

A framework for policy coherence between food security, climate change adaptation and disaster risk reduction in South Africa

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PREFACE

This PhD research was done as a PhD-by-articles, which met the North-West University's thesis submission requirements of having at least one research paper published in a prestigious authorised journal. The thesis is divided into seven chapters in accordance with the PhD-by-articles style. The study's overview and the topic it addresses are presented in Chapter 1. The key variables and theoretical foundations of the study are discussed in Chapter 2. In Chapters 3 to 6, the four distinct articles that resulted from the research are given in chronological order. In Chapter 7, the research's overall findings and recommendations are offered. Finally, at the end of the thesis, references from Chapters 1 to 7 are compiled into a consolidated bibliography in accordance with the NWU Harvard referencing style (NWU, 2012).

Specifically, the following articles were produced:

Zembe A., Nema-konde L.D. and Chipangura C. 2022. Policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa: A summative content analysis approach **(Published in Jamba: Journal of Disaster Risks Studies)**.

Zembe A., Nema-konde L.D. and Chipangura C. 2022. Institutional mechanism for policy coherence between climate change adaptation, disaster risk reduction and food security in South Africa and beyond **(Accepted to be published in International Journal of Agricultural Resources, Governance and Ecology)**.

Zembe A., Nema-konde L.D. and Chipangura C. 2022. A policy coherence framework for climate change adaptation, disaster risk reduction and food security in South Africa **(Submitted to International Journal of Environment and Sustainable Development)**.

Zembe A., Nema-konde L.D. and Chipangura C. 2022. Using technology to incorporate climate change adaptation, disaster risk reduction for food security in South Africa **(To be submitted to International Journal of Agricultural Sustainability)**.

In accordance with Section 5 of the NWU's General Academic Rules, Section 4 of the NWU's Manual for Master's and Doctoral Studies, and Section 6.11 of the NWU's Quality Manual of the Faculty of Natural and Agricultural Sciences, the student is the main author on all four (4) article manuscripts and was supported by supervisors as co-authors (NWU, 2016; NWU, 2018a; NWU, 2018b).

The following are included in the appendices:

Appendix A: Letters of permission to utilise the papers in the thesis from all co-authors participating in the research.

Appendix B: Language Editor's Letter.

Appendix C: Ethics approval for research.

Appendix D: Consent form.

Appendix E: Author standards and journal criteria.

Appendix F: Interview guide.

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ABSTRACT

Most food security (FS), climate change adaptation (CCA), and disaster risk reduction (DRR) policies and structures have basically evolved in parallel internationally and in governments, and as a result they operate in isolation. The implication is that there has been a lack of coherence in coordination between institutions that address FS, CCA and DRR policy areas. Therefore, debates on reducing such incoherencies have revolved around developing frameworks, such as the Paris Agreement for Climate Change, Sendai Framework for Disaster Risk Reduction, and the Sustainable Development Goals (SDGs) No. 2, themes and models that bring the three policy areas together. However, appropriate tools or mechanisms (e.g. technology and innovation), alignment of content (text/terms), and coordination mechanisms to support the integration process have received less attention, which were explored in this thesis. To effectuate these implementation mechanisms from oratory to practice is contingent upon coherent policies and institutional mechanisms. Thus, more emphasis was put on policy coherence as a mechanism to bring FS, CCA and DRR together in the study. Nilsson *et al.* (2012:396) define policy coherence as an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives. Policy coherence as a policy objective, tool or a methodology has been widely used to foster synergies and maximise efficiency and effectiveness, while minimising conflicts, gaps, and duplications in delivery between related policies. Due to the increase in experiences with droughts, floods, veld fires and food insecurity across the globe, including South Africa, policy coherence would constitute a crucial step in reducing the impacts of climate change and disasters on FS in South Africa.

This tripartite linkage could facilitate the collection of information and experience relevant to CCA and DRR issues through a vast platform that comprises government entities, Non-Governmental Organisations (NGOs), experts and other stakeholders. It could also result in a joint output of new methods, approaches, techniques, and strategies that could enhance the adaptation of climate change and the reduction of disaster risk by the food sector. The relationship might once again serve as a foundation for climate negotiations and financial distribution for successful disaster reduction and increased adaption, particularly in South Africa, where both policy areas are embedded in different ministries with different budgets. Finally, policy coherence is critical for collaborating entities to identify and assume precise roles that govern how they interact and collaborate to achieve their objectives. Whereas it might not be sufficient on its own, policy coherence is used as a deliberate, forward-looking strategy to accelerating measures to decrease disaster risk,

assist climate adaption, and develop resilience in the country's food insecure and at-risk groups. This research effort thus sought to develop a framework that brings coherence between FS, CCA, and DRR policy domains in South Africa.

Based on the discovered gaps in present knowledge, this research utilised a post-positivism approach because it is concerned with the development and understanding of new knowledge, does not isolate theory from practice, and is committed to social movements that strive to transform the world. Using the post-positivism approach, the study examined how experiences, perceptions and practices impact the way FS, CCA and DRR concepts or policy areas are understood and implemented across the globe, including South Africa. This provided the means to understand the discursive dimensions of why policy coherence between FS, CCA, and DRR is important, how it can be achieved and for whom coherence is being sought. The study employed a qualitative research design approach to better understand the social and environmental phenomena that result from social actors' perceptions and actions, with the goal of determining how addressing FS, CCA, and DRR in concert could help to mitigate the impact of climate change and disaster risks on FS in South Africa.

Gathering of the primary data was mainly through key informant interviews (KIIs) and content analysis of policy and legislative documents. Semi-structured KIIs were applied based on role in organisation, knowledge of the subject matter, willingness to cooperate as fully as possible, ability to communicate their knowledge, and impartiality to avoid biasness. All key informants were selected from eight government and research institutions that have a focus on agriculture (food security), environment, and disaster risk reduction. These include the Water Research Commission (WRC), the Department of Agriculture, Land Reform and Rural Development (DALRRD), Agri South Africa (Agri SA), Department of Forestry, Fisheries and Environment (DFFE) (Climate Change Directorate), South African Weather Services (SAWS), Department of Cooperative Governance and Traditional Affairs (CoGTA) (NDMC), Human Sciences Research Council (HSRC), Agricultural Research Council (ARC).

Content analysis was also used as a primary data collection technique on FS, CCA and DRR legislation and policy documents to gain an in-depth understanding of the content and its influence on policy coherence. Content analysis was done on documents such as policy directives, regulations, guidelines, and archival information. Four research articles were written in order to meet the study's objectives, and they are included in the thesis.

In the first article, two research questions were addressed, the first of which was formulated to conceptualise the FS-CCA-DRR nexus and policy coherence within the context of FS.

Secondly, the article aimed to investigate the usage of content in FS, CCA and DRR policy and legislative documents in order to better comprehend its meaning and context in order to promote coherence. Understanding written material (text) was critical for establishing reproducible and valid insights from data to their context in order to provide information, fresh insights, a depiction of facts, and a pragmatic guidance to policy coherence. Consequently, the findings presented in this research confirmed that bringing coherence between FS, CCA and DRR policy domains is advocated as one of the methods for promoting FS sustainability in South Africa. However, the interlinkages found between these three policy sectors revealed that many policies have not yet picked up the button that brings related policies together. This paper submitted that establishing coherence to the three policy areas necessitates explicit and precise content in policy documents, as well as a review of policy documents and legislative changes, to recognise the interlinkages that exist between the policy domains. Ultimately, this would assist in bridging the gaps that exist between the entities responsible for FS.

Therefore, Article 2 sought to explore institutional mechanisms responsible for ensuring coherence between FS, CCA and DRR policy areas and practices. The evidence in this article has established that there are numerous inconsistencies in how institutions carry out the food functions in South Africa. These include a lack of implementation plans that coordinate who should do what, when and where, resulting in conflicting goals and redundancy in interventions. To address the incoherencies, the paper proposed coordination support mechanisms to give insights for policy-makers and practitioners to enable them to coordinate FS, CCA and DRR functions using the six aspects (input, time, preconditions, resources, control, and output) of functional resonance analysis method (FRAM). The proposed coordination mechanism allows for simultaneous participation of relevant stakeholders through a systematic characterisation of FS functions. It also allows policy-makers and practitioners to identify variabilities, challenges, and opportunities that should be considered before an activity is executed through clarifying every component of similar roles and responsibilities across FS, CCA and DRR sectors.

It is through Article 3 that the use of technologies that incorporate CCA and DRR measures when addressing FS are explored. The investigation started with the realisation that disasters and climate change risks, such as floods and droughts, have and continue to affect FS in South Africa, therefore using technology that incorporates CCA and DRR measures would be viable to solve FS issues in the country. This paper used the Western Cape FS project using Sentinel-2 Earth Observation technology and the Urban Agricultural Initiative (UAI) FS project using hydroponics technology as case studies. The main evidence from the study established that both projects incorporate CCA and DRR measures

in most of their food value chains. Although the projects are different in nature, they still face similar challenges, such as the lack of expertise, resources, funding, and an inadequate regulatory environment to improve their farming practices. Again, although KIIs argued that more success of the projects could be achieved at small-scale farming, the majority key informants applauded the successes of the innovation so far and its ability to bring coherence to FS, CCA and DRR issues. On this basis, the study proposed the use of technology as a mechanism that could be incorporated into main FS, CCA and DRR frameworks.

Subsequently, Article 4 focused on how policy coherence between FS, CCA and DRR may be achieved. This article drew on the previous three articles as well as empirical evidence. A novel policy coherence framework was developed in this article. The proposed novel framework for policy coherence in this article followed a six-step process, including (1) Alignment of objectives between global frameworks and national policies and legislation; (2) Alignment of FS, CCA, and DRR objectives at national level; (3) The use of content (text) when setting and prioritising objectives; (4) Coordinating implementation of policies between FS, CCA, and DRR; (5) The use of research and technology for policy coherence; and (6) Flexible processes and systems for regular monitoring, reporting and analysis to guide the development of the framework. The framework helps in understanding that well-coordinated mechanisms or tools, such as technological, resources and institutional, bring collective use of resources, which in turn could increase efficiency, enhance sustainable approaches, and create one-stop-shop systems for knowledge-sharing needed for coherence. The framework is a significant step in translating the theoretical FS-CCA-DRR nexus into a set of practical arrangements that practitioners may use to manoeuvre the nexus's dynamic and changing landscape.

Keywords: climate change adaptation, disaster risk reduction, food security, policy coherence, legislations.

