.

¹⁸⁹¹ Paragraphs 41 and 61.

¹⁸⁹² Section 1 NWA.

¹⁸⁹³ Section 16 NWA.

¹⁸⁹⁴ NDP at 182.

¹⁸⁹⁵ National Climate Change Adaptation Strategy Republic of South Africa Version UE10 (13 November 2019).

¹⁸⁹⁶ NCCAS 9.

5.16 The recognition of social-ecological systems and the introduction of new technology

In relation to new technology, section 2(4)(b) of the NEMA refers to the integrative and interrelated nature of environmental management that requires the identification and use of the best practicable environmental option.¹⁸⁹⁷ This section states:

Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option.¹⁸⁹⁸

What constitutes "best practicable environmental option" is not clear. In addition, it is questionable whether the best environmental option actually does get taken up in assessment and decision-making. This is so because the technology has already been decided on before the EIA is undertaken.¹⁸⁹⁹ It seems that the best environmental option will have to consider the people who may be affected by the activity.

Several other policy instruments and legislation refer to the introduction of technology. The *Climate Change Bill* requires the Minister to review the National Adaptation Strategy and Plan also in relation to new technology and the "best available science, evidence [and] information".¹⁹⁰⁰ The NDP acknowledges that new technology and technological breakthroughs (such as geo-engineering) could potentially have great risks. The NDP states the need for technological development within the agriculture sector, specifically that of water-saving technology. The NCCAS refers specifically to the advancement of new climate change adaptation technologies, while the National Policy on Food and Nutrition Security, 2013 calls for technology to respond to climate change impacts on agriculture.

The *White Paper on Science, Technology and Innovation* of March 2019 acknowledges that technological advancement brings not only uncertainty and challenges, but also

¹⁸⁹⁷ Section 2(4)(b).

¹⁸⁹⁸ Section 2(4)(b).

¹⁸⁹⁹ Du Plessis and Nel "Selecting, adopting and using the most sustainable and efficient technologies: Expanding the South African legal framework".

¹⁹⁰⁰ Clause 18(3).

opportunities.¹⁹⁰¹ Chapter 2 of the White Paper identifies the drivers of global change as social, scientific and technological, environmental, economic, geopolitical, informed by the SDGs and the NDP. The White Paper further indicates that people react slowly to change and are careful to embrace new technology.¹⁹⁰² It foresees, however, that "new technological solutions can help address challenges around energy and food security",¹⁹⁰³ and has "significant transformative potential".¹⁹⁰⁴ Although the White Paper speaks to agriculture and a greener economy it does not do so in an integrated manner. It does not introduce nexus thinking into the discussion of new technological innovations.

An example of socio-ecological considerations is to be found in the NEMPA. On receiving an application to conduct commercial prospecting, mining, exploration, production or related activities in a protected area, the NEMPA states that the Minister must take the ecological integrity of the environment into account.¹⁹⁰⁵ In addition, on receiving an application to conduct any mining, exploration or production activities in a protected area the Minister may take the potential impact on ecological functioning and ecosystem services to society into account.¹⁹⁰⁶ NEMPA defines ecological integrity as the total of the physical, biological and chemical components of an ecosystem and their interactions.¹⁹⁰⁷ While this confirms the recognition of socio-ecological systems generally, there is no direct reference to the interconnection of water, energy and food. The reference to socio-ecological systems and water in this section has a rather general and non-descriptive quality. In addition, this general recognition of socio-ecological systems and water is at the discretion of the Minister and therefore not obligatory. While the recognition of socio-ecological systems implies the existence of a holistic approach or understanding of inter-dependency, complexity and scale

¹⁹⁰¹ Paragraph 1.1.4.

¹⁹⁰² Paragraph 2.2.1.

¹⁹⁰³ Paragraph 2.2.11.

¹⁹⁰⁴ Chapter 4.

¹⁹⁰⁵ Section 48(5)(a)(i, ii and iv). As added by S 40 of the *National Environmental Management Laws Amendment Act 2 of 2022* (Proc 125 in GG 48869 of 30 June 2023).

¹⁹⁰⁶ Section 48(5)(b)(i). As added by s 40 of the *National Environmental Management Laws Amendment Act 2 of 2022* (Proc 125 in GG 48869 of 30 June 2023).

¹⁹⁰⁷ Section 1.

between elements that make up a socio-ecological system or systems, no such reference is made.

The NDP 2030 indicates that it is important to involve communities in order to assist them to take action to "ensure the equal distribution and use of water and energy".¹⁹⁰⁸ While the NDP acknowledges government's duty to realise people's rights (such as access to water and energy) it is quick to point out that citizens also have roles and responsibilities to be agents of their own development. In terms of the WEF nexus approach and the governance elements identified in Chapter 3, this approach within the NDP omits the key node of food and hence any decision-making on water and energy management will not be sustainable. Further, while it is a noble request of government that people should work out ways of fair water and energy services between themselves, the reality in practical terms is not straightforward. This is due, to among other, deep-seated poverty for most of the population versus an economic struggling middle class versus the rich.¹⁹⁰⁹ While numerous examples exist of middle- and rich-income groups assisting poorer communities with the provision of water and energy (also food), the sheer magnitude and level of WEF nexus insecurity make these endeavours unsustainable.¹⁹¹⁰ While the rich may still fund their water, energy and food security (for the most part), the middle income group is starting to feel the very real impacts of WEF nexus insecurity.¹⁹¹¹ Most are not financially secure to purchase alternative electricity options, such as diesel generators, solar panel and battery systems. Unless the energy insecurity aspect is resolved (estimates point to 24 months at least), the water and food insecurity will increase. This is putting people in South Africa in a survival mode where it will be difficult to assist others. Having indicated this, there are numerous examples of people, communities, NGOs and the business sector assisting people and communities that are in need of water, energy and food. For example, local community groups circulate addresses of people willing to pump and share borehole water.¹⁹¹² People are using water containers ranging between five and 20 litres to fill and move the water to their dwellings by foot, minibus taxi or

¹⁹⁰⁸ Chapter 15.

¹⁹⁰⁹ Paragraph 4.

¹⁹¹⁰ Paragraph 4.

¹⁹¹¹ Paragraph 4.

¹⁹¹² Social media communication such as WhatsApp is popular.

sharing of vehicles. Depending on the geographical setting, farmers tend to have water and food resources (not energy) to share with farmworkers, families and their communities. However, farmers' ability to provide food is becoming severely hampered by the lack of energy to pump water to dams and also for irrigation of crops. In short, farmers may not be able to plant, produce and deliver food in future. Returning to the NDP, it is difficult to ascertain how any equal distribution and use of water and energy can be made when all of society (from industrial to household level) is struggling and in dire need of those resources.

The NCCAS stresses the value of ecological infrastructure.¹⁹¹³ It defines ecological infrastructure to be "... naturally functioning ecosystems that deliver valuable services to people, such as water and climate regulation, soil formation and disaster risk reduction".¹⁹¹⁴ The NCCR-WP indicates that climate change will not only impact on ecosystems but will directly impact on the socio-economic life of people, affecting those that can ill-afford additional impacts, namely the poor and vulnerable. It is not only the poor and vulnerable that will be affected, but also agriculture and industries that rely on water, such as the mining and electricity generation. It recognises the "social and ecological pillars of sustainable development – recognising that a robust and sustainable economy and a healthy society depends on the services that well-functioning ecosystems provide, and that enhancing the sustainability of the economic, social and ecological services is an integral component of an effective and efficient climate change response".¹⁹¹⁵ Therefore, it is important to strengthen communities' and individuals' resilience to climate change.¹⁹¹⁶ The integration in decision-making does not always take place as illustrated in the 2022 *Wildcoast* case:¹⁹¹⁷

The area to which the exploration right applies enjoys a special legal status that affords the environment and within this area a particularly high level of protection and necessitates that decisions affecting it be taken in a manner that complies with

¹⁹¹³ https://www.dffe.gov.za/sites/default/files/docs/nationalclimatechange_adaptationstrategy_ue10november2019.pdf.

¹⁹¹⁴ NCCAS 3.

¹⁹¹⁵ Paragraph 3.

¹⁹¹⁶ Paragraph 1.

¹⁹¹⁷ 2022 *Wild Coast* case para 130.

the requirements of ICMA.¹⁹¹⁸ One of the objectives of ICMA is to introduce an integrated approach to management and in this instance, the decision-maker did quite the opposite and dealt with the application as an energy sector-specific issue.

Although implied in policies and legislation, socio-ecological systems and the introduction of new technology such as UGD may not be that clear. The need for such consideration specifically should be spelled out clearly.