LIST OF ABBREVIATIONS AND ACRONYMS

Agri SA	Agri South Africa
APAP	Agricultural Policy Action Plan
ARC	Agricultural Research Council
CCA	Climate change adaptation
CoGTA	Department of Cooperative Governance and Traditional Affairs
DALRRD	Department of Agriculture, Land Reform and Rural Development
DRR	Disaster risk reduction
DEA	Department of Environmental Affairs
DEFF	Department of the Environment, Forestry and Fisheries
DFFE	Department of Forestry, Fisheries, and the Environment
DMA	Disaster Management Act
DMAA	Disaster Management Amendment Act
EU	European Union
FAO	Food and Agriculture Organisation
FNASREC	Faculty of Natural and Agricultural Sciences Ethics Committee
FRAM	Functional Resonance Analysis Method
FS	Food security
FTFPI	Fetsa Tlala Food Production Initiative's
GIDRM/GIZ	Global Initiative Disaster Risk Management Deutsche Gesellschaft für Internationale Zusammenarbeit
Gol	Government of India
GoM	Government of Mongolia
HFA	Hyogo Framework for Action
HSRC	Human Sciences Research Council
ICSU	International Council for Science
IFAD	International Fund for Agricultural Development
IFSS	Integrated Food Security Strategy
IGCCC	Intergovernmental Committee on Climate Change
LDC	Least developed country
LTAS	Long-Term Adaptation Strategies
NAP	National Adaptation Plan (Global Network)
NCCAS	Climate Change Adaptation Strategy
NDMAF	National Disaster Management Advisory Forum
NDMC	National Disaster Management Centre
NDMF	National Disaster Management Framework

NDP	National Development Plan
NFNAC	National Food and Nutrition Advisory Committee
NGO	Non-governmental organisation
NPFNS	National Policy of Food and Nutrition Security
NWU	North-West University
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
PCD	Policy Coherence for Development
RQs	Research Questions
SAWS	South African Weather Services
SDGs	Sustainable development goals
SFDRR	Sendai Framework for disaster risk reduction
UAI	Urban Agricultural Initiative
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
VIIRS	Visible Infrared Imaging Radiometer Suite
WEF	World Economic Forum
WFP	World Food Programme
WHO	World Health Organization
WRC	Water Research Commission

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CHAPTER 1: STUDY OVERVIEW

1.1 INTRODUCTION

Most food security (FS), climate change adaptation (CCA) and disaster risk reduction (DRR) policies and structures have largely developed in parallel internationally and in governments, and as a result they operate in isolation (Food and Agriculture Organization [FAO], 2012; Habiba *et al.*, 2016). The implication is that there has been a lack of coherence in coordination between institutions that address FS, CCA and DRR policy areas. Therefore, debates on reducing such incoherencies have revolved around developing frameworks, such as the Paris Agreement for Climate Change (United Nations Framework Convention on Climate Change [UNFCCC], 2015), Sendai Framework for Disaster Risk Reduction (United Nations International Strategy for Disaster Reduction [UNISDR], 2015), and the Sustainable Development Goals (SDGs) No. 2 (United Nations [UN], 2015), themes and models (Global Initiative Disaster Risk Management Deutsche Gesellschaft für Internationale Zusammenarbeit [GIDRM/GIZ], 2019) that bring the three policy areas together. However, Nemakonde and Van Niekerk (2017) have argued that less attention has been given to the provision of tools or mechanisms (e.g. technology and innovation, alignment of content (text/terms), coordination mechanism) to support the coherence process, which was explored in this thesis.

Effectuating these implementation mechanisms from oratory to practice is contingent on the coherence of policies and institutional mechanisms (Habiba *et al.*, 2016). Different terms, including integration, consistency, coordination, linking, convergence, and synergy have been used in the literature to denote the coming together of FS, CCA and DRR (Nemakonde *et al.* 2020; Nemakonde and Van Niekerk, 2017; Habiba *et al.*, 2016; Forino *et al.*, 2015; Begum *et al.*, 2014; Djalante and Thomalla, 2012). The study preferred to use the term coherence because coherence is central to bringing policy objectives of various sectors together to achieve joint goals, while other terms such as integration and its components, which include coordination, collaboration, and merging, works better with inter-organisational relations (Nemakonde and Van Niekerk, 2017) rather than policy objectives (Nilsson *et al.*, 2012). Policy coherence is defined as an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives (Nilsson *et al.*, 2012:396). In light of this definition, Madurapperuma *et al.* (2021) argued that tackling the problem of food insecurity caused by increased climatic variability, extremes, and disasters necessitates coordinated policies, tactics, and programmes. Thus, more

emphasis was put on policy coherence as a mechanism to bring FS, CCA and DRR together in the study rather than integration that focuses on organisational design and performance (Kodner and Spreewenbergen 2002; Nemaikonde *et al.*, 2020).

Policy coherence as a policy objective, tool or a methodology has been widely used to foster synergies and maximise efficiency and effectiveness, while minimising conflicts, gaps, and duplications in delivery between related policies (GIDRM/GIZ, 2019; Koff *et al.*, 2020). Due to the increase in experiences with droughts, floods, veld fires and food insecurity across the globe, including South Africa (FAO, IFAD, UNICEF, WFP and WHO, 2017), policy coherence would constitute a crucial step in reducing the impacts of climate change and disasters on FS (Habiba *et al.*, 2016) in South Africa. Through a vast platform that comprises government entities, international authorities, non-governmental organisations (NGOs), and specialists, this tripartite relationship could facilitate the pooling of experience and knowledge relevant to CCA and DRR issues (FAO, 2012). It could also result in a joint output of new methods, approaches, techniques, and strategies that could accelerate the reduction of disaster risk and adaptation to climate change by the food sector (FAO, 2012; Habiba *et al.*, 2016; Seidler *et al.*, 2018).

Again, the linkage between FS, CCA, and DRR might form a basis for climate negotiations and financial administration for optimal disaster reduction and increased adaption (FAO, 2012; Habiba *et al.*, 2016), especially in South Africa, where both policy areas are embedded in different ministries with different budgets. Finally, policy consistency is critical for cooperating entities to identify and accept precise roles that clearly describe how they interact and collaborate to achieve their objectives (Gero *et al.*, 2011). Policy consistency is described as the degree to which government policies (in this case FS, CCA and DRR) are constant and steady over time (White *et al.*, 2013), which in turn guarantees coherence. While policy coherence may not be adequate in and of itself (Cubie and Natoli, 2022), it is employed as a strategic forward-looking approach to accelerate efforts to minimize disaster risk, assist climate adaptation, and build resilience in food insecure and at-risk populations across the country (Habiba *et al.*, 2016).

The achieved purpose of this thesis was thus to develop a framework that brings coherence between FS, CCA, and DRR policy domains in South Africa through a study conducted over a four-year period. This opening chapter serves as the study's foundation, explaining the study's contextual alignment and the research topic it solves. The central theoretical statements shed light on the research's theoretical foundation. The research aims and research questions that the study attempted to answer are also included in this chapter. The chapter extensively covers the research process that guided this research during the study period. It also provides philosophical assumptions and research methodology,

describing how empirical data and existing literature were used to construct the FS, CCA and DRR policy coherence framework, adding to the body of knowledge. The chapter ends with a summary of the several chapters that make up the complete thesis.

1.2 ORIENTATIONS AND PROBLEM STATEMENT

Extreme weather events, climate change impacts, and disasters are the primary causes of hunger worldwide, affecting all aspects of FS, including access to food, supply availability and stability, and nutrition (Habiba *et al.*, 2016). As a result, the global food crisis is exposing existing and potential food insecurity vulnerabilities among households, governments, and the international system (FAO, 2021). Some scholars (Fan, 2020; Mottaleb *et al.*, 2020; Balagtas, 2014) claim that the issue of food crises and security is a question of resources distribution, whereby the most affected populations are the vulnerable groups, including women, children and marginal who do not have access to adequate resources. This study approached the vector of food security and crises from climate change and disasters' point of view, whereby the potential impacts of climate change are acting as a multiplier of existing threats to FS (Khoza *et al.*, 2020), such as changes in rainfall variability, warmer or cooler temperatures that lead to change in growing seasons (Alemu and Mengistu, 2019).

Other challenges, such as frequent and intense land and water scarcity, disasters, and a decrease in agricultural productivity are attributed to climate change (Habiba *et al.*, 2016). The consequences for poor people who are already food insecure and malnourished are enormous. The livelihoods and lives of the poorest and most vulnerable, especially women, children, and remote communities, are particularly exposed to the potential effects of climate change, particularly in least developed countries (LDCs) and small island developing nations (FAO, IFAD, UNICEF, WFP and WHO, 2017; Khoza *et al.*, 2020). This is owing to their high vulnerability to natural disasters, direct reliance on climate-sensitive resources such as water, land, plants, animals, trees, and limited ability to adapt to and cope with climate change effects (Habiba *et al.*, 2016).

Meanwhile, in most of the developing world, including South Africa, the presence of such risks is compromising the capacity of FS policies to meet its long-term sustainability goals, especially SDG No. 2: achieving FS by 2030 (UN, 2015). According to the FAO (2002), FS exists when all people have physical, social, and economic access to enough, safe, and nutritious food that always meets their dietary needs and food preferences for an active and healthy life. Therefore, at minimum, to achieve FS, four components, namely utilisation, availability, stability, and accessibility are needed. However, there is sufficient evidence from authors (Birkmann and Mechler, 2015; FAO, 2021; Habiba *et al.*, 2016; Howes *et al.*,

2012; O'Brien *et al.*, 2006) that climate change and disaster risks have and will affect FS to move from predictable value chains to volatility. The evidence ranges from increases in temperature, heat waves, changing precipitation patterns, veld fires, and droughts that will lead to decreased crop yields, livestock productivity and declines in fisheries and agroforestry (FAO, 2017). Additionally, the South African long-term adaptation strategies (LTAS) (2013-2014), anticipate a decline in yields of staple foods by 2050, whereby annual maize yields will decline by 25% under worst-case scenario (Department of Environmental Affairs [DEA], 2017:46), whereas optimal growing areas for field crops such as soybean, barley, sugarcane, wheat, maize, and sorghum are likely to shift due to climate impacts such as loss of biodiversity, land degradation, and population increase (DEA, 2017). In this regard, vulnerability would determine the extent to which people suffer from the manifestation of climate and disaster risks that they are exposed to (Dilley and Boudreau, 2001). Vulnerability is a basis for assessment methods in several contexts, including disaster management, climate impact analysis, and FS analysis (Dilley and Boudreau, 2001).

South Africa is prone to both meteorological and agricultural droughts caused by a temporary lack of water due to abnormal climate conditions (Kallis, 2008:86), such as the 1991/1992, 1997/1998, 2001/2002, 2003/2004, 2013-2016 and 2018-2020 droughts (National Disaster Management Centre [NDMC], 2015, 2016; Vollgraaff, 2020). While agricultural droughts are defined in terms of timing of the rainfall, which is crucial to crop development (Glantz and Katz, 1977:192), meteorological droughts are described as that period when the amount of precipitation is less than some designated percentage of the long-term mean (Glantz and Katz, 1977:192). In the first half of 2019 these drought episodes have affected about 37% of South Africa's rural community farmers and were considered the worst in the past 100 years (Department of Agriculture, Land Reform and Rural Development [DALRRD], 2019). Although the droughts were mainly due to natural climatic conditions, the other reason was due to a lack of access to water as most dams dried up due to excessive evaporation. The drought impact resulted in disbursement of R430 million for disaster relief from the National Treasury to help affected farmers (Vollgraaff, 2020). Equally important are the 622 visible infrared imaging radiometer suite (VIIRS) fire alerts reported in South Africa between 2020 and 2021, of which 62% were high confidence alerts (Global Forest Watch, 2021). Most fires recorded in 2020 in the Mid-Illovo/Eston area in Kwa-Zulu Natal province and in the Free State province have destroyed two thousand to one hundred thousand hectares of field crops (McCain, 2020; Singh, 2020:1). Such an increase in frequency and intensity of fires is described by Cooley

(2006:98) to be influenced by dry vegetation combined with high temperatures and low humidity.

According to the NDMC (2015), wildfires damaged grazing land, water infrastructure, storage facilities, crops, and cattle in the Kwa-Zulu Natal and 604 farms in the Free State provinces in the year 2015. The country is also prone to flooding disasters, which are mainly induced by weather that diverges from normal conditions due to random variability or cyclical weather patterns (Cooley, 2006:106). Recently, floods induced by Cyclone Eloise were recorded in early 2021, particularly in the Lowveld of the Mpumalanga and Limpopo, as well as KwaZulu-Natal provinces. These flooding episodes have resulted in leaching, waterlogging of crops while damaging roads and bridges used to supply food around the areas. In 2011 and 2012, the country witnessed flooding events in Kwa-Zulu Natal, Northern Cape, Northwest, Limpopo, Mpumalanga, Gauteng, Eastern Cape, and the Free State, which inundated a total of 1543 farms, destroying agricultural crops, fruit orchards, vineyards, and livestock (NDMC, 2011). Consequently, an amount of R600 million was allocated to aid long-term recovery and reconstruction efforts (NDMC, 2011, 2015). As a result of these catastrophes, individual countries' FS, poverty alleviation, and sustainable development aspirations, especially those of afflicted regions including South Africa, are impeded (Khoza *et al.*, 2020; Lipper *et al.*, 2018). This only emphasizes the importance of a more strategic, forward-thinking approach to escalate efforts to enhance adaptation to climate change, building resilience, and minimise disaster risk in food-insecure or at-risk communities (Habiba *et al.*, 2016).

Combining history and future projections of the effects of climate change and disasters on FS, various scholars and internationally agreed frameworks have advocated for governments to address FS, CCA and DRR in coherence. These include Agenda 21, Chap. 9 (Protection of the atmosphere), the 2030 Agenda for Sustainable Development Goals (SDG 2) (UN 2015), the Sendai Framework for Disaster Risk Reduction 2015-2030 (paragraphs 19 (h) and 30 (j)) (UNISDR, 2015), and the Paris Agreement on Climate Change (Articles 7.1, 8.1 and 8.4) (UNFCCC 2015), (Gero *et al.*, 2011; Habiba *et al.*, 2016; Van Zyl, 2013). Research and policy goals in FS, CCA and DRR are increasingly focused on resilience and how to bring innovations, ideas, and experiences from these three domains together (Habiba *et al.*, 2016). In this respect, policy coherence offers a systematic way to ensure that while governments or organisations are dealing with such diverse yet related fields, there should be a well-coordinated mechanism in place to examine possible areas of tensions and synergies with parties concerned (Nilsson *et al.*, 2012). Policy coherence can be described as an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes

associated with jointly agreed policy objectives (Nilsson *et al.*, 2012:396). Drawing from this definition, policy coherence in this study is used to bring synergies between FS, CCA, and DRR policy domains. This is done to address the impact of climate and disaster risks on FS in South Africa.

To enforce such action, Forster and Stokke (2013:20) and Nilsson *et al.* (2012) give precedence to individual policies' (FS, CCA, and DRR) objectives, intentions and motives to be attuned to each other and not conflicting, specifically, decisions and arrangements formulated by authorities or actors (CCA/DRR) responsible for implementing policy instruments (Nilsson *et al.*, 2012) to achieve FS policy goals. In return, such alignments could enable policy-makers to identify priorities and areas needing further analysis and action. The fact that FS, CCA, and DRR policies are administered in different departments or ministries in South Africa, horizontal or intragovernmental coherence (between policy domains at the sectoral level) (Hoebink, 2004; Nuttal, 2005) is relevant to this study.

This study mainly draws from the Organisation for Economic Co-operation and Development (OECD, 2002) and Nilsson *et al.* (2012), who are of the views that to have joint policy outputs and implementation practices, there should be constant interactions between related institutions (FS, CCA, and DRR) to strengthen synergies. Other authors (Adger *et al.*, 2003; UNISDR, 2009) argue for the need to confront climate and disaster risks in the agricultural sector based on the agricultural context in which they occur to ensure cross-fertilisation of policies. Equally important is the argument by Gero *et al.*, (2011), Howes (2014), UNFCCC (2017), and Venton and La Trobe (2008), who cite possible benefits that can be brought to the food sector when addressing CCA and DRR policies in coherence. The benefits include (i) reduced climate-related risks through DRR measures and vice versa; (ii) collective use of DRR and CCA resources (human, finance and natural) which in return can increase efficiency towards FS; (iii) enhanced sustainability and effectiveness of CCA and DRR approaches to FS; (iv) information and data sharing; and (v) one stop-shop systems for stakeholders as a tool to reduce costs from policy formulation to implementation. However, these benefits could only be achieved when using multi-sectoral and multi-stakeholder expertise from FS, CCA, and DRR disciplines in a coherent manner (Gero *et al.*, 2011).

Currently, South Africa has different policy and legislative frameworks for FS, CCA, and DRR. As a result, these issues are treated as separate development issues and, as such, measures are implemented in isolation with limited coordination, if any. Van Zyl (2013) argues that this has led to the issue of FS to continue unresolved. Most legislative documents (National Policy of Food and Nutrition Security (NPFNS) of 2014, Integrated Food Security Strategy (IFSS) 2002, Fetsa Tlala Food Production Initiative's (FTFPI) of

2013, and Agricultural Policy Action Plan (APAP) of 2013) that contribute to FS fail to acknowledge the role that climate and disaster risk have on FS. Moreover, there is a lack of awareness and avenues through which government departments and non-state organisations could give inputs during policy development (Boatemma *et al.*, 2018; Pereira and Drimie, 2016). For example, the IFSS emphasises the need to address socio-environmental challenges, including climate and disaster risks to FS through increasing safety nets, food emergency management systems and FS monitoring systems at all government levels (DALRRD, 2002), but does not establish a coherent way to engage all relevant stakeholders, such as the Department of the Environment, Forestry and Fisheries (DEFF) and NDMC in order to learn adaptation and risk reduction measures needed in the food sector in case of any environmental uncertainty. Another example is that of the NPFNS, where in its effort to forge stricter alignment and coordination with CCA and DRR policies through the National Food and Nutrition Advisory Committee (NFNAC), it failed to establish the committee in practice (Boatemma *et al.* 2018), which is causing disintegration of FS projects across sectors while limiting external engagements for coherent planning and implementation.

Again, one of the Fetsa Tlala Food Production Initiative's (FTFPI) (2014) pillars (land capability) of the programme is required to check climate conditions of any area to consider which crop between maize and beans can flourish in a chosen area. The missing link is that there is no mention in the FTFPI of the need to engage the DEFF and NDMC in any of the arrangements, although it is an act that requires climate change modelling to inform land use planning decisions for crop cultivation choices (DALRRD, 2013:20), although it could be argued that there is no need to consult such stakeholders as there is a directorate of CCA and disaster risk management within DALRRD. Questions may arise, such as will there be no duplication of tasks or conflicts if more than three organisations (FS, CCA, and DRR) are responding to the same risk without a coordination mechanism? How would resources, grants or safety nets from the national government be managed when responding to a FS problem? This study argues that such gaps should be addressed in the context of coherence, whereby, regardless that every sector has its directorate or platform to deal with its own hazards, a central platform informed of a framework should be created and embedded in all legislative documents that could clarify all stakeholder roles and responsibilities, from formulation to implementation stage, to avoid conflicting goals.

Further, the fact that the scope and interests of CCA and DRR are comparable in terms of attempting to enhance resilience and adaptive ability in the context of hazards within the FS context (Glantz, 2003) makes it even more convenient to address them in coherence. However, in South Africa, the DRR legislations and policy documents are also addressing

DRR in silo of FS, although they cite the need to engage DALRRD when responding to FS disasters. Specifically, the Disaster Management Act (DMA) of 2002 emphasises the need for DRR, mitigation, preparedness, effective response, and recovery when dealing with every hazard to reduce its impacts on people's livelihoods, including FS and safety (Pelling and Holloway, 2006; Van Niekerk, 2006; Visser and Van Niekerk, 2009). To enforce such measures, the DMA indicates the need for cooperation between government departments, private sector, NGOs, and civil societies (Hoogstad and Kruger, 2008; Van Niekerk, 2005). The legal mandate that enforces cooperation of all relevant stakeholders to participate in disaster management is given under section 20 (1) (a-d), section 25 (1) (i-vi) (2) and section 15 of DMA No. 57.

Specifically, section 5 (1) (e) (i-xiii) of the DMA (Department of Cooperative Government and Traditional Affairs [CoGTA], 2002) has the legal mandate to convene all relevant stakeholders quarterly to discuss disaster risks affecting every sector under a platform called National Disaster Management Advisory Forum (NDMAF). These sections are created to give platforms for all relevant stakeholders, including DALRRD, to share their disaster risk concerns while devising a jointly agreed solution to engage DRR measures in everyday functions. Although the NDMAF highlights the need to engage organised agriculture quarterly, which could only refer to a specific group of farmers that are well established (in other terms, commercial farmers), it neglects the poor small-scale farmers who are directly exposed to disasters as they are ecosystem dependent. In addition, one can argue that the fact that this Forum is engaged on a quarterly basis and that FS is not explicitly mentioned in the DMA, can in some way make the NDMAF feel not obligated to put FS issues on every agenda, which could in some way affect the coherence of DRR activities.

In the same way, the DMA of 2002, and National Disaster Management Framework (NDMF) of 2005 have overlooked the need to engage CCA institutions to help in reducing climate hazards after specifically identified climate-related hazards (drought and floods) as major hazards that affect FS in South Africa. Although the Disaster Management Amendment Act (DMAA) No. 16 of 2015 was established to provide measures to reduce the risk of disasters through CCA (CoGTA, 2015), it does not provide an operational plan that is inclusive of DEFF and DALRRD. Against this backdrop, developing a framework that aligns FS, CCA, and DRR activities seems long overdue.

Finally, the CCA mechanisms have tried to accommodate both DRR and FS measures in its legislation and policy documents. For example, the National Climate Change Response white paper of 2011 emphasised the need to create adaptation strategies based on vulnerability and risk reduction in various sectors, including the food sector (DFFE, 2011).

Again, it also advocates for adaptation strategies to be integrated into sectoral plans, including the strategic plan for South African Agriculture, the National Framework for Disaster Risks Management and the National Water Resources Strategy through a bottom-up approach informed by the responses of local government and communities (DFFE, 2011:19). To emphasise how CCA measures acknowledge DRR, and FS is through the Climate Change Adaptation Strategy (NCCAS) of 2019 (DFFE, 2019) that uses the DMAA of 2015 as a term of reference for DRR measures.