5.17 Conclusion

The aim of this chapter was to assess the extent to which the South African regulatory framework that applies to UGD follows a nexus (integrated) approach to water, energy and food resource systems. After measuring the WEF nexus elements against the UGD regulatory framework the following conclusions are relevant:

- Little to no evidence was found for six of the fifteen WEF nexus elements. These five elements include (i) Clear role and responsibilities of different government departments and spheres, (ii) Integration of sources of information and information-gathering tools, (iii) Flexible approaches, that imply being able to adapt or adjust when necessary, (iv) The capacity to introduce new projects and programmes (training), (v) The interconnection of water, energy and food in a holistic perspective, taking into account inter-dependency, complexity and scale and (vi) The recognition of social-ecological systems and the introduction of new technology.
- Partial evidence was found for eight of the fifteen WEF nexus elements. They include: (i) Water, energy and food insecurity that should be addressed with sustainable outcomes, (ii) Informed public participation, (iii) Lifecycle approach, (iv) Inter-governmental cooperation and integrated decision-making, (v) Integration on a policy and regulation level, (vi) Provision for strategic planning and reporting, (vii) Provision for monitoring and auditing, and (viii) Synergies and trade-offs amongst natural systems.

¹⁹¹⁸ Refers to the National Environmental Management: Integrated Coastal Management Act 24 of 2008.

- Evidence of the existence of WEF nexus approach was only found in one of the elements, namely that of the integration of multiple-governance tools.

As a general finding, the legal and governance framework applicable to UGD in South Africa, is for the most part sectoral and fragmented. While there is legislation and policy that specifically addresses the water, energy and food sectors, it does so in a fragmented and sectoral way. Notably, the ICMA and specifically the *Marine Spatial Planning Act* provide examples of how WEF nexus elements can be incorporated in a regulatory framework.¹⁹¹⁹ The *Marine Spatial Planning Act* requires the taking into consideration of numerous factors such as spatial data of different sector users, compatible and incompatible uses, synergies among compatible users, analysis of emerging uses, environmental change impacts, current uses, activities and pressures for change, and future uses for all sectors. While these examples deal with offshore development aspects there is no reason why these can and should not be used as a blue print for onshore UGD. The *Infrastructure Development Act* proposes a one stop shop which can serve as an example for a one-stop shop for UGD ensuring that water, energy and food related decisions are taken in an integrated manner.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The aim of this study was to answer the following central question, namely to what extent the South African regulatory framework on UGD promote a nexus approach to water, energy and food, and if it does so insufficiently, how could it be reformed to more comprehensively embrace a nexus approach?

In order to fulfil this objective, the following subsidiary objectives were set:

- To identify and describe regulatory challenges posed by UGD in South Africa.

¹⁹¹⁹ See 5.8.

- To critically consider the origins, development and elements that make up the nexus approach to water, energy and food resource systems.
- To define the WEF nexus within a socio-ecological context.
- To identify and describe the regulatory framework applicable to UGD in South Africa.
- To assess the South African regulatory framework on UGD against the main elements of the WEF nexus approach.
- To make recommendations to the regulation of UGD following a WEF nexus approach.

The main research question and objective were based on the hypothesis that the WEF nexus pertaining to UGD is not clearly defined and regulated in South Africa.

The South African government continues to explore unconventional gas as an option to bolster energy security in South Africa.¹⁹²⁰ Onshore UGD by way of hydraulic fracturing on a horizontal plane poses a number of sustainability and regulatory challenges to water, energy and food resource systems.¹⁹²¹ Of particular relevance is the interconnected and interrelated nature of impacts emanating from UGD across the different water, energy and food sectors. The WEF nexus follows a cross-sectoral and multi-centric approach to and within integrated natural resource governance. It differs from other governance approaches that tend to have a sectoral and or single-centric approach (e.g. being either water, or energy or food-centric). The WEF nexus acknowledges that sectoral approaches, and particularly sectoral governance and regulatory approaches to natural resource management, are unsustainable. The WEF nexus aims to address regulatory and decision-making challenges emanating from UGD in South Africa by following a cross-sectoral and multi-centric approach.

South Africa is experiencing serious water, energy and food insecurity. The energy crisis in South Africa is continuing to negatively impact the water and food resource systems. It is a classic example of the interconnected and interdependent nature of

¹⁹²⁰ See 1.1 and 1.6.

¹⁹²¹ See 2.3 and 2.4.

the WEF nexus. The existing energy crisis (in the form of energy insecurity) has resulted in numerous serious trade-offs with water and food resource systems. In short, the impacts of energy insecurity have also manifested in water and food insecurity. Within this WEF nexus insecurity construct, the development of unconventional gas as a way to address energy insecurity is severely hampered by trade-offs between water, energy and food systems. In this sense it is a good example of a wicked problem or a "catch 22" situation in the sense that a specific course of action will likely have unintended consequences (some foreseen and others not).

This thesis has indicated that UGD potentially has major socio-ecological impacts that straddles water, energy and food systems. Notably, these socio-ecological impacts straddle human, animal (both domestic and wild), vegetation, and health aspects. While water and energy are needed as resource inputs to develop unconventional gas, the flip side of the coin is that further energy is needed for additional activities such as water-pumping and water-purification, etc. Further, the risk of water pollution in already water-stressed areas will exacerbate water insecurity that in turn will impact food resource systems negatively and likely lead to food insecurity.

In other words, numerous trade-offs will exist within the WEF nexus UGD construct. One way or the other, decisions need to be made on these trade-offs by the relevant decision-makers. Notably, this thesis has indicated that decision-making on WEF nexus issues (such as trade-offs) need to take note of and implement WEF nexus governance elements identified in Chapter 3 and applied in Chapter 5.

This study has confirmed as regulatory challenges, the existence of a number of set policies, legislation, rules, and regulations that apply to the governance of UGD and which straddle the water, energy and food sectors.¹⁹²² While this may point to a comprehensive regulatory framework on UGD it does, however, not follow a WEF nexus but rather a silo-based approach.¹⁹²³ It remains a fragmented regulatory framework with little if any evidence of addressing integrated or cross-sectoral principles that make up the WEF nexus approach as set out in Table 6.1.¹⁹²⁴ At best,

¹⁹²² See 4 and 5.

¹⁹²³ See 5.17 and Figure 4-5.

¹⁹²⁴ See 5.1 – 5.17.

cross-cutting issues such as water, energy and food are only mentioned in overarching policies, such as climate change. There is not a single piece of policy or legislation that addresses the WEF nexus holistically.¹⁹²⁵

Table 6-1: Assessment indicators - the South African regulatory framework on UGD against elements of the WEF nexus elements

WEF nexus element	UGD regulatory framework		
	Yes	No	Partial
Water, energy and food insecurity should be addressed with sustainable outcomes			✓
Clear role and responsibilities of different government departments and spheres		✓	
Informed public participation,			✓
Integration of sources of information and information-gathering tools		✓	
Life-cycle approach			✓
Flexible approaches, that is, namely, being able to adapt or adjust when necessary		✓	
Inter-governmental cooperation and integrated decision-making			✓
Integration on a policy and regulation level,			✓
Integration of multiple governance tools	✓		
The capacity to introduce new projects and programmes (training).		✓	
Provision for strategic planning and reporting			✓
Provision for monitoring and auditing			✓
The interconnection of water, energy and food in a holistic perspective, taking into account inter-dependency, complexity and scale		✓	
Synergies and trade-offs amongst natural systems			✓
The recognition of social-ecological systems and the introduction of new technology		✓	

The study considered two empirical studies on the water-energy-food nexus and one on UGD in the Karoo.¹⁹²⁶ While recognising the limitation of empirical studies, some conclusions can be reached. The studies indicate, for example, that there is a link

¹⁹²⁵ See 5.17.

¹⁹²⁶ See 4.8, and for specific conclusions 4.8.7 and 4.8.8.

between water, energy and food (agriculture) and that environmental and social impacts from UGD are interlinked. In the UGD study, the respondents specifically indicated the environmental and health impacts thereof. The respondents also favoured the introduction of renewable energy over gas development as it is uncertain that the communities where UGD takes place will actually benefit or rather bear the brunt of the impacts of UGD. This study also emphasised the importance of transparency in decision-making where communities are involved. The other two empirical studies stressed the trade-offs that households have to make in relation to decision-making on their access to water, energy and food. As stated before, the three studies straddle governance aspects of the WEF nexus within UGD in rural areas that are generally known to include and represent communities where difficult socio-economic conditions are the reality.¹⁹²⁷ The introduction of UGD within stressed communities will not necessarily contribute to the development of those communities, but may severely impact on their already limited access to water, energy and food. Any decision-making in relation to UGD will have to ensure integrated decision-making for the benefit of everyone and not only urban communities.

The study has led to several findings that are discussed in the following paragraph.

6.2 Findings

UGD does not consist of hydraulic fracturing only. It consists of a range of integrated activities within integrated phases that have social and ecological impacts over time and space dimensions.¹⁹²⁸ Techniques employed within UGD, such as hydraulic fracturing across a horizontal plane is a more recent exploitation technique, and hence scientific understanding of its potential socio-ecological impacts is uncertain.¹⁹²⁹ There is a lack of environmental base-line data in South Africa to use within any measurement and assessment of potential social and ecological impacts emanating from UGD.¹⁹³⁰ UGD differs substantially from conventional mining operations (such as the extraction of minerals, such as coal). Potential social and ecological impacts from

¹⁹²⁷ Within this general statement on the socio-economic status of these communities it should be noted that different communities' socio-economic conditions are not homogeneous.