The NCCAS also recognises FS mechanisms such as the Agriculture Policy Action Plan, National Policy on Food and Nutrition Security, Mid-Term Strategic Framework 2015-2019 that it could work with for the purpose of advancing its adaptation measures, such as climate-smart agriculture, crop diversification, water harvesting technologies, reduction of land degradation, soil erosion and siltation levels of irrigation dams (DFFE, 2019). However, there is not yet a comprehensive and operational document in either FS or DRR legislations that can address climate change considerations currently except the CCA and Mitigation Plan for DALRRD and the Sectoral Cold Spell Management Plan that are still in their infancy stages (DFFE, 2019). As an illustration, one could say that the strategy has established the most comprehensive document that could align DRR and food security issues as of to date; however, it is still too early to operationalise or evaluate the document as it has been only two years in operation. Also, with the attention to avenues embedded to accommodate other stakeholders, it is still difficult to engage and align CCA measures with those of DRR and FS without a framework that fosters policy coherence between FS, CCA, and DRR.

Taking cognizance of the fact that policy coherence is a relatively new topic in South Africa (Gero *et al.*, 2011), it is understandable how the available literature falls short of spelling out the precise actions that must be taken to engage CCA and DRR measures, as well as the contribution it might bring to the FS discourse. Most of the literature available focuses on integrated institutional arrangements as the fundamental apparatus needed to encourage policy coherence (Pereira and Drimie, 2016), policy alignment between FS objectives (internal policies) (Thow *et al.*, 2018), and the necessity for dialogue between sectors that deal with FS (Boatemma *et al.* 2018). Furthermore, studies of CCA and DRR have a greater emphasis on the factors that connect and make them compatible, with a particular focus on points on convergence, integration issues, similarities, and contrasts (Nemakonde *et al.*, 2021). Others are concerned with mainstreaming CCA and DRR into sectoral policies and development plans (Escorcia, 2016). Admittedly, given the substantial threats to FS, focus should turn to an action-oriented research agenda that guarantees that CCA and DRR initiatives are relevant to those most vulnerable to climate change and disaster risks, especially for a country like South Africa that is heavily reliant on agriculture.

Therefore, in order to address such gaps in FS, CCA, and DRR legislation and policy documents in South Africa, the study sought to develop a framework for policy coherence that could enable FS, CCA, and DRR policy areas and institutions to work together with minimum conflicts to reduce the impact of climate and disaster risks on FS. Development of such a framework builds from an understanding of 1) the use of content in FS, CCA and DRR legislative and policy documents that promotes coherence; 2) how institutional mechanisms are used to coordinate FS, CCA and DRR in their functions for effective coherence; and finally, 3) how the use of technology could help in incorporating CCA and DRR measures when addressing FS in South Africa, which was all explored in this study. A set of five research questions and five research objectives were developed to meet the study's goal.

1.3 RESEARCH QUESTIONS

The following research questions were posed to address the gap in research on the need for a framework to align FS, CCA and DRR policies in solving the FS problem in South Africa:

1. What is CCA, DRR and policy coherence within the context of FS?
2. How does the content (text) within FS, CCA and DRR legislation and policy documents reflect coherence?
3. What institutional mechanisms are used to coordinate FS, CCA and DRR institutions and functions for effective coherence in South Africa?
4. What practical examples, experiences, and tools are used to bring coherence between FS, CCA and DRR policies in South Africa?
5. What contribution can a framework make in guiding policy coherence between FS, CCA and DRR in South Africa?

1.4 RESEARCH OBJECTIVES

The goal of this research was to develop a framework that would bring the FS, CCA and DRR policy domains together. The following research objectives were met to reach this goal:

1. To conceptualise FS, CCA and DRR and policy coherence within the context of FS.
2. To explore how content (text) within FS, CCA and DRR policy and legislation documents is used to influence policy coherence.

3. To explore and develop institutional mechanisms to bring coherence between FS, CCA and DRR institutions and functions in South Africa.
4. To explore practical examples, experiences, and tools used to bring coherence to FS, CCA and DRR in South Africa.
5. To introduce a novel framework that could assist in bringing policy coherence between FS, CCA and DRR policies in South Africa.

While this study cannot guarantee that achieving these objectives will lead to a reduction of disasters and climate change risks and climate-related disasters or that integration of CCA and DRR will solve silo approaches to FS, achieving these goals has a lot of potential for improving how the effects of disasters and climate change on FS can be reduced in a coherent manner while improving FS in South Africa.

1.5 CENTRAL THEORETICAL STATEMENTS

Policy coherence was the main theoretical framework on which this study was grounded. Coherence was pursued to enhance synergies and reduce silos between similar policy domains (Nilsson *et al.*, 2012). Policy coherence refers to consistency and interaction of policy objectives, strategies, mechanisms, and outcomes individually or collectively among FS, CCA and DRR policy areas (Fukasaku and Hirata, 1995:20). The degree of coherence between FS, CCA and DRR policy domains was determined using a policy coherence approach within the broader public policy and environmental scientific discourse as a vital first step in addressing the impact of disasters and climate risks on FS in South Africa.

The study also used the Policy Coherence for Development (PCD) methodology, which is defined as a method or policy tool for integrating the social, economic, governance, and environmental components of sustainable development at all levels of international and domestic policymaking (OECD, 2015). The concept arose from successful European NGO campaigns in the early 1990s, which pushed European Union (EU) policymakers to consider the interests of developing nations when establishing new policies that should be logical or compatible with development objectives. Based on an examination of policy documents and peer-reviewed research on the policy coherence for development movement, Fourie (2018) asserts that five PCD guidelines could be useful for South Africa in aligning national development agenda with global development priorities.

These guidelines are: 1) considering policy impacts from a long-term and transnational perspective; 2) utilising and improving existing institutional structures and processes; 3) ensuring country ownership of development priorities; 4) prioritising political buy-in; and 5)

encouraging cross-departmental cooperation through an issue-based approach. In following such guidelines, stakeholder involvement, knowledge management, capacity building and awareness, institutional or political commitment and leadership (OECD, 2002) were considered as criteria for effective policy coherence. Again, the study drew from Nilsson *et al.* (2012), who strongly believe that constant interactions across sectors could help in achieving a common goal, while avoiding disruptions undermining the goals and measures of other institutions (Hoebink, 2004; Nuttall, 2005; Oberthür and Gehring, 2006:46).

The study also drew from Forster and Stokke's (2013) rational choice approach that argues that there is no set definition of policy coherence; however, there is a broad agreement as to the need to specify a number of parameters in order to make the concept operative. Therefore, this approach helped the study to answer the questions, such as coherence for what and for whom, and what levels at which coherence are to be achieved in a defined administration system. The parameters relate to that system:

- a) Objectives should be formulated in clear terms and harmonised. The implication is that objectives within a policy framework, for instance, the FS policy, should be internally consistent, while objectives pursued within other policy frameworks of the system, for instance DRR or CCA, should be attuned to each other or, as a minimum, not be conflicting.
- b) Strategies and mechanisms should be attuned to the objectives and, as a minimum, not conflict with them or the intentions and motives on which they rest.
- c) The outcomes should correspond with intentions and objectives or, as a minimum, not conflict with them (Forster and Stokke, 2013).

Rational choice theory emerges from classical microeconomics (Scott, 2000). It is formal, axiomatic, and deductive. Although there are two well-known assumptions (methodological individualism and rationality) that the rational choice operates (Scott, 2000), the study followed the concept of rationality to attain greater policy coherence through consistency of policy objectives and instruments individually or collectively (Fukasaku and Hirata, 1995). This was further pursued in Chapter 2 of the study.

The study also drew from the body of knowledge that describes FS, CCA, and DRR as interlinked concepts that seek to reduce the impact of climate and disaster risks on FS (Habiba *et al.*, 2016). The work of Habiba *et al.* (2016) and the FAO (2012), who constructed a framework demonstrating the nexus between FS, CCA and DRR, is thus incorporated into the thesis. The framework explores the CCA-FS nexus, DRR-FS nexus; CCA-DRR nexus; and FS-CCA-DRR nexus to investigate how they relate to each other, as will be illustrated in Chapter 2. The main goals of connecting FS, CCA, and DRR policies are to

improve the efficiency of development planning and decision-making by implementing the same plans of action in terms of measures and objectives. FS, CCA, and DRR all aim to use integrated, multi-sectoral methods to reduce risks faced by poor agricultural-dependent people while also making them more resistant and less susceptible to shocks and strains induced by climate change and disasters (Pradhan *et al.*, 2018). Finally, a successful linked CCA and DRR provides cost-effective measures to reducing the harmful effects of landslides, droughts, flooding, heat waves, severe storms, and temperature extremes on FS. In this case, coordination between FS, CCA and DRR helps to reduce redundancy in interventions, incoherent funding structures, terminological differences, and reduces administrative inefficiencies (Gero *et al.*, 2011; Seidler *et al.*, 2018), especially when responding to FS disasters, such as droughts and crop diseases. As a result, it is critical for collaborating entities to define and adopt precise roles that spell out how they will communicate and cooperate to achieve their objectives.

1.6 RESEARCH METHODOLOGY

Leedy (1993) describes a research methodology as an operational framework within which facts are presented so that their meaning may be perceived in the context of the investigation. In addition, a methodology is regarded as the heart of the study as it addresses how theoretical notions are tied to empirical testing (Chipangura, 2019). The methodological approach used to collect data to answer the research questions is detailed below.

1.6.1 Research process

This thesis was written in article format. As a result, four research publications were written and submitted to peer-reviewed international journals over the course of four years. Figure 1 below depicts the three stages of the research process. The study's overview and theoretical underpinnings were established in stage one. In stage 2, mechanisms for policy coherence, including use of content and technology, and institutional mechanisms, were explored. Finally, stage 3 presented a novel framework for policy coherence between FS, CCA, and DRR.

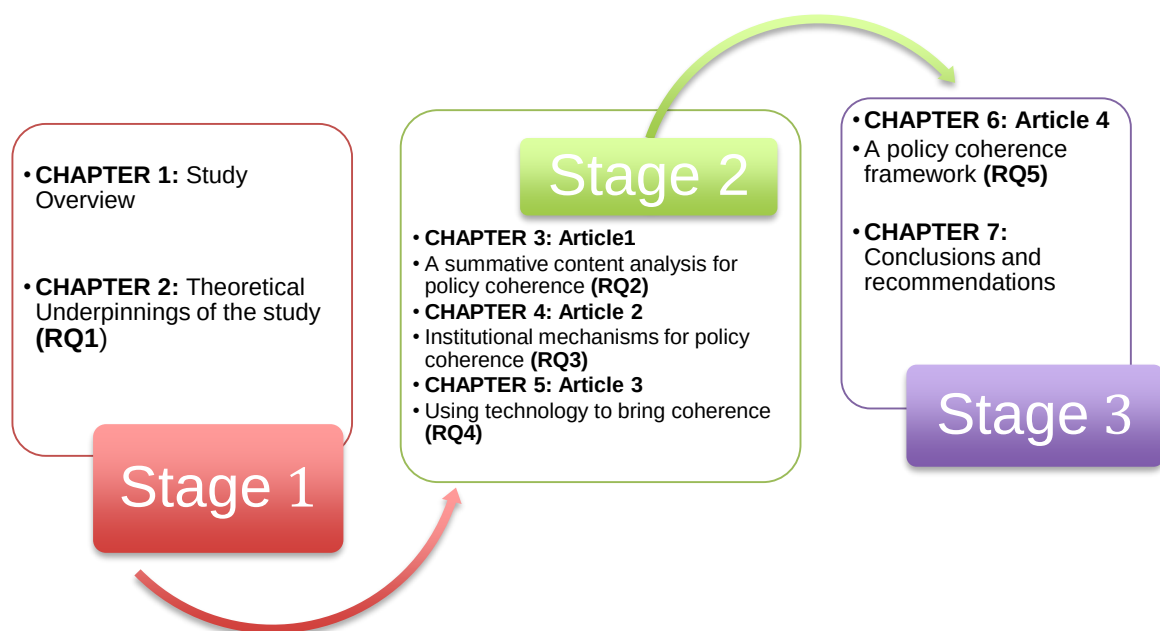


Figure 1: Stages of the research process

Stage 1

In this phase the study overview (Chapter 1) and the theoretical underpinnings of the study (Chapter 2) were developed. Chapter 1 provides the introduction, problem statement, central theoretical statements, research questions and objectives, and the research methodology. The central theoretical statements as outlined in Chapter 1 guided the theoretical underpinnings of the study explored in Chapter 2. Chapter 2 explored the interface between the FS- CCA-DRR nexus and provided clarity on the concept of policy coherence from policy coherence for development and rational choice approach.

Stage 2

In this stage the empirical findings (Chapters 3, 4, and 5) of the study were written. which addressed multiple mechanisms required to promote policy coherence between FS, CCA and DRR policies, as illustrated in Figure 1. Specifically, Chapter 3 (Article 1) assessed how the meaning and usage of content (texts) in policy and legislative documents promote policy coherence. In the process the chapter addresses the second objective of the study (RO2) Chapter 4 (Article 2) addresses the third objective of the study (RO 3). The chapter provided a coordination mechanism that allows for simultaneous participation of relevant stakeholders in the identification of variabilities, challenges, and opportunities that should be considered when carrying out related tasks across the FS, CCA AND DRR . Chapter 5 (Article 3) explored how the use of agriculture technology could help in incorporating FS,

CCA, and DRR information when addressing FS. This chapter addressed the fourth objective (RO 4) of the study. In the end, all the literature and findings from the chapters in Stage 2 informed Chapter 6 of the study.

Stage 3

Chapter 6 (Article 4) provides a novel framework for policy coherence between FS, CCA, and DRR that considers proper use of content (text) (Article 1), enforce proper coordination among institutions (Article 2), and promote innovation and technology (Article 3) for effective coherence between FS, CCA, and DRR in South Africa. Finally, conclusions, recommendations, limitations and the way forward of the study findings were presented in Chapter 7 of the thesis.

1.6.2 Research philosophy

To address the research aims and objectives as outlined in Section 1.4 above, this research was approached from a post-positivist philosophy. According to Ryan (2006:12), a post-positivism philosophical position focuses on the meaning and the creation of new knowledge, and supports committed social movements, that is, movements that aspire to change the world and contribute towards social justice. Fox (2008:2) describes post-positivism as an approach to knowledge and assessment of the nature and reality. Thus it is both an epistemological and ontological position (Fox, 1998). Post-positivist research is broad rather than specialised, theory and practice cannot be separated, and the researcher's motivations for and commitment to research are important and crucial to the project (Schatz and Walker, 1995). These characteristics helped to set parameters for the research study, including gathering and categorisation of information or data (Schatz and Walker, 1995). The study followed a post-positivist philosophical insight because it allowed the researchers to investigate their own epistemologies (underlying assumptions they use to sense day-to-day lives) and understand how they affect them to understand how people construct and maintain perceptions of the world. Along with discourse and debate, this was accomplished while maintaining honesty, perseverance, patience, imagination, courage, self-discipline, and sympathy (Ryan, 2006). Another rationale was that the research allowed people to be part of the research in their own settings, thus instilling a sense of ownership that allowed participants to provide the information without hindrance (Wolcott, 1990: 19; Richie and Rigano, 2001: 744).

Post-positivism positions are found on the theoretical belief that understanding the meanings and interpretations of the research subjects is the key element to the approach

rather than causality (Fox, 2008). This stance acknowledges the interpretivists social science and constructionist approaches, which recognises the meanings, interpretations and construction of social reality to emerge from the research subjects (Fox, 1998). Taking the post-positivist stance allowed the researchers to take a moral stand and recognise the complexity of the web of life and experience in a reflexive manner to avoid dogma or authoritarian tones (Ryan, 2006). In the study, four key features of post-positivism philosophy influenced the qualitative methods used for data collection and formulation of research questions. These include the acknowledgement that the objects of study are themselves engaged in an ongoing project of producing the social world, and that, as a result, their sense-making must itself become part of the subject matter of a social science, rejecting a crude restriction of study to “social facts” and accepts the context-specificity of knowledge; it acknowledges that human beings’ innate abilities to perceive the world serve as the study’s primary research tools. As a result, these tools operate through the exact same intersubjective meaning attribution the researcher is interested in researching. Although the researcher may aspire to objectivity, this stems primarily for the separation from the practical commitments and interests of the subjects rather than from any fundamental difference in the researcher’s ability to interpret free of values and norms; the third feature guided the researcher to be reflexive on their interpretive work and to simultaneously strive for and acknowledge the difficulty of detachment (Fox, 2008). These features provided the means to understand the discursive dimensions of why policy coherence between FS, CCA and DRR is important, how it can be achieved and for whom coherence is being sought.

1.6.3 Research approach

A qualitative research design was adopted in this study following a post-positivist approach. The post-positivist approach allows for both qualitative and quantitative research designs, thus the choice of design depended on the type of research questions being asked in the study (Ryan, 2006). In case of this study, all five research questions pointed to subjective FS, CCA and DRR issues, which required indepth inquiries that align with a qualitative study. Thus, a qualitative research design was conducted to see how addressing FS, CCA and DRR in a coherent manner could help minimise the impact of climate change and disaster risks on FS in South Africa (Saunders *et al.*, 2009). While the pursuit of knowledge remained the aim of the social scientific inquiry, the post-positivism approach helped the study to aspire absolute truth qualitatively. The study used qualitative study because it acknowledges the role of the researcher as the interpreter of data, which contributes to reflexivity in research practice (Fox, 1998). Although, the qualitative research did not

attempt “to avoid biasness” as in a quantitative study, the researcher acknowledged their subjectivity and that of the respondents (Braun and Clarke, 2013). The goal of qualitative research was to interpret the meaning and the relationship between language and meaning using the concept of discourse, which is a web of beliefs and categories, statements, practices and habits (Ryan, 2006). The fact that the study focused most on the meanings and relationships from human perspectives automatically rolled out quantitative methods.

1.6.4 Research strategy

South Africa was used as a case study to gain a better understanding of the dynamics of FS, CCA and DRR policy areas at the national level. South Africa has a dual agricultural economy, which includes a well-developed commercial farming and subsistence-based production in rural areas. The country has a land area of approximately 1.2 million square kilometers whereby 13.7% of the land is potentially arable; 9.6% is protected for nature conservation; 68.6% is grazing land; 1.2% is under forestry; and 2.5 million hectares are in the former homelands and were originally used for small-scale farming; while 14.2 million hectares are used for commercial farming (Mnkeni and Mutengwa, 2014:3).

The agricultural activities range from sheep farming in the arid regions, cattle ranching in the bushveld, intensive crop production and mixed farming in both summer and winter rainfall regions. The crops that are widely grown include maize, followed by wheat, sugarcane and sunflowers (Mnkeni and Mutengwa, 2014). According to the Department of Environmental Affairs [DEA], 2017:46), the South African long-term adaptation strategies (LTAS) (2013-2014) have projected the decline in yields of the crops by 2050 due to the impact of climate change and disasters. According to Senyolo *et al.* (2017), the impact of climate change is expected to worsen water scarcity and related socio-economic development issues, which are a major threat to food security, sustainable development, and poverty in South Africa. For example, Mpandeli *et al.* (2015) asserted that climate change and disasters such as droughts affect various provinces in South Africa, including parts of the Western Cape, Northern Cape, the Free State, and Limpopo, which are augmenting food insecurity.

Further, the dominance of rain-fed agriculture in South Africa reflects that climate-related disasters pose a major challenge to food security due to poor and unreliable rainfall, regular droughts and periodic flooding (Senyolo *et al.*, 2017). Based on such predicaments, the case selection was justified in order to seek understanding of how the three issues (FS, CCA and DRR) are being addressed. The case study was thus examined in the perspective of the DFFE, DALRRD and CoGTA, which guide as the national systems that formulate and

implement policies regarding FS, CCA and DRR in South Africa. The inclusion of research institutions provided relevant knowledge for inquiring into the bringing together of FS, CCA and DRR concepts, methods, language, and strategies for effective coherence. The central motivation for selecting the case study was because the country is agricultural dependent, and its food system is mainly affected by climate and disaster risks, as shown in Section 1.2 (orientation and problem of the study). Again, this makes it relevant to provide first-hand concrete and real-life ideas that could help in achieving the objectives of the study (Ruyter and Scholl, 1998).

1.6.5 Data collection methods and sampling

The primary data collection was mainly through key informant interviews (KIIs), indepth interviews, and content analysis of policy and legislative documents. KIIs were semi-structured and were employed based on role in organisation, knowledge of the subject matter, willingness to cooperate as fully as possible, ability to communicate their knowledge, and impartiality to avoid biasness (Marshall, 1996). These interviews therefore provided a deep understanding of different experiences, challenges and opportunities encountered by FS, CCA and DRR policy-makers and practitioners when responding to FS disasters. An informed consent form was sent via e-mail to purposefully selected organisations to seek permission to conduct interviews. The target number of the research respondents amounted to three (3) per organisation because it was based on the hierarchy of seniority in the departments, which comprised chief directors, directors and deputy directors or project managers. Selection of respondents was done through use of institutions' organograms where they list names, positions, phone numbers and e-mail addresses of the top management. Thus, the total number of key informant interviews respondents was twenty-four (24).

The advantages of KIIs for this research were the position of respondents in the organisation, because they provided more information and deeper insight on what is going on around them (Marshall, 1996). All key informants were selected from eight institutions including Agricultural Research Council (ARC), DALRRD, Water Research Commission (WRC), DFFE (Climate Change Directorate), Agri South Africa (Agri SA), South African Weather Services (SAWS), CoGTA (NDMC), and Human Sciences Research Council (HSRC) constituted the same group of respondents that was interviewed for each of the studies reported in Articles 1, 2, 3, and 4. All KIIs were conducted on different platforms, including telephonic (3), face-to-face(15), e-mail (1), and online (5) interview platforms that were most convenient to respondents. Interview sessions were recorded with the

interviewee's authorisation. In addition, ten (10) indepth-interviews with respondents from Western Cape food security project using Sentinel-2 Earth observation and Urban Agricultural Initiative (UAI) food security project using hydroponics technology was conducted. The indepth- interviews were done face-to face with project beneficiaries (6) and project managers (4). The selection of respondents was based on purposive and snowball sampling. Purposive sampling was done through browsing names and contact details of project managers on the project website whereby two (2) contacts from each project was provided. Snowball sampling was done when the identified project managers would be requested to recommend two suitable project beneficiaries. In the end, the total number of people who participated in the study was thirty-four (34) altogether.