¹⁹²⁸ See 2.3.4 and 2.4.8.

¹⁹²⁹ See 2.4 and 2.5.

¹⁹³⁰ See 2.4.8.

UGD cannot be compared to that of conventional mining in South Africa.¹⁹³¹ Socio-ecological impacts from UGD are interconnected and interdependent within and between water, energy and food systems.¹⁹³² Because these impacts straddle water, energy and food resources, it poses new challenges to regulatory and decision-making frameworks, generally and locally in South Africa.¹⁹³³

The survey of empirical research indicates that community members do not necessarily make trade-offs between water, energy and food, except in relation to what they spend (in financial terms) on these commodities. In some areas, communities do not even have sufficient access to water and food production and any UGD would impact severely on the communities' ability to have access to water and food.¹⁹³⁴ Over and above this, energy insecurity is having complex and non-linear impacts on water and food security in South Africa.¹⁹³⁵

There is, therefore, a need for a regulatory and governance framework that acknowledges the integrated nature of socio-ecological impacts from UGD.

Two main drivers of the WEF nexus approach were identified, namely, (i) a risk/resource security/green/circular economic driver, and (ii) a socio-ecological systems driver.¹⁹³⁶ This means that the WEF nexus concept is still evolving.¹⁹³⁷ By following a multi-centric approach the nexus is able to identify and understand interlinkages (in the form of trade-offs and synergies) between resource systems on an equal weighting.¹⁹³⁸ The ability of the nexus approach to identify and understand numerous and sometimes complex (non-linear) interactions between water, energy and food resource systems makes for better-informed decision-making within regulatory and governance frameworks.¹⁹³⁹ Governance of the WEF nexus is therefore defined from a socio-ecological perspective namely: it is an approach to provide a way

¹⁹³¹ See 2.3.3.

¹⁹³² See 2.4.8 and 4.6 – 4.8.

¹⁹³³ See 2.5, 4.6 – 4.8 and 5.8.

¹⁹³⁴ See 4.8.3 and 4.8.7.

¹⁹³⁵ See 3.5.5 and 3.10.

¹⁹³⁶ See 3.4.

¹⁹³⁷ See 3.4 and 3.10.

¹⁹³⁸ See 3.1 and 3.3.

¹⁹³⁹ See 3.10.

to understand a) complex interconnections and interdependencies between water, energy and food, (b) as well as (in relation to their scarcity) their synergy and "natural cycles and human use", (c) "their cross-sectoral and cross-scale interactions", also in relation to socio-economic impacts, "and the opportunities for increasing efficiency", (d) the minimising of their trade-offs, (e) the improvement of the integrated governance (also in relation to the legislation and policy context and institutions), (f) in order to ensure efficient resource use, and finally (g) "to enhance water, energy, and food security" and ensure "that development is sustainable".¹⁹⁴⁰

The WEF nexus is both the problem and solution to fragmented, sectoral, and unsustainable resource systems and plays a critical role within regulatory and governance frameworks for more sustainable outcomes.¹⁹⁴¹

The study found that the WEF nexus approach aims to provide a way to understand a) complex interconnections and interdependencies between water, energy and food, (b) as well as (in relation to their scarcity) their synergy and "natural cycles and human use", (c) "their cross-sectoral and cross-scale interactions", also in relation to socio-economic impacts, "and the opportunities for increasing efficiency", (d) the minimising of their trade-offs, (e) the improvement of the integrated governance (also in relation to the legislation and policy context and institutions), (f) in order to ensure efficient resource use, and finally (g) "to enhance water, energy, and food security" and ensure "that development is sustainable".

Various policies, strategies, plans, legislation and regulations pertain to UGD.¹⁹⁴² They do not necessarily address or introduce a WEF nexus governance approach.¹⁹⁴³ The survey of empirical research indicates that WEF nexus decision-making is not a reality and that the trade-offs between water, energy and food are not necessarily taken into account.¹⁹⁴⁴

¹⁹⁴⁰ See 3.8 and 3.9.

¹⁹⁴¹ See 3.10.

¹⁹⁴² See 4.3 – 4.7.

¹⁹⁴³ See 5.1 – 5.17.

¹⁹⁴⁴ See 4.8.3 - 4.8.7.

South Africa is following a business as usual approach, but is not so good at identifying and dealing with negative impacts from externalities. The repercussions that could come from following a business as usual, that is, a sectoral approach to water, energy and food, could result in a multiplier effect if water, food and energy stress or insecurity came together in a specific region or location. It may lead to non-linear shocks that will negatively impact on social and ecological systems.

6.3 Recommendations

A principal recommendation is that any consideration of UGD should not only take note of but should incorporate the WEF nexus governance approach.¹⁹⁴⁵ The WEF nexus governance approach should include multiple elements namely:¹⁹⁴⁶

- Water, energy and food insecurity should be addressed with sustainable outcomes that balances social, economic and environmental impacts between them in a holistic manner.
- There should be clear designated roles and responsibilities of different government departments and spheres in relation to UGD.
- Informed public participation is non-negotiable and in the case of traditional communities or communities with insecure land rights, prior and informed consent should be given.
- Sources of information and information-gathering tools should be integrated and used in decision-making.
- A lifecycle approach should be followed from the inception of UGD until its closure, rehabilitation and post-closure management of impacts.
- Flexible approaches, that is, namely, being able to adapt or adjust when necessary, should be used.
- Inter-governmental cooperation and integrated decision-making structures should be developed, for instance, to use the example of the *Intergovernmental Relations Framework Act*,¹⁹⁴⁷ *Infrastructure Development Act* and the *Climate Change Bill*, by

¹⁹⁴⁵ See 3.9.

¹⁹⁴⁶ See 3.9.

¹⁹⁴⁷ See 5.4.

enabling integrated decision-making in relation to water, energy and food issues within UGD.

- There should be integration on a policy and regulation level, which may mean some amendments to the NEMA, MPRDA, NWA and the *Upstream Petroleum Resources Development Bill* and its eventual Act.
- Integration of multiple governance tools should ensure that if one instrument fails, another will enable integrated decision-making.
- The capacity to introduce new projects and programmes (e.g. training) should be assessed and addressed.
- Provision for strategic planning and reporting would assist in the indication of areas where UGD can take place. An example is the SEA for the Karoo area.¹⁹⁴⁸
- It is necessary to provide for monitoring, auditing and reporting. Follow-up actions need to be undertaken to ensure compliance to the monitoring and auditing reports.¹⁹⁴⁹
- The interconnection of water, energy and food in a holistic perspective, taking into account the tinter-dependency, complexity and scale, and then all decision-making should depend on scientific outcomes of quality outcomes in this regard.
- Synergies and trade-offs amongst natural systems, as well as the recognition of socio-ecological systems should form the basis of the WEF nexus decision-making.

As UGD has so many potential impacts in the form of trade-offs across the WEF nexus,¹⁹⁵⁰ consideration should be given to a one-stop shop for UDG developments, taking into account all the relevant governmental department and spheres that would have to issue authorisations, from agriculture, water and sanitation, environment, health, amongst others.¹⁹⁵¹ The *Infrastructure Development Act* serves as an example in this regard.¹⁹⁵²

¹⁹⁴⁸ See 4.9.12 and 5.11.

¹⁹⁴⁹ See 3.9 and 5.13.

¹⁹⁵⁰ See 2.4.1-2.4.5.

¹⁹⁵¹ See 5.12.

¹⁹⁵² See 5.12.

Ideally, there should be a link or continuation between *ex ante* and *ex post* assessment or deliberation of UGD that includes the WEF nexus.¹⁹⁵³ This should reflect in either a single instrument (legislation) or a specific link between different Acts or regulations.

An *ex ante* assessment has value in that it will point out whether interlinkages (particularly trade-offs) between water, energy and food are identified or incorporated in the regulation of UGD. This is invaluable, since once a certain course of action has been taken (i.e. the exploitation of unconventional gas) the issue of "path dependency" or "lock in" can lead to social-ecological consequences that are difficult to reverse. Suitable instruments in this regard, include, for example, that of the committee on planning found within the ICMA,¹⁹⁵⁴ and the *Marine Spatial Planning Act*,¹⁹⁵⁵ or implementation protocols such as found within SEAs¹⁹⁵⁶ and the IGRFA¹⁹⁵⁷ that already provide a framework for intergovernmental cooperative governance.¹⁹⁵⁸ The WEF nexus should then be reflected in legislation such as that of NEMA, the NWA and the MPRDA. This will create a link or continuation between the *ex ante* and *post ante* assessment of UGD within the WEF nexus.