To augment the primary data collected through interviews, content analysis of FS, CCA and DRR legislation and policy documents was conducted. Content analysis was done on documents such as policy directives, regulations, guidelines, and archival information as listed below in Table 1. The documents were selected through searching on government departmental websites using search keywords like “climate change adaptation” disaster risk reduction”, “food security”, “disaster risk”, “climate change”, and “food and nutrition security”. The selection was done on government websites under the legislation section that shows bills, acts, policies, white and green papers, strategies, and action plans. The inclusion criteria of the retrieved documents were that: (i) legislations that dates back from 1994 and are currently used), (ii) legislations formulated and published by the South African government, (iii) legislations that directly address CCA, DRR and/ or FS and (iv) other relevant policy documents cited in the legislative documents under review. A total of 34 documents were identified as follows CCA-12; DRR-8; FS-14 as shown in Table 1 below.

Table 1: Policy documents and legislations used in the study

Document names
White Paper Marine Fisheries Policy for South Africa,1997
National Climate Change Response White Paper, 2011
National Climate Change Response Green Paper 2010_ Department of Environmental Affairs briefing _ PMG
National Climate Change Adaptation Strategy, 2019
National Environment Management Act-107-of-1998 amended 2013
National Climate Change Response Strategy South Africa, 2004
National Water Act 36, 1998
National Environmental Management Act, 1998 (107): Regulations: Environmental Management Framework, 2010
National Environment Management Act Air Quality Act of 39, 2004
South African Weather Services Act 8, 2001
Climate Change Bill, 2018
National Forest Act, 1998
Disaster Management Monitoring and Evaluation Framework, 2014
National Disaster Risk Management Education and Training Framework, 2013
Disaster Management Amendment Act, 2015
Disaster Management Urban Search and Rescue Framework, 2014
Disaster risk Management White Paper, 1999
Disaster Risk Management Green Paper, 1998
Disaster Risk Management Policy Framework, 2005
Disaster Risk Management Act 57, 2002
South Africa Agricultural Policy Action Plan, 2014
Gazette-Climate Smart Agriculture Strategy Framework, 2018
Draft Conservation Agriculture Policy, 2017

Department of Agriculture Forestry and Fisheries draft sector IGDP, 2010
Policy on Agriculture in Sustainable Development - 8th Draft,
Indigenous Knowledge Systems Strategy, 2008
Rural Development Framework Policy, 2013
Draft Climate Change Sector Plan for Agriculture, 2015
Green Paper Land Reform, 2011
National Policy for Food and Nutrition Security, 2014
Integrated Food Security Strategy, 2002
Mechanization Support Policy Framework, 2014
Fetsa Tlala- Integrative Food Production Initiative, 2013
Household Food and Nutrition Strategy for South Africa, 2013

As detailed below, data gathering methodologies and sampling differed depending on the research aims and article the focus of the article developed.

Objective 1: To conceptualise FS, CCA, DRR, and policy coherence within the context of FS.

An extensive literature research was done to conceptualise and contextualise CCA and DRR in the context of FS in order to achieve this objective. A literature review, according to Hart (2009:13), is a selection of available literature (both published and unpublished) on a topic that incorporates ideas, information, evidence, and data produced from a particular viewpoint to achieve specific goals. It also communicates specific viewpoints on the nature of the issue and how it will be examined, as well as how these documents will be evaluated in relation to the planned research. Various search combinations were utilised to locate relevant literature on topics such as food security, climate change, policy coherence, and disaster risk, which served as the foundation for creating the study's theoretical frame of reference. This was done to have a better grasp of the nature and significance of the identified problem. Machi and McEvoy's (2012) six-step literature review process guided the research strategy. It started with choosing a topic; searching the literature; creating arguments; studying the literature; critiquing the literature; and finally producing the literature review.

An assessment of the legitimacy of the material obtained from various sources was done through cross-examining different authors' reasoning and discoveries on viewpoints, as well as the direct link between the major variables under investigation. At the same time, trying to harness the opportunities and outcomes of well-coordinated FS, CCA and DRR policies into solving FS problems in South Africa. Literature sources ranged from academic books on FS, CCA, DRR, and policy studies, government publications, NGOs and international multilateral reports, scholarly journal articles, Internet sources, and dissertation and monographs. Literature was thoroughly synthesised, summarised, and analysed to provide the latest information while providing a theoretical foundation for the research (De Vos, 2008; Hart, 1998; Randolph, 2009), as presented in Chapter 2 of this thesis, to attain research Objective 1.

Objective 2: To explore how content (text) within FS, CCA and DRR policy and legislation documents is used to influence policy coherence.

In addressing this objective, a document content analysis was employed on 34 FS (14), CCA (12) and DRR (8) legislation and policy documents.

This was done in four stages, starting with browsing for and obtaining documents from government webpages; identifying preliminary themes and developing key terms through qualitative inductive reading of literature; using Atlas.ti to define policy quantitative features and trends using the keywords; and finally, comparing the themes by qualitative deductive with KII findings.

This was followed by KIIs with a total of 24 participants who were purposively selected from eight institutions (government research institutions and government sectors) (see Section 1.6.5). The methodology's motivation was to employ content analysis (CA) to identify and quantify data from policy and legislative texts in order to understand the contextual use in regard to coherence, while KIIs used CA themes to allow meaningful comparison of the findings.

Objective 3: To explore and develop institutional mechanisms to bring coherence between FS, CCA and DRR institutions and functions in South Africa.

In addressing this objective, a qualitative research design was used, including a conventional content analysis on three main policy documents (NDMF of 2005, the NPFNS of 2014, and the NCCAS of 2019). In addition, a total of 24 participants were purposively selected from eight institutions (government sectors and government-supported research institutions) for the purpose of conducting KIIs (see Section 1.6.5) to get in-depth information on how FS, CCA and DRR institutions interact, and the challenges and opportunities encountered when carrying out FS functions. The reason for using both

methods was because they complemented each other, since content analysis focused on manifest and latent contents from policy documents, while KIIs provided a rich and complex interpretation of data found in content analysis.

Objective 4: To explore practical examples, experiences, and tools used to bring coherence to CCA, DRR and FS in South Africa.

The study utilised a qualitative research design, including a literature review relating to Sentinel-2 earth observation and hydroponic farming technology in general and South Africa in particular, while in-depth interviews with ten (10) respondents from the Western Cape food security project using Sentinel-2 Earth observation and Urban Agricultural Initiative (UAI) food security project using hydroponics technology projects were conducted, whereby purposive sampling was used to select project managers who would then refer researchers to project beneficiaries. In addition, KIIs were conducted with twenty four (24) purposively selected respondents from eight institutions (government sectors and government-supported research institutions) (see Section 1.6.5). The significance of interviewing government and research institution officials was a deliberate choice to get an external perspective of how the FS projects are performing in terms of incorporating CCA and DRR measures.

Objective 5: To introduce a novel framework that could assist in bringing policy coherence between FS, CCA and DRR policies in South Africa.

The data for this study was gathered by conventional content analysis (CA) of three policy documents relevant to FS, CCA and DRR in South Africa, as well as key informant interviews (KIIs). The conventional method to content analysis was used in the study to see how FS, CCA and DRR policies promote coherence in South Africa.

The conventional content analysis in the study was broken down into three stages:

- Using government websites to find and collect policy and legislative materials.
- Using qualitative inductive reading of text, develop keywords and topics from existing literature and policy documents.
- Comparing qualitative deductively with KII data to assess the themes.

The primary data was gathered through 24 KIIs purposively selected from eight institutions (government sectors and government-supported research institutions) (see Section 1.6.5). Both methods were motivated by looking for gaps in the existing literature and perspectives of relevant officials to inform the development of a framework that brings FS, CCA and DRR policies together.

1.6.6 Data analysis

Qualitative data analysis is described as the examination and categorisation of information collected with the goal of making sense of data and what is depicted in it (Flick 2014:370). For key informant interviews, the study employed thematic analysis that commits to transparency and shows the criteria of validity through its stages of data analysis. Thematic analysis is a technique for detecting, analysing, and presenting patterns (themes) in data, with the data set minimally organised in rich detail (Boyatzis, 1998). Data gathered was transcribed verbatim.

The analysis followed the six-phase process established by Terry *et al.* (2017:23-24). The procedure started with (i) getting familiar with the data (browsing through data to get the meaning). Phases ii and iii (creating and generating codes) were omitted from the study as they were out of scope. Phases iv and v (reviewing prospective themes, defining, and naming themes) were constructed in alignment with the major interview questions. Finally, the sixth phase (producing the final report) was presented in the results section. The reason for choosing thematic analysis in this study was because it offers a more accessible and flexible form of investigation, especially for those early in qualitative research, unlike grounded theory and thematic decomposition analysis that require detailed technological and theoretical knowledge of approaches (Braun and Clarke, 2006:81). Thematic analysis helped to unpick or unravel the surface of reality that there is a need for addressing FS, CCA and DRR as interlinked developmental issues with many overlapping targets, which therefore should be addressed in harmony to solve FS issues in South Africa.

Content analysis was used to analyse the primary data collected from policy and legislative documents. The term "content analysis" refers to a group of methods for systematically examining text in order to find themes, meanings, and patterns (Hall and Steiner, 2020). Summative and conventional content analyses were used in this study. Conventional content analysis is an inductive method that focuses on text data, whereas summative content analysis involves counting and comparing keywords or content, then interpreting the underlying context (Hsieh and Shannon, 2005).

In Article manuscript 1, conventional and summative content analyses were used to analyse data gathered from Atlas.Ti (a computer-assisted qualitative data analysis software tool that analyses text data by the generation of codes, categories, and themes from data sources [Smit, 2002:65]). Thematic analysis was used to analyse data from KIIs. In Article manuscript 2, both content analysis and thematic analysis were used to complement each other, where content analysis focused on manifest and latent contents from the policy documents and thematic analysis provided a rich and complex interpretation of what was

found in content analysis. To this end, a coordination mechanism evolved from both analyses with conceptual density that helped to coordinate FS, CCA and DRR institutions and functions. Data from Article manuscript 3 was analysed through thematic analysis, while Article manuscript 4 used both conventional content analysis and thematic analysis for data analysis, which later informed the development of a framework for policy coherence between FS, CCA and DRR in South Africa.

1.6.7 Ethical considerations

The Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC), North-West University, South Africa, granted ethical approval for the study (Ethics no. NWU-01386-20-A9). The data was collected from September 2019 to December 2019 before the COVID-19 pandemic. It was critical to follow ethical guidelines throughout the study to guarantee that the dignity and rights of study participants were respected, and that the data collected was not tainted by bias (Creswell, 2014). After being informed of the purpose, methods, and planned applications of the research findings, research participants gave their voluntary and informed consent during data collection. Following that, where quotes from research participants were utilised, there was no precise identification of people in the articles published.

1.7 DIVISION OF CHAPTERS

The study constitutes the Introduction and Orientation, Literature Review, Four Research Articles, and a Conclusion.

Chapter 1: Overview of the study

The chapter introduced pertinent material to the reader, which also served to contextualise the study problem. The study's Research Questions, Objectives, and Central Theoretical Statements were all discussed. Finally, a summary of the research methods was presented.