The establishment of or amendment of an existing framework vehicle to act as a one-stop shop for UGD with its related WEF nexus aspects should provide for WEF nexus governance decision-making as referred to above. In addition, the community must be able to comprehend scientific complexity in their mother tongue or in an acceptable language and level that ensure understanding for non-scientists.¹⁹⁵⁹ There should be regulatory independence on WEF nexus matters as in contrast to a regulatory single silo or sectoral capture approach. Regulators should acknowledge and apply their minds to the multi-centric nature of nexus issues.¹⁹⁶⁰ A national supervisory body for

¹⁹⁵³ See 5.12.

¹⁹⁵⁴ See 5.16.

¹⁹⁵⁵ See 5.8.

¹⁹⁵⁶ See 5.12.

¹⁹⁵⁷ See 4.6. and 5.4.

¹⁹⁵⁸ See 4.6. and 5.4.

¹⁹⁵⁹ See 3.4, 3.6, 3.9, 4.9 and 5.6 and 5.14.

¹⁹⁶⁰ See 3.6, 3.10, 4.9 and 5.17.

regulation of WEF nexus within UGD could be established similar to the structures proposed in the *Climate Change Bill*.¹⁹⁶¹

It will be necessary to improve public understanding and trust of the WEF nexus regulatory process, which includes transparency of data, processes and the inclusion of stakeholders, amongst others.¹⁹⁶² In addition, it will be necessary to improve capacity, in terms of knowledge and number of people receiving training on regulation and decision-making on WEF nexus projects and developments.¹⁹⁶³

This research (findings and suggestions) could potentially be used in other instances where development projects intersect with water, energy and food resource systems.

The WEF nexus governance elements could in future be used to test whether and to what extent regulatory frameworks follow a nexus approach to water, energy and food resource systems. Such a test could indicate whether and to what extent the specific regulatory framework enables or disables the sustainable management of water, energy and food resource systems.

Avellán and Roidt developed a useful assessment model by identifying indicators that could be used to determine possible governance gaps in WEF policies, legislation and projects or programmes.¹⁹⁶⁴ This model could be used when the regulatory framework is assessed in relation to:

- Accountability gaps (roles and responsibilities and mechanisms to ensure social and environmental responsibility).
- Administrative gaps (vertical and horizontal mismatch between geographic and administrative scale and problem configuration)
- Policy gaps (Definition of shared governance principles).
- Policy gaps (Vertical and horizontal integration of objectives across different scales (geographic and temporal) and sectors (ministries, public sector agencies)).

¹⁹⁶¹ See 5.11, 5.12 and 5.16.

¹⁹⁶² See 3.8, 3.9, 4.8.2-4.8.7 (empirical studies), 5.6 and 5.8.

¹⁹⁶³ See 3.9 and 5.12.

¹⁹⁶⁴ See Chapter 3.9.

- Power imbalances and negotiation.
- Capacity gaps (assessment of existing policies and institutions).
- Capacity gaps (attitude towards knowledge-sharing and participation).
- Data and information gaps (data availability and nexus system boundaries).
- Data and information gaps (communication).
- Data and information gaps (monitoring).

The indicators pose several questions that could be used when assessing whether laws or policies actually address WEF nexus issues, the lack of which was also pointed out in Chapter 5 of this study.

South Africa could benefit from the nexus approach by using it to move past historical approaches that regulated water, energy and food as individual (separate) sectors. The value or practical benefits of following a regulatory framework that is embedded within a nexus approach is that it has the potential to manage water, energy and food resources in the development of UGD in a more sustainable way and ultimately move closer to the goal of water, energy and food security.

The contribution of this study is that it is original and relevant on multiple levels. It is original in that a study of this kind has not been undertaken before. Regulating and or governing the WEF nexus is one of the major challenges of the 21st century – particularly as the regulation of the nexus is a key part of the problem as well as the solution. It is relevant because the regulation and governance of the WEF nexus is a global issue and therefore includes regional and local levels, such as those in South Africa. The nexus approach is a new way of framing the interconnected challenges in water, energy and food within sustainable and transformational development goals and offer new insights and knowledge to national energy, water and food policies in relation to UGD.

6.4 *Future research agenda*

Chapter 3 indicated that a main critique of the WEF nexus is its "fuzziness" in the sense that the concept is not well-defined and therefore means different things to

different people.¹⁹⁶⁵ The critique follows that the concept's all-encompassing nature is problematic - there is no agreement on a workable definition of the WEF nexus - and that its value as an approach for (more) sustainable outcomes in natural resource management, is therefore not tenable.¹⁹⁶⁶ While this critique is valid, it is this same "short-coming" that is arguably its main strength, namely its "openness" for different interpretations by different people.¹⁹⁶⁷ The concept's flexibility provides opportunities to apply the key-tenant thereof, namely the identification, understanding and managing of critical interlinkages between water, energy and food resource systems.

This "openness" of the concept has proved to be an enabler for more inclusive and plural understandings of the many socio-ecological aspects linked to water, energy and food resource systems.¹⁹⁶⁸ In this sense, future research may find value in exploring how the nexus approach – an approach that recognises socio-ecological interlinkages – informs new views, approaches and concepts, such as Earth System Law and co-viability that aim to overcome the unsustainable human-nature divide that exists within the current anthropogenic epoch. The nexus approach can therefore be used to examine the many ways that relationships exist between not only water, energy, and food resource systems but also on institutional level where aspects of political power, social justice etc. are prominent. Improving regulatory integration across water, energy and food resource systems is primarily a political process that requires negotiation between different actors. Different actors have distinct perceptions, interests and practices that need to be understood and taken up in any conceptualising of the WEF nexus approach. Decisions within regulatory frameworks create, particularly in instances where trade-offs feature strongly, winners and losers in the sense that a change in the *status quo* has different impacts for different people. In other words, the WEF nexus approach is not and cannot be applied as an a-political technical solution. This brings into focus aspects of political-ecology, such as how humans relate to the biophysical world and how inequalities in access to natural resources are framed and addressed by stakeholders. This addresses complex or

¹⁹⁶⁵ See 3.3 and 3.7.

¹⁹⁶⁶ See 3.3 and 3.7.

¹⁹⁶⁷ See 3.10.

¹⁹⁶⁸ See 3.8 and 3.10.

wicked socio-ecological issues and how the existence of inequalities and injustices are embedded in governance and institutional frameworks.

The interlinkages between water, energy and food resource systems are, for a number of reasons, often complex to identify, understand and manage.¹⁹⁶⁹ More recent research points to the need for further research on multi-level and multi-scale governance challenges.¹⁹⁷⁰ That is the challenge of multi-level governance set within different temporal and spatial scales across the different water, energy and food resource systems. Water, energy and food resource systems operate in very different ways from one another: both in physical terms (such as measuring units, infrastructure etc.) and institutional embeddedness (different management approaches in the way of differences in time scales to contracts, differences in the way that price/value is decided by the market or not). This points to the need for planning of WEF nexus projects and development over a longer term, which tend to go against the short-term views of political realities. This aspect is arguably more relevant in countries where the government's primary focus is on keeping or gaining political power (i.e. short-term and populist solutions). South Africa may very well be such an example. There is likely scope for research to understand and more importantly to look for possible solutions from this short-term political approach to longer term sustainability issues within a WEF nexus governance approach, generally, and specifically, within UGD in South Africa. Empirical research in the communities, affected by or about to be affected, by UGD, will also have to be undertaken.

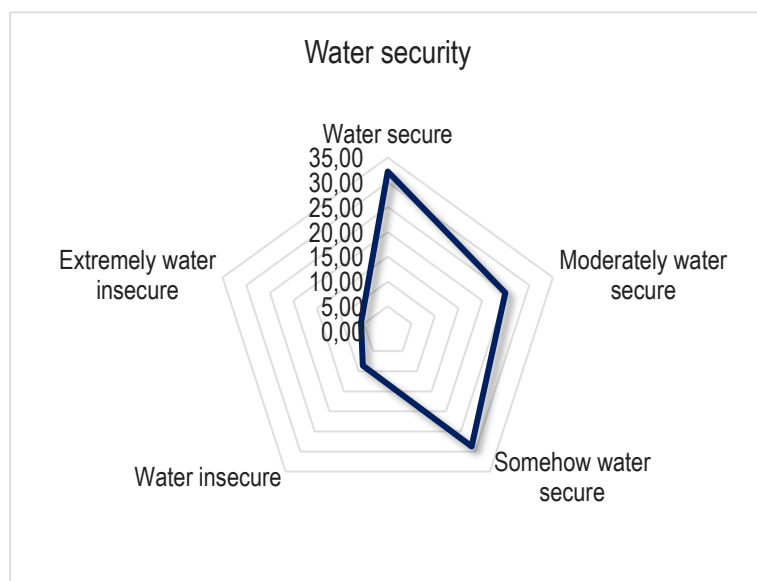
¹⁹⁶⁹ See 3.6, 3.10 and 4.9.

¹⁹⁷⁰ See 3.9. Pahl-Wostl *et al* 2021 *Sustainability Science* 615-629.

Annexure 1: Water, energy and food descriptives of the empirical study

In coming up with the water, energy and food security measures, the HWISE (Household Water Insecurity Experiences), HFIAS (Household Food Inaccess Scale) and MEPI (Multidimensional Energy Poverty Index) were used.