Chapter 2: Literature review: Theoretical underpinnings of food security, disaster risk reduction, and climate change adaptation, and policy coherence

This chapter provided theoretical underpinnings that show gaps in literature, and sought to answer RQ 1: *What is FS, CCA, and DRR policy coherence within the context of food security?* The Chapter explored the interface between the CCA-DRR-FS nexus to determine linkages, common goals, and gaps that influence coherence. It further explored policy coherence as a concept, from policy coherence for development perspective, and from a rational choice approach to determine how it can be applied in the South African context.

Chapter 3: Article 1 – Policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa: A summative content analysis approach.

This article sought to answer the second research question: *How does the content within FS, CCA and DRR legislation and policy documents reflect coherence?* The purpose of this article was to see if South Africa's FS, CCA and DRR policies are all in sync. This was accomplished by investigating the use of material (text) in FS, CCA and DRR policy and legislative documents to better understand its meaning and context in order to improve coherence.

Chapter 4: Article 2 – Institutional mechanism for coherence between climate change adaptation, disaster risk reduction and food security in South Africa.

The article sought to answer RQ 3: *What institutional mechanisms are used to coordinate FS, CCA and DRR institutions and functions for effective coherence in South Africa?* In answering the research question, the article sought to develop a coordination mechanism that could help in aligning FS functions undertaken by FS, CCA and DRR institutions. The coordination mechanism was developed using aspects from the functional resonance analysis method (input, time, preconditions, resources, control, and output) to allow for simultaneous participation of stakeholders across sectors with fewer conflicts. It also allows policy-makers and practitioners to identify variabilities, challenges, and opportunities that should be considered before an activity is executed.

Chapter 5: Article 3 – Using technology to bring coherence between climate change adaptation and disaster risk reduction for food security in South Africa.

This article sought to answer RQ 4: *What are practical examples, experiences, and tools used to bring coherence between FS, CCA and DRR policies in South Africa?* To answer the research question, the article explored two FS projects in South Africa, namely The Urban Agriculture Initiative (UIA) that used hydroponic farming technology in Johannesburg, and the Western Cape project that uses Sentinel-2 earth observation technology as case studies. In doing this, the study brought in the practical side of addressing coherence between FS, CCA and DRR through technology and recommended review of policies that supports agriculture innovation to accommodate CCA and DRR measures.

Chapter 6: Article 4 – A policy coherence framework for food security, climate change adaptation, disaster risk reduction in South Africa.

The article sought to answer RQ 5: *What contribution can a framework make in guiding policy coherence between FS, CCA and DRR in South Africa?* The article sought to develop a novel framework for bringing coherence between FS, CCA and DRR policy areas in South Africa. The framework has the potential to accelerate policy coherence by aligning global and national objectives, coordinate implementation and monitoring mechanisms to have efficient or effective joint outcomes.

Chapter 7: Conclusions

This chapter summarizes the study's findings and makes recommendations for future research. It considers the practical and theoretical contributions of a framework for policy coherence between FS, CCA and DRR in South Africa.

1.8 CONCLUSION

The purpose of this chapter was to give the reader an overview of the study and a knowledge of the research process that was used to get to a conclusion on the statement of the problem. As a result, the chapter introduced the major issues that prompted the research. To aid in the study's direction, the research questions and objectives were highlighted. The research methods used in the study were then discussed. This chapter provided the reader with the study's core theoretical statements. It also attempted to describe the research methodology used to achieve the study's aims. The chapter ended with explaining the thesis' structure to make it easier for the reader to follow. The theoretical foundations that grounded the study are outlined in the next chapter.

CHAPTER 2: THEORETICAL UNDERPINNINGS OF FOOD SECURITY, CLIMATE CHANGE ADAPTATION, DISASTER RISK REDUCTION AND POLICY COHERENCE

2.1 INTRODUCTION

The basic theoretical statements that underpin the research were introduced in the prior chapter. Following that, this chapter expands on Chapter 1 (Section 1.5) by offering a complete overview of the literature that informed the thesis. Within the perspective of food security (FS), this chapter investigates the relationship between climate change adaptation (CCA), disaster risk reduction (DRR), and food security (FS) policies. This is done through exploring the CCA–DRR nexus, the DRR-FS nexus, the CCA-FS nexus and the CCA-FS-DRR nexus. It explores what is policy coherence, why and how it was used to bring harmony, coverage and implementation, and coordination between FS, CCA and DRR policy frameworks. It also explored the concept of rational choice approach and its contribution to policy coherence.

2.2 THEORETICAL UNDERPINNINGS FOR POLICY COHERENCE

Policy coherence is defined as a feature of policy that systematically reduces tensions and fosters synergies between and within policy areas in order to realize the outcomes associated with mutually agreed policy objectives (Nilsson *et al.*, 2012:396). The operational definition of policy coherence in this study would refer to deliberate processes and actions to integrate FS, CCA and DRR policies to increase efficiency, effectiveness, and the achievement of common (e.g. resilience) and respective goals. Policy coherence in this study is defined as a mechanism of policy that brings FS, CCA and DRR policy objectives together for the purpose of reducing climate change and disasters to improve food security in South Africa.

The working definition intends to provide a shared understanding for what the study means by “coherence” in the context of FS, CCA and DRR frameworks and policies within South Africa. Although not always precisely defined, “coherence” in this study is referred to as:

- An approach to improve the processes and achievement of policies' goals in terms of maximising effectiveness, synergies, efficiency, and minimising conflicts, and duplications in delivery.
- An approach to incorporate, as adequate, the objectives of FS, CCA and DRR.

In addition, coherence should be context-specific and flexible in response to country (South Africa) structures, conditions, and mechanisms in a flexible manner (GIDRM/GIZ,

2019). Thus, for coherence to occur, it should be operationalised horizontally across actors, including communication and cooperation between government and research entities at national level. Again, this can happen not only during policy development and planning, but also throughout implementation, monitoring, and reporting (GIDRM/GIZ, 2019).

The policy coherence concept has manifested itself in through, for example, the 2030 Agenda for Sustainable Development Goal (SDGs) 17, Target 13 (improve global macroeconomic stability including through policy coherence and coordination), Target 14 (promote policy coherence for sustainable development), and the impact assessment procedure in the European Union, and more various “road maps” (CEC, 2011a; 2011b). The Paris Agreement on Climate Change (UNFCCC, 2015) and the Sendai Framework Disaster Risk Reduction 2015-2030 (SFDRR) (UNISDRR, 2015) have also endorsed policy coherence as a way of aligning FS, CCA and DRR policies and their mechanisms. These calls for more coherence in policymaking are frequently expressed in the context of improving interconnections between various social, environmental, and economic policies, as well as enhancing synergies and reducing disputes across other interacting policy sectors (Nilsson *et al.*, 2012). In the end, this study advocated for a coherent operationalisation of CCA, DRR and FS policies, mainly because:

- a) The topics, which the policies address, including climate variability, vulnerability and exposure reduction, resilience building, promotion of a proactive and inclusive disaster risk management, declining ecosystems, and food insecurity (Habiba *et al.*, 2016; FAO, 2021) are inextricably linked to each other, although there is less success in addressing them in coherence and tackling such underlying factors holistically (UNDP, 2017; UNISDR, 2015).
- b) There are shared concepts which are drivers behind CCA, DRR and FS policy frameworks from global to local levels, such as “building resilience”, “risk reduction”, “reducing vulnerability” (GoI/UNISDR, 2016; 2018; ICSU, 2017; ODI, 2016; UNCC Secretariat, 2017). However, the context in which these terms or content is used differs in each policy framework, and understanding these differences is important when coherence is pursued to achieve related goals as each policy depends on the other (GoI/UNISDR, 2016; UNISDR, 2017). This was further addressed in Chapter 3 of the study.
- c) The benefits of heightened coherence between CCA, DRR and FS policy frameworks may include improved effectiveness and efficiency (NAP Global Network, 2018; UNCC Secretariat, 2017). Increased efficiency refers to the recognition that, in situation of limited technical, financial, and human resources to achieve a common objective, a country could make better use of available capacities through a concerted effort (GIZ, 2017; ICSU, 2017); and enhanced effectiveness refers to the understanding that fulfilling the objectives of one

policy framework successfully would result in considerable progress towards the other two (ODI, 2016).

To achieve the benefits highlighted above, the study explored the policy coherence for development, which is described as an industry standard for creating policy coherence, including illustrating how it could be pursued (Fourie, 2018).

2.2.1 Policy coherence for development

According to Fourie (2018), policy coherence has been influenced by the policy coherence for development (PCD) movement. PCD is “an approach to integrate the dimensions of sustainable development throughout domestic and international policy-making” (Koff *et al.*, 2020:2). The goals of PCD are to advance the integrated implementation of the 2030 Agenda by: (i) trying to address the transboundary and long-term effects of policies, even those that are likely to affect LDCs, such as South Africa (OECD, 2019); (ii) facilitating synergies and maximising benefits across economic, environmental, and social policy areas, and (iii) attempting to balance globally renowned SDGs with domestic policy objectives. The study used Fourie's (2018) criteria for integrating National Development Plans and Agenda 2030 in South Africa to explore policy coherence between FS, CCA, and DRR. According to Fourie (2018)'s first criteria, policy coherence is dependent on political buy-in, which includes everything from raising awareness (OECD, 2016) to guaranteeing political commitment at the highest levels and ensuring leadership at the centre of government (OECD, 2016). Numerous researchers on policy coherence, such as Olsen (2008) and Sianes (2017), have indicated that political will plays a crucial role in achieving coherence. This could provide a framework for discovering constructive coherence between DRR and FS policies, especially when combined with the political commitment stated in CCA policies.

Policy coherence, according to the second criterion, stems from the belief that national ownership of development priorities is critical for development effectiveness. Although South Africa is not reliant on development funding, shifts in development thinking regarding the 2030 Agenda may have an impact on how coherence is implemented at the national level. This means that when it comes to establishing alignment between FS, CCA, and DRR and the 2030 Agenda, South Africa can use components of the 2030 Agenda as well as the global development context and priorities as initial points for policy coherence.

Thirdly, Fourie (2018) stresses the necessity of utilising existing structures and procedures, particularly cross-sectoral and whole-of-government methods. Rather than imposing a new structure, the entire government approach tries to harness and strengthen the capabilities

of existing systems. One advantage of this strategy is that, even before any coordinated effort targeted at strengthening policy coherence, many stakeholders in every government are already involved in activities related to policy coherence (OECD, 2016). This is why using existing coordination mechanisms to steer policy coherence between FS, CCA and DRR in the study should be prioritised. In South Africa, such coordination capacities already exist between FS, CCA and DRR policies, such as the National Disaster Management Advisory Forum (NDMAF), National Food and Nutrition Advisory Committee (NFNAC), Intergovernmental Committee on Climate Change (IGCCC) (DFFE, 2019; DALRRD, 2014; CoGTA, 2005), which are positioned well to champion policy coherence between the three policy areas.

The fourth guideline by Fourie (2018) states that an issue-based approach to policy coherence encourages collaboration across government agencies and sectors, particularly where developmental agendas are interrelated (Le Blanc, 2015). For example, FS is regarded as a model case for demonstrating the importance of interdisciplinary approaches. Fourie (2018) claims that securing FS necessitates collaboration with departments other than agriculture (e.g. DFFE and CoGTA). Without a sense of ownership and cooperation across government ministries, FS cannot be ensured. Furthermore, acknowledging these interconnections and the necessity for collaboration across government agencies has the potential to improve production in terms of outputs.