Water



Frequencies

Notes

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Comments		
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	1184
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	Cases Used	Statistics are based on all cases with valid data.

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Resources	Processor Time	00:00:00,00
	Elapsed Time	00:00:00,00

Statistics

		... how frequently did you or anyone in your household worry you would not have enough water for all your household needs?	... how frequently has your main water source been interrupted or limited e.g. water pressure, less water than expected, river dried up?	... how frequently have problems with water meant that clothes could not be washed?	... how frequently have you or anyone in your household had to change schedules or plans due to problems with your water situation?	... how frequently have you or anyone in your household had to change what was being eaten because there were problems with water?
N	Valid	1184	1184	1184	1184	1184
	Missing	0	0	0	0	0

		Statistics				
		... how frequently have you or anyone in your household had to go without washing hands after dirty activities because of problems with water?	... how frequently have you or anyone in your household had to go without washing their body because of problems with water?	... how frequently has there not been as much water to drink as you would like for you or anyone in your household?	... how frequently did you or anyone in your household feel angry about your water situation?	... how frequently have you or anyone in your household gone to sleep thirsty because there wasn't any water to drink?
N	Valid	1184	1184	1184	1184	1184
	Missing	0	0	0	0	0

		Statistics	
		... how frequently has there been no useable or drinkable water whatsoever in your household?	... how frequently have problems with water caused you or anyone in your household to feel ashamed/excluded /stigmatised?
N	Valid	1184	1184
	Missing	0	0

Frequency Table

... how frequently did you or anyone in your household worry you would not have enough water for all your household needs?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	266	22,5	22,5	22,5
	Rarely	205	17,3	17,3	39,8
	Sometimes	415	35,1	35,1	74,8
	Often	137	11,6	11,6	86,4
	Always	161	13,6	13,6	100,0
	Total	1184	100,0	100,0	

... how frequently has your main water source been interrupted or limited e.g. water pressure, less water than expected, river dried up?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	229	19,3	19,3	19,3
	Rarely	200	16,9	16,9	36,2
	Sometimes	440	37,2	37,2	73,4
	Often	160	13,5	13,5	86,9
	Always	155	13,1	13,1	100,0
	Total	1184	100,0	100,0	

... how frequently have problems with water meant that clothes could not be washed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	305	25,8	25,8	25,8
	Rarely	222	18,8	18,8	44,5
	Sometimes	418	35,3	35,3	79,8
	Often	139	11,7	11,7	91,6
	Always	100	8,4	8,4	100,0
	Total	1184	100,0	100,0	

... how frequently have you or anyone in your household had to change schedules or plans due to problems with your water situation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	290	24,5	24,5	24,5
	Rarely	235	19,8	19,8	44,3
	Sometimes	439	37,1	37,1	81,4
	Often	125	10,6	10,6	92,0
	Always	95	8,0	8,0	100,0
	Total	1184	100,0	100,0	

... how frequently have you or anyone in your household had to change what was being eaten because there were problems with water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	352	29,7	29,7	29,7
	Rarely	236	19,9	19,9	49,7
	Sometimes	407	34,4	34,4	84,0
	Often	114	9,6	9,6	93,7
	Always	75	6,3	6,3	100,0
	Total	1184	100,0	100,0	

... how frequently have you or anyone in your household had to go without washing hands after dirty activities because of problems with water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	522	44,1	44,1	44,1
	Rarely	203	17,1	17,1	61,2
	Sometimes	328	27,7	27,7	88,9
	Often	73	6,2	6,2	95,1
	Always	58	4,9	4,9	100,0
	Total	1184	100,0	100,0	

... how frequently have you or anyone in your household had to go without washing their body because of problems with water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	493	41,6	41,6	41,6
	Rarely	240	20,3	20,3	61,9
	Sometimes	331	28,0	28,0	89,9
	Often	71	6,0	6,0	95,9
	Always	49	4,1	4,1	100,0
	Total	1184	100,0	100,0	

... how frequently has there not been as much water to drink as you would like for you or anyone in your household?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	500	42,2	42,2	42,2
	Rarely	220	18,6	18,6	60,8
	Sometimes	326	27,5	27,5	88,3
	Often	86	7,3	7,3	95,6
	Always	52	4,4	4,4	100,0
	Total	1184	100,0	100,0	

... how frequently did you or anyone in your household feel angry about your water situation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	326	27,5	27,5	27,5
	Rarely	204	17,2	17,2	44,8
	Sometimes	379	32,0	32,0	76,8
	Often	108	9,1	9,1	85,9
	Always	167	14,1	14,1	100,0
	Total	1184	100,0	100,0	

... how frequently have you or anyone in your household gone to sleep thirsty because there wasn't any water to drink?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	660	55,7	55,7	55,7
	Rarely	160	13,5	13,5	69,3
	Sometimes	273	23,1	23,1	92,3
	Often	62	5,2	5,2	97,6
	Always	29	2,4	2,4	100,0
	Total	1184	100,0	100,0	

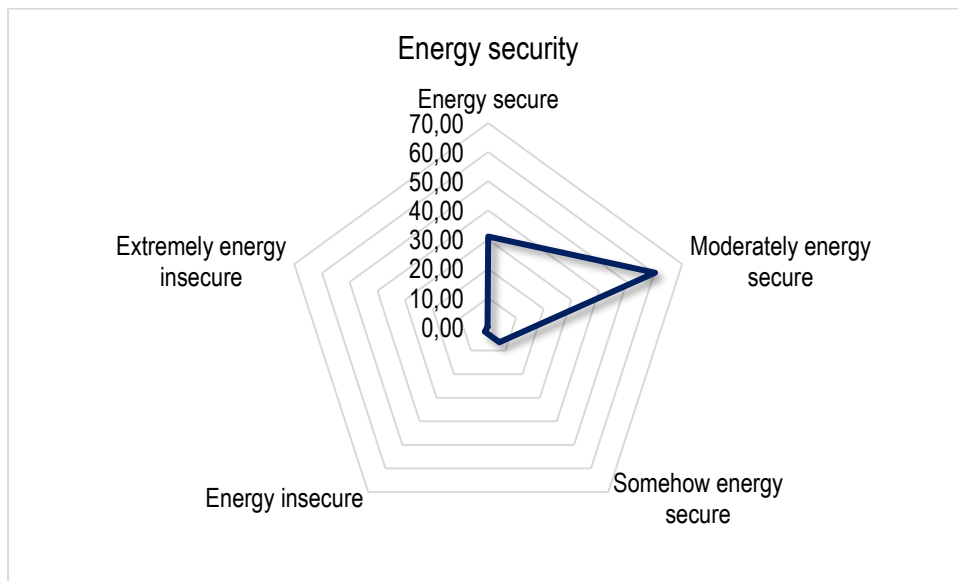
... how frequently has there been no useable or drinkable water whatsoever in your household?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	543	45,9	45,9	45,9
	Rarely	214	18,1	18,1	63,9
	Sometimes	314	26,5	26,5	90,5
	Often	70	5,9	5,9	96,4
	Always	43	3,6	3,6	100,0
	Total	1184	100,0	100,0	

... how frequently have problems with water caused you or anyone in your household to feel ashamed/excluded/stigmatised?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	498	42,1	42,1	42,1
	Rarely	216	18,2	18,2	60,3
	Sometimes	312	26,4	26,4	86,7
	Often	83	7,0	7,0	93,7
	Always	75	6,3	6,3	100,0
	Total	1184	100,0	100,0	

Energy



Frequencies

Notes

Output Created		23-JAN-2023 14:34:35
Comments		
Input	Data	C:\Users\Ngara001\Desktop\VA ARLHARTS DATA\WEF Nexus governance for social justice data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	1184
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data.
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What_type_of_energy_se_for_s
 pace_heatingcandles
 What_type_of_energy_se_for_s
 pace_heatingmanure_dung
 What_type_of_energy_se_for_s
 pace_heatingcrop_residue
 What_type_of_energy_se_for_s
 pace_heatingpetrol_diesel
 What_type_of_energy_se_for_s
 pace_heatingfuelwood_wood
 What_type_of_energy_se_for_s
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 pace_heatinghydropower
 What_type_of_energy_se_for_s
 pace_heatingbiogas
 What_type_of_energy_se_for_s
 pace_heatingother
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 _for_cookingbiogas
 What_type_of_energy_you_use
 _for_cookingother
 What_type_of_energy_you_use
 _for_cookingnone
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Resources	Processor Time	00:00:00,03
	Elapsed Time	00:00:00,03

		Statistics				
		What type of energy do you use for space heating?	Energy from grid used for space heating?	Energy from paraffin used for space heating?	Energy from gas used for space heating?	Energy from candles used for space heating?
N	Valid	833	1114	1114	1114	1114
	Missing	351	70	70	70	70

		Statistics				
		Energy from manure/dung energy used for space heating?	Energy from crop residue used for space heating?	Energy from petrol/diesel used for space heating?	Energy from fuelwood/wood used for space heating?	Energy from solar panels used for space heating?
N	Valid	1114	1114	1114	1114	1114
	Missing	70	70	70	70	70

		Statistics				
		Energy from hydropower used for space heating?	Energy from biogas used for space heating?	Energy from other used for space heating?	No energy used for space heating?	What type of energy do use for water heating?
N	Valid	1114	1114	1114	1114	679
	Missing	70	70	70	70	505

		Statistics				
		Energy from grid used for water heating?	Energy from paraffin used for water heating?	Energy from gas used for water heating?	Energy from candles used for water heating?	Energy from manure/dung energy used for water heating?
N	Valid	1112	1112	1112	1112	1112
	Missing	72	72	72	72	72

		Statistics				
		Energy from crop residue used for water heating?	Energy from petrol/diesel used for water heating?	Energy from fuelwood/wood used for water heating?	Energy from solar panels used for water heating?	Energy from hydropower used for water heating?
N	Valid	1112	1112	1112	1112	1112
	Missing	72	72	72	72	72

		Statistics				
		Energy from biogas used for water heating?	Energy from other used for water heating?	No energy used for water heating?	What type of energy you use for lighting?	Energy from grid used for lighting?
N	Valid	1112	1112	1112	800	1110
	Missing	72	72	72	384	74

		Statistics				
		Energy from paraffin used for lighting?	Energy from gas used for lighting?	Energy from candles used for lighting?	Energy from manure/dung energy used for lighting?	Energy from crop residue used for lighting?
N	Valid	1110	1110	1110	1110	1110
	Missing	74	74	74	74	74

		Statistics				
		Energy from petrol/diesel used for lighting?	Energy from fuelwood/wood used for lighting?	Energy from solar panels used for lighting?	Energy from hydropower used for lighting?	Energy from biogas used for lighting?
N	Valid	1110	1110	1110	1110	1110
	Missing	74	74	74	74	74

		Statistics				
		Energy from other used for lighting?	No energy used for lighting?	What type of energy you use for cooking?	Energy from grid used for cooking?	Energy from paraffin used for cooking?
N	Valid	1110	1110	553	1111	1111
	Missing	74	74	631	73	73

		Statistics				
		Energy from gas used for cooking?	Energy from candles used for cooking?	Energy from manure/dung energy used for cooking?	Energy from crop residue used for cooking?	Energy from petrol/diesel used for cooking?
N	Valid	1111	1111	1111	1111	1111
	Missing	73	73	73	73	73

		Statistics				
		Energy from fuelwood/wood used for cooking?	Energy from solar panels used for cooking?	Energy from hydropower used for cooking?	Energy from biogas used for cooking?	Energy from other used for cooking?
N	Valid	1111	1111	1111	1111	1111
	Missing	73	73	73	73	73

		Statistics				
		No energy used for cooking?	What type of energy do you use for appliances?	Energy from grid used for appliances?	Energy from paraffin used for appliances?	Energy from gas used for appliances?
N	Valid	1111	1080	1109	1109	1109
	Missing	73	104	75	75	75

		Statistics				
		Energy from candles used for appliances?	Energy from manure/dung used for appliances?	Energy from crop residue used for appliances?	Energy from petrol/diesel used for appliances?	Energy from fuelwood/wood used for appliances?
N	Valid	1109	1109	1109	1109	1109
	Missing	75	75	75	75	75

		Statistics				
		Energy from solar panels used for appliances?	Energy from hydropower used for appliances?	Energy from biogas used for appliances?	Energy from other used for appliances?	No energy used for appliances?
N	Valid	1109	1109	1109	1109	1109
	Missing	75	75	75	75	75

		Statistics				
		What type of energy do you use for growing crops?	Energy from grid used for growing crops?	Energy from paraffin used for growing crops?	Energy from gas used for growing crops?	Energy from candles used for growing crops?
N	Valid	1134	1107	1107	1107	1107
	Missing	50	77	77	77	77

		Statistics				
		Energy from manure/dung energy used for growing crops?	Energy from crop residue used for growing crops?	Energy from petrol/diesel used for growing crops?	Energy from fuelwood/wood used for growing crops?	Energy from solar panels used for growing crops?
N	Valid	1107	1107	1107	1107	1107
	Missing	77	77	77	77	77

		Statistics				
		Energy from hydropower used for growing crops?	Energy from biogas used for growing crops?	Energy from draught power used for growing crops?	Other energy used for growing crops?	No energy used for growing crops?
N	Valid	1107	1107	1107	1107	1107
	Missing	77	77	77	77	77

		Statistics				
		What type of energy se for growing cropsnone 1	What type of energy do you use for rearing livestock?	Energy from grid used for rearing livestock?	Energy from paraffin used for rearing livestock?	Energy from gas used for rearing livestock?
N	Valid	1107	1136	1104	1104	1104
	Missing	77	48	80	80	80

		Statistics				
		Energy from candles used for rearing livestock?	Energy from manure/dung energy used for rearing livestock?	Energy from crop residue used for rearing livestock?	Energy from petrol/diesel used for rearing livestock?	Energy from fuelwood/wood used for rearing livestock?
N	Valid	1104	1104	1104	1104	1104
	Missing	80	80	80	80	80

		Statistics				
		Energy from solar panels used for rearing livestock?	Energy from hydropower used for rearing livestock?	Energy from biogas used for rearing livestock?	Energy from other used for rearing livestock?	No energy used for rearing livestock?
N	Valid	1104	1104	1104	1104	1104
	Missing	80	80	80	80	80

		Statistics				
		What type of energy or rearing livestock a	What type of energy do you use for getting water?	Energy from grid used for getting water?	Energy from paraffin used for getting water?	Energy from gas used for getting water?
N	Valid	1104	1142	1104	1104	1104
	Missing	80	42	80	80	80

		Statistics				
		Energy from candles used for getting water?	Energy from manure/dung energy used for getting water?	Energy from crop residue used for getting water?	Energy from petrol/diesel used for getting water?	Energy from fuelwood/wood used for getting water?
N	Valid	1104	1104	1104	1104	1104
	Missing	80	80	80	80	80

		Statistics				
		Energy from solar panels used for getting water?	Energy from hydropower used for getting water?	Energy from biogas used for getting water?	Energy from other used for getting water?	No energy used for getting water?
N	Valid	1104	1104	1104	1104	1104
	Missing	80	80	80	80	80

Frequency Table

What type of energy do you use for space heating?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	323	27,3	38,8	38,8
	Paraffin	25	2,1	3,0	41,8
	Gas	11	,9	1,3	43,1
	Candles	2	,2	,2	43,3
	Manure/dung	1	,1	,1	43,5
	Petrol/diesel	1	,1	,1	43,6
	Fuelwood/wood	384	32,4	46,1	89,7
	Solar panels	3	,3	,4	90,0
	Hydropower	1	,1	,1	90,2
	Other	1	,1	,1	90,3
	None	81	6,8	9,7	100,0
	Total	833	70,4	100,0	

Missing	System	351	29,6		
Total		1184	100,0		

Energy from grid used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	537	45,4	48,2	48,2
	No	577	48,7	51,8	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from paraffin used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	113	9,5	10,1	10,1
	No	1001	84,5	89,9	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from gas used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	81	6,8	7,3	7,3
	No	1033	87,2	92,7	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from candles used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	59	5,0	5,3	5,3
	No	1055	89,1	94,7	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from manure/dung energy used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	19	1,6	1,7	1,7
	No	1095	92,5	98,3	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from crop residue used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1114	94,1	100,0	100,0
Missing	System	70	5,9		
Total		1184	100,0		

Energy from petrol/diesel used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	,3	,4	,4
	No	1110	93,8	99,6	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from fuelwood/wood used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	678	57,3	60,9	60,9
	No	436	36,8	39,1	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from solar panels used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	,8	,9	,9
	No	1104	93,2	99,1	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from hydropower used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	,4	,4	,4
	No	1109	93,7	99,6	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from biogas used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1113	94,0	99,9	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

Energy from other used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	,3	,4	,4
	No	1110	93,8	99,6	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

No energy used for space heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	82	6,9	7,4	7,4
	No	1032	87,2	92,6	100,0
	Total	1114	94,1	100,0	
Missing	System	70	5,9		
Total		1184	100,0		

What type of energy do use for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	311	26,3	45,8	45,8
	Paraffin	19	1,6	2,8	48,6
	Gas	19	1,6	2,8	51,4
	Manure/dung	2	,2	,3	51,7
	Petrol/diesel	1	,1	,1	51,8
	Fuelwood/wood	316	26,7	46,5	98,4
	Solar panels	2	,2	,3	98,7
	None	9	,8	1,3	100,0
	Total	679	57,3	100,0	
Missing	System	505	42,7		
Total		1184	100,0		

Energy from grid used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	644	54,4	57,9	57,9
	No	468	39,5	42,1	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from paraffin used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	125	10,6	11,2	11,2
	No	987	83,4	88,8	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from gas used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	127	10,7	11,4	11,4
	No	985	83,2	88,6	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from candles used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	,7	,7	,7
	No	1104	93,2	99,3	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from manure/dung energy used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	23	1,9	2,1	2,1
	No	1089	92,0	97,9	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from crop residue used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1112	93,9	100,0	100,0
Missing	System	72	6,1		
Total		1184	100,0		

Energy from petrol/diesel used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1110	93,8	99,8	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from fuelwood/wood used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	771	65,1	69,3	69,3
	No	341	28,8	30,7	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from solar panels used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1109	93,7	99,7	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from hydropower used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	,5	,5	,5
	No	1106	93,4	99,5	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from biogas used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1111	93,8	99,9	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

Energy from other used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1111	93,8	99,9	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

No energy used for water heating?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	,8	,9	,9
	No	1102	93,1	99,1	100,0
	Total	1112	93,9	100,0	
Missing	System	72	6,1		
Total		1184	100,0		

What type of energy you use for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	617	52,1	77,1	77,1
	Gas	2	,2	,3	77,4
	Candles	99	8,4	12,4	89,8
	Petrol/diesel	2	,2	,3	90,0
	Fuelwood/wood	13	1,1	1,6	91,6
	Solar panels	61	5,2	7,6	99,3
	Biogas	1	,1	,1	99,4
	Other	1	,1	,1	99,5
	None	4	,3	,5	100,0
	Total	800	67,6	100,0	
Missing	System	384	32,4		
Total		1184	100,0		

Energy from grid used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	886	74,8	79,8	79,8
	No	224	18,9	20,2	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from paraffin used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	37	3,1	3,3	3,3
	No	1073	90,6	96,7	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from gas used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	1,0	1,1	1,1
	No	1098	92,7	98,9	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from candles used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	389	32,9	35,0	35,0
	No	721	60,9	65,0	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from manure/dung energy used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1110	93,8	100,0	100,0
Missing	System	74	6,3		
Total		1184	100,0		

Energy from crop residue used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1110	93,8	100,0	100,0
Missing	System	74	6,3		
Total		1184	100,0		

Energy from petrol/diesel used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1107	93,5	99,7	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from fuelwood/wood used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	51	4,3	4,6	4,6
	No	1059	89,4	95,4	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from solar panels used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	134	11,3	12,1	12,1
	No	976	82,4	87,9	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from hydropower used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	,5	,5	,5
	No	1104	93,2	99,5	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

Energy from biogas used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1110	93,8	100,0	100,0
Missing	System	74	6,3		
Total		1184	100,0		

Energy from other used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	,6	,6	,6
	No	1103	93,2	99,4	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

No energy used for lighting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	,3	,4	,4
	No	1106	93,4	99,6	100,0
	Total	1110	93,8	100,0	
Missing	System	74	6,3		
Total		1184	100,0		

What type of energy you use for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	300	25,3	54,2	54,2
	Paraffin	6	,5	1,1	55,3
	Gas	32	2,7	5,8	61,1
	Candles	1	,1	,2	61,3
	Manure/dung	1	,1	,2	61,5
	Petrol/diesel	1	,1	,2	61,7
	Fuelwood/wood	206	17,4	37,3	98,9
	Solar panels	2	,2	,4	99,3
	Biogas	1	,1	,2	99,5
	None	3	,3	,5	100,0
	Total	553	46,7	100,0	
Missing	System	631	53,3		
Total		1184	100,0		

Energy from grid used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	751	63,4	67,6	67,6
	No	360	30,4	32,4	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from paraffin used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	138	11,7	12,4	12,4
	No	973	82,2	87,6	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from gas used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	202	17,1	18,2	18,2
	No	909	76,8	81,8	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from candles used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	1,0	1,1	1,1
	No	1099	92,8	98,9	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from manure/dung energy used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	31	2,6	2,8	2,8
	No	1080	91,2	97,2	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from crop residue used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1109	93,7	99,8	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from petrol/diesel used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1109	93,7	99,8	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from fuelwood/wood used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	768	64,9	69,1	69,1
	No	343	29,0	30,9	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from solar panels used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1109	93,7	99,8	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from hydropower used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	,4	,5	,5
	No	1106	93,4	99,5	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from biogas used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1109	93,7	99,8	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

Energy from other used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1109	93,7	99,8	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

No energy used for cooking?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1108	93,6	99,7	100,0
	Total	1111	93,8	100,0	
Missing	System	73	6,2		
Total		1184	100,0		

What type of energy do you use for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	821	69,3	76,0	76,0
	Paraffin	1	,1	,1	76,1
	Gas	8	,7	,7	76,9
	Candles	3	,3	,3	77,1
	Petrol/diesel	2	,2	,2	77,3
	Fuelwood/wood	22	1,9	2,0	79,4
	Solar panels	59	5,0	5,5	84,8
	Hydropower	3	,3	,3	85,1
	Other	2	,2	,2	85,3
	None	159	13,4	14,7	100,0
	Total	1080	91,2	100,0	
Missing	System	104	8,8		
Total		1184	100,0		

Energy from grid used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	838	70,8	75,6	75,6
	No	271	22,9	24,4	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from paraffin used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	,8	,8	,8
	No	1100	92,9	99,2	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from gas used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	29	2,4	2,6	2,6
	No	1080	91,2	97,4	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from candles used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	1,1	1,2	1,2
	No	1096	92,6	98,8	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from manure/dung used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1107	93,5	99,8	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from crop residue used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1108	93,6	99,9	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from petrol/diesel used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	,3	,4	,4
	No	1105	93,3	99,6	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from fuelwood/wood used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	64	5,4	5,8	5,8
	No	1045	88,3	94,2	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from solar panels used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	91	7,7	8,2	8,2
	No	1018	86,0	91,8	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from hydropower used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	,5	,5	,5
	No	1103	93,2	99,5	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

Energy from biogas used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1109	93,7	100,0	100,0
Missing	System	75	6,3		
Total		1184	100,0		

Energy from other used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1106	93,4	99,7	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

No energy used for appliances?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	160	13,5	14,4	14,4
	No	949	80,2	85,6	100,0
	Total	1109	93,7	100,0	
Missing	System	75	6,3		
Total		1184	100,0		

What type of energy do you use for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	81	6,8	7,1	7,1
	Paraffin	1	,1	,1	7,2
	Candles	1	,1	,1	7,3
	Manure/dung	51	4,3	4,5	11,8
	Crop residue	6	,5	,5	12,3
	Petrol/diesel	13	1,1	1,1	13,5
	Fuelwood/wood	6	,5	,5	14,0
	Solar panels	2	,2	,2	14,2
	Hydropower	3	,3	,3	14,5
	Biogas	2	,2	,2	14,6
	Other	19	1,6	1,7	16,3
	None	949	80,2	83,7	100,0
	Total	1134	95,8	100,0	
Missing	System	50	4,2		
Total		1184	100,0		

Energy from grid used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	55	4,6	5,0	5,0
	No	1052	88,9	95,0	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from paraffin used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1104	93,2	99,7	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from gas used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1105	93,3	99,8	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from candles used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	,3	,4	,4
	No	1103	93,2	99,6	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from manure/dung energy used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	58	4,9	5,2	5,2
	No	1049	88,6	94,8	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from crop residue used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	1,0	1,1	1,1
	No	1095	92,5	98,9	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from petrol/diesel used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	1,2	1,3	1,3
	No	1093	92,3	98,7	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from fuelwood/wood used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	19	1,6	1,7	1,7
	No	1088	91,9	98,3	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from solar panels used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1105	93,3	99,8	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from hydropower used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	,3	,4	,4
	No	1103	93,2	99,6	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from biogas used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1106	93,4	99,9	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Energy from draught power used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	1,0	1,1	1,1
	No	1095	92,5	98,9	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

Other energy used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	47	4,0	4,2	4,2
	No	1060	89,5	95,8	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

No energy used for growing crops?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1107	93,5	100,0	100,0
Missing	System	77	6,5		
Total		1184	100,0		

What type of energy se for growing cropsnone 1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	905	76,4	81,8	81,8
	No	202	17,1	18,2	100,0
	Total	1107	93,5	100,0	
Missing	System	77	6,5		
Total		1184	100,0		

What type of energy do you use for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	69	5,8	6,1	6,1
	Paraffin	1	,1	,1	6,2
	Crop residue	2	,2	,2	6,3
	Petrol/diesel	1	,1	,1	6,4
	Fuelwood/wood	11	,9	1,0	7,4
	Solar panels	6	,5	,5	7,9
	Biogas	1	,1	,1	8,0
	Other	41	3,5	3,6	11,6
	None	1004	84,8	88,4	100,0
	Total	1136	95,9	100,0	
Missing	System	48	4,1		
Total		1184	100,0		

Energy from grid used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	3,4	3,6	3,6
	No	1064	89,9	96,4	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from paraffin used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1101	93,0	99,7	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from gas used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1102	93,1	99,8	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from candles used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1101	93,0	99,7	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from manure/dung energy used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1103	93,2	99,9	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from crop residue used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	,3	,3	,3
	No	1101	93,0	99,7	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from petrol/diesel used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1103	93,2	99,9	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from fuelwood/wood used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	1,8	1,9	1,9
	No	1083	91,5	98,1	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from solar panels used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	,5	,5	,5
	No	1098	92,7	99,5	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from hydropower used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1104	93,2	100,0	100,0
Missing	System	80	6,8		
Total		1184	100,0		

Energy from biogas used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1102	93,1	99,8	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from other used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	35	3,0	3,2	3,2
	No	1069	90,3	96,8	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

No energy used for rearing livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1004	84,8	90,9	90,9
	No	100	8,4	9,1	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

What type of energy or rearing livestockn a

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1104	93,2	100,0	100,0
Missing	System	80	6,8		
Total		1184	100,0		

What type of energy do you use for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Energy from grid	112	9,5	9,8	9,8
	Petrol/diesel	27	2,3	2,4	12,2
	Fuelwood/wood	14	1,2	1,2	13,4
	Solar panels	60	5,1	5,3	18,7
	Other	67	5,7	5,9	24,5
	None	862	72,8	75,5	100,0
	Total	1142	96,5	100,0	
Missing	System	42	3,5		
Total		1184	100,0		

Energy from grid used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	89	7,5	8,1	8,1
	No	1015	85,7	91,9	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from paraffin used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1104	93,2	100,0	100,0
Missing	System	80	6,8		
Total		1184	100,0		

Energy from gas used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1	,1	,1	,1
	No	1103	93,2	99,9	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from candles used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	2	,2	,2	,2
	No	1102	93,1	99,8	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from manure/dung energy used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1104	93,2	100,0	100,0
Missing	System	80	6,8		
Total		1184	100,0		

Energy from crop residue used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1104	93,2	100,0	100,0
Missing	System	80	6,8		
Total		1184	100,0		

Energy from petrol/diesel used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	2,4	2,5	2,5
	No	1076	90,9	97,5	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from fuelwood/wood used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	30	2,5	2,7	2,7
	No	1074	90,7	97,3	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from solar panels used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	62	5,2	5,6	5,6
	No	1042	88,0	94,4	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Energy from hydropower used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1104	93,2	100,0	100,0
Missing	System	80	6,8		
Total		1184	100,0		

Energy from biogas used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1104	93,2	100,0	100,0
Missing	System	80	6,8		
Total		1184	100,0		

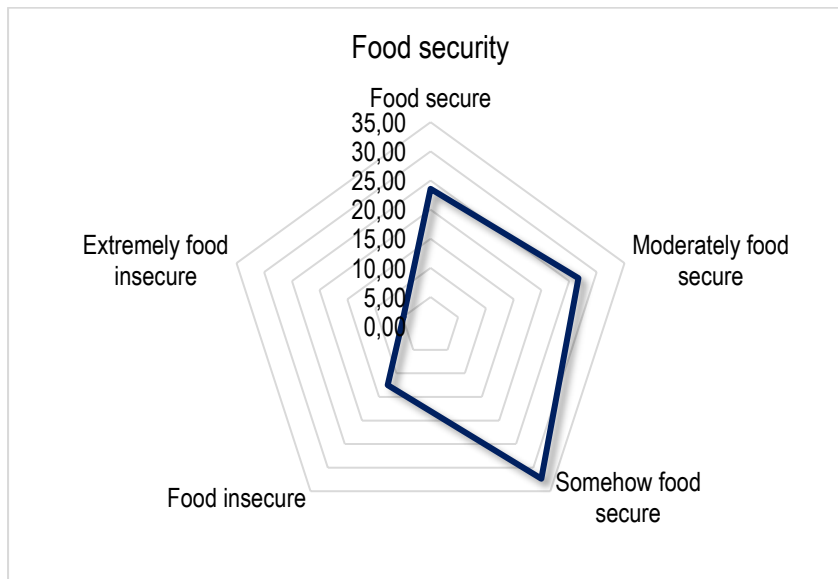
Energy from other used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	54	4,6	4,9	4,9
	No	1050	88,7	95,1	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

No energy used for getting water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	995	84,0	90,1	90,1
	I don't know	109	9,2	9,9	100,0
	Total	1104	93,2	100,0	
Missing	System	80	6,8		
Total		1184	100,0		

Food



Frequencies

Notes

Output Created		23-JAN-2023 14:32:02
Comments		
Input	Data	C:\Users\Ngara001\Desktop\VA ARLHARTS DATA\WEF Nexus governance for social justice data.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	1184
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data.
Syntax		FREQUENCIES VARIABLES=@_did_you_worry_ that_not_have_enough_food @_were_you_or_any_ho_a_lac k_of_resources @_did_you_or_any_hou_a_lack _of_resources @_did_you_or_any_hou_ave_a ny_alternatives

		@_did_you_or_any_hou_was_n ot_enough_food @_did_you_or_any_hou_was_n ot_enough_food_001 @_was_there_ever_no_esource s_to_get_food @_did_you_or_any_hou_was_n ot_enough_food_002 @_did_you_or_any_hou_was_n ot_enough_food_003 /ORDER=ANALYSIS.
Resources	Processor Time	00:00:00,00
	Elapsed Time	00:00:00,00

[DataSet1] C:\Users\Ngara001\Desktop\VAARLHARTS DATA\WEF Nexus governance for social justice data.sav

		Statistics				
		... did you worry that your household would not have enough food?	... were you or any household member not able to eat the kinds of foods you preffered because of a lack of resources	... did you or any household member have to eat a limited variety of foods due to a lack of resources?	... did you or any household member have to eat some foods that you really did not want to eat because you didn't have any alternatives?	... did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
N	Valid	1184	1184	1184	1184	1184
	Missing	0	0	0	0	0

		Statistics			
		... did you or any household member have to eat fewer meals in a day because there was not enough food ?	... was there ever no food to eat of any kind in your household because of lack of resources to get food ?	... did you or any household member go to sleep at night hungry because there was not enough food ?	... did you or any household member go a whole day and night without eating because there was not enough food ?
N	Valid	1184	1184	1184	1184
	Missing	0	0	0	0

Frequency Table

... did you worry that your household would not have enough food?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	180	15,2	15,2	15,2
	Rarely	196	16,6	16,6	31,8
	Sometimes	509	43,0	43,0	74,7
	Often	176	14,9	14,9	89,6
	Always	123	10,4	10,4	100,0
	Total	1184	100,0	100,0	

... were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	192	16,2	16,2	16,2
	Rarely	204	17,2	17,2	33,4
	Sometimes	507	42,8	42,8	76,3
	Often	170	14,4	14,4	90,6
	Always	111	9,4	9,4	100,0
	Total	1184	100,0	100,0	

... did you or any household member have to eat a limited variety of foods due to a lack of resources?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	208	17,6	17,6	17,6
	Rarely	217	18,3	18,3	35,9
	Sometimes	493	41,6	41,6	77,5
	Often	165	13,9	13,9	91,5
	Always	101	8,5	8,5	100,0
	Total	1184	100,0	100,0	

... did you or any household member have to eat some foods that you really did not want to eat because you didn't have any alternatives?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	189	16,0	16,0	16,0
	Rarely	214	18,1	18,1	34,0
	Sometimes	506	42,7	42,7	76,8
	Often	178	15,0	15,0	91,8
	Always	97	8,2	8,2	100,0
	Total	1184	100,0	100,0	

... did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	237	20,0	20,0	20,0
	Rarely	238	20,1	20,1	40,1
	Sometimes	466	39,4	39,4	79,5
	Often	150	12,7	12,7	92,1
	Always	93	7,9	7,9	100,0
	Total	1184	100,0	100,0	

... did you or any household member have to eat fewer meals in a day because there was not enough food ?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	251	21,2	21,2	21,2
	Rarely	260	22,0	22,0	43,2
	Sometimes	454	38,3	38,3	81,5
	Often	135	11,4	11,4	92,9
	Always	84	7,1	7,1	100,0
	Total	1184	100,0	100,0	

... was there ever no food to eat of any kind in your household because of lack of resources to get food ?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	316	26,7	26,7	26,7
	Rarely	242	20,4	20,4	47,1
	Sometimes	426	36,0	36,0	83,1
	Often	122	10,3	10,3	93,4
	Always	78	6,6	6,6	100,0
	Total	1184	100,0	100,0	

... did you or any household member go to sleep at night hungry because there was not enough food ?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	572	48,3	48,3	48,3
	Rarely	165	13,9	13,9	62,2
	Sometimes	348	29,4	29,4	91,6
	Often	67	5,7	5,7	97,3
	Always	32	2,7	2,7	100,0
	Total	1184	100,0	100,0	

... did you or any household member go a whole day and night without eating because there was not enough food ?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	562	47,5	47,5	47,5
	Rarely	176	14,9	14,9	62,3
	Sometimes	339	28,6	28,6	91,0
	Often	75	6,3	6,3	97,3
	Always	32	2,7	2,7	100,0
	Total	1184	100,0	100,0	

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