The fifth and last guideline that emerged from Fourie (2018) is the complex view of policy coherence on policy-making. Thus, policy coherence under this guideline is more than just a tool for accomplishing a specific government department's goal for a given year; it is also a tool for reflecting on the consequences of policies beyond the current generation and beyond national borders (OECD, 2016). These traits are emphasized heavily in the 2030 Agenda, and they are perhaps the most essential contribution to policy-making processes that should be taken into account when tying FS, CCA, and DRR policies together.

2.2.2 Rational Choice approach

The concept of rational choice comes from economics, which assumes that people are driven by money and the potential for profit, which prompted sociologists and economists to develop formal, and often predictive, models of human behaviour (Scott, 2000). For the rational choice method, sociologists and political scientists have attempted to construct theories around the assumption that all action is fundamentally "rational" in nature, and that people weigh the expected costs and rewards of any action before selecting what to do (Scott, 2000). The rational choice theory is the name given to this approach to theory, while

exchange theory is the name given to its application to social interaction (Browning *et al.*, 1999). According to rational choice theories, individuals predict the effects of alternative courses of action and determine which is best for them (Forster and Stokke, 2013). As a result, rational people choose the option that will provide them with the most satisfaction (Heath, 1976:3).

Considering that policy coherence involves bringing together various policies and institutions, Forster and Stokke (2013) argue that conflict is inevitable. This is because achieving policy coherence within the complex setting is a demanding challenge, where policies (e.g. FS, CCA and DRR) are located in different sectors within a pluralistic political system, because in policy-making, policy-makers are usually biased towards what benefits them. Again, the arena for decision-making may differ from one policy to another, each arena having actors who may share worldviews that emerge from specialised agenda and predominant objectives set for the particular policy area (Forster and Stokke, 2013).

In addition, Forster and Stokke (2013) argue that not all actors carry the same political weight, nor do they have equal access to decision-makers at various levels. Against this backdrop, Forster and Stokke (2013) argue that the aspiration to attain greater coherence is based on a rational choice approach, whereby instead of defining policy coherence, more focus should be on setting parameters in which policy coherence could be achieved. These parameters should be able to define the ultimate objective of policy coherence in relation to coherence for and for whom the level at which coherence is to be achieved. Another parameter should distinguish coherence between various stages of policy formulation and implementation between motives and objectives, between objectives and strategies and mechanisms for policy implementation, and between motives and objectives and actual outcomes and impacts (Forster and Stokke, 2013).

Forster and Stokke (2013) further argue that if the parameters are set, the administrative system in which these policies (e.g. FS, CCA, DRR) should occur should have the following acceptable features. The core features are that, within this particular system:

- Objectives should be formulated in clear terms and harmonised. The implication is that objectives within a policy framework, for instance FS policy, should be internally consistent. Objectives pursued within other policy frameworks of the systems, for instance CCA and DRR, should be attuned to each other or, as a minimum, not be conflicting.
- The outcome should correspond with intentions and objectives or, as a minimum, not conflict with them (Forster and Stokke, 2013).

- Strategies and methods should be aligned with the goals and, at the very least, not conflict with them or the intentions and motives that underpin them (Forster and Stokke, 2013).

The advantages associated with the rational choice approach is that if the parameters are set and features are followed, there is a possibility of increased policy coherence, which may strengthen some values and interests and weaken others, affecting the various stakeholders differently (Forster and Stokke, 2013). To this end, this may influence policy makers and practitioners' attitude towards coherence, as well as their preference of arena for decision-making.

2.2.3 FS-CCA-DRR Nexus

This section examined the interface between FS, CCA and DRR policies within the context of FS. This was done through exploring the CCA–DRR nexus, the DRR-FS nexus, the CCA-FS nexus and the CC-FS-DRR nexus. As a point of departure, the CCA-DRR nexus was identified as elements with similar goals and targets (i) promoting proactive and inclusive disaster risk management; (ii) managing climate change and disaster risk through vulnerability and exposure reduction; (iii) resilience building and risk transfer and sharing; and (iv) minimising the impact of hazards and associated risks (Birkmann and von Teichman, 2010; Djalante and Thomalla, 2012; IPCC, 2012; Ireland, 2010). Because of these visible interlinkages, steps were taken through the Hyogo Framework for Action 2005–2015 (HFA), UNFCCC's Bali Plan of Action, Cancun Adaptation Framework by UNFCCC in 2010, Sendai Framework for disaster risk reduction (SFDRR) and Paris Agreement for climate change both developed in 2015, to call for CCA and DRR integration (Begum *et al.*, 2014; Rivera and Wamsler, 2014). However, because the frameworks failed to propose adequate means to operationalise their aims of CCA and DRR integration, implementation remains difficult. Such failure has led to isolation and separation of scientists' and practitioners' use of different theoretical frameworks, institutions, financial channels, languages, and goals, which is preventing a joint and shared action in facing climate change and disaster risks (Howes, 2014; IPCC, 2012). Thus, for better coherence between CCA and DRR, Nemakonde and Van Niekerk (2017) and Forino *et al.* (2015) argue that institutional structures must always be collaborative, integrated, transformed, and multi-sector dialogue must be strengthened, and the learning process among scientific communities should always be intensified.

The literature on the CCA-FS nexus is rooted mostly in developing countries that primarily depend on agriculture for their livelihoods (Habiba *et al.*, 2016; Khoza *et al.*, 2019).

Evidence from global to local perspectives has shown that the victims of climate change-related disasters are those who are dependent on natural resources with a lack of capacity to take adaptive measures. CCA measures are considered a critical component of any policy response to climate change if FS is to be achieved considering long-term changes in rainfall patterns and shifting temperature zones projected to increase the frequency of climate-related shocks such as floods and droughts (Brooks and Adger, 2005; Deressa *et al.*, 2009; Gbetibouo, 2009; Habiba *et al.*, 2016; Khoza *et al.*, 2019).

The examples of climate change adaptation strategies for agriculture include (a) institutional changes, primarily government responses such as subsidies/taxes and improvements in agricultural markets (Mendelsohn, 2001); (b) market responses such as income diversification and credit schemes (Hussain and Mudasser, 2007); (c) micro-level options such as crop diversification and changing the timing of operations (Deressa *et al.*, 2007); and (d) technological developments such as water management techniques, promotion of new crop varieties (Kurukulasuriya and Rosenthal, 2003; Mendelsohn, 2001; Smit and Skinner, 2002; Smith and Lenhart, 1996).

However, studies done in South Africa revealed that most farmers, especially smallholder farmers, face challenges while trying to adopt CCA measures due to poverty, a lack of savings to cover the costs of various adaptation solutions, inaccessible credit to boost farmers' financial resources, insecure property rights to invest in adaptation measures, a lack of markets or centralised markets, and a lack of policies that encourage coherence between CCA and FS (Ringler (2007). Therefore, Pradhan *et al.* (2018) advocate for policies to be tailored in a way that encourages investment in sustainable rural and urban agriculture, and the dissemination of appropriate technologies such as increasing irrigation for greater food and livelihood security in the face of climate change. Again, it would necessitate the development of a long-term strategy that would lessen the farming community's susceptibility and sustainably expand agricultural production while decreasing environmental degradation (Pradhan *et al.*, 2018).

In exploring the DRR-FS nexus, Conforti *et al.* (2018) argue that food insecurity and disaster risk reinforce each other whereby people who are food insecure are driven to take drastic means to meet their immediate needs in disaster situations, such as over-exploiting common property resources, including community forests, pastures, ponds, riverbanks and groundwater with medium to long-term consequences for agricultural production and FS. Therefore, the availability of DRR strategies is required to guarantee that hazardous events do not trap countries or communities into poverty and food insecurity loops (Conforti *et al.*, 2018). To this end, there have been significant efforts by international organisations and governments, including South Africa, to strengthen institutional, legislative, and legal

structures to reduce the devastating impacts of disasters on FS through the SFDRR and Food Agriculture Organisation (FAO) (UNISDR, 2009). Both frameworks (SFDRR, FAO) offer opportunities to scale up DRR efforts in a reliable and holistic manner across all agriculture sectors (livestock, crops, forestry, aquaculture, and fisheries), while the FS strategies are there to strengthen resilience against a varied range of disasters (Conforti *et al.*, 2018). However, from the South African government policy perspective, they still address the DRR-FS nexus in silo or as separate developmental initiatives, in which FS remains unresolved (Van Zyl, 2013).

The final nexus explored was the CCA-DRR-FS nexus. The nexus revealed that building a societal resilience to climate change, disaster risk and food insecurity is a shared, progressively more coordinated, and goal-oriented concern of the South African National Development Plan 2015-2030 (National Development Plan (NDP) 2012). The South African government commitment to the 2030 Agenda for Sustainable Development Goal No. 2 - Achieving food security (UN 2015) and complementary frameworks, including the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030 (UNISDR, 2015) and the Paris Agreement on Climate Change (UNFCCC, 2015), has sponsored greater policy coherence within the country. Significantly, the SFDRR has explicitly in its content advocated for coherence in paragraphs 19 (h) and 30 (j), in which it gives guiding principles to implement DRR in coherence to FS and climate change agendas at national levels (UNISDR, 2015:26). In a similar manner, the Paris Agreement gives priority to safeguarding FS and ending hunger by enhancing adaptive capacity towards extreme weather and slow onset events (UNFCCC, 2015: Article 7.1, 8.1 and 8.4), whilst SDG No 2, target 2.4 claims by 2030 to enhance sustainable food production systems through implementing resilience, which interpreted the three concepts as interlinked.

The nexus displayed core benefits that could be achieved if these three policy areas are addressed in coherence, which includes reduced climate-related risks through DRR measures and vice versa, (ii) collective use of DRR and CCA resources (human, finance and natural) which in return could increase efficiency towards FS, (iii) enhanced sustainability and effectiveness of CCA and DRR approaches to FS, (iv) information and data sharing, and (v) one-stop-shop systems for stakeholders as a tool to reduce costs from policy formulation to implementation (Gero *et al.*, 2011; Howes, 2014; UNFCCC, 2017). However, the fact that the shared objectives of FS, CCA and DRR are still implemented in silo has caused the drawbacks of achieving these benefits and the separation has resulted in the use of its own political contexts, different terms, different funding structures (OECD, 2018:10), fragmented responsibilities (Seidler *et al.*, 2018:35), temporal mismatch due to difference in origins (Birkmann and von Teichman, 2010:37; Thomalla *et al.*, 2006:16),

regardless of how they are interrelated (Peters *et al.*, 2016:32). The next stage, based on this evidence, was to look at how the existing content of FS, CCA and DRR policies promotes coherence.

2.3 CONCLUSION

Critical points emphasised throughout this chapter are that DRR and CCA are of critical importance in ensuring FS to millions of people, as is the fact that vulnerability reduction can serve as a cornerstone for initiatives to mitigate the detrimental effects of climate change and disaster risks. There is a substantial body of research on DRR and CCA that might be used to establish coordinated FS initiatives; however, this material has yet to be completely reviewed (if not already underway). Furthermore, it is becoming obvious that neither DRR nor CCA are solely concerned with disasters or climate change alone (UN, 2008), but rather with the socio-economic environment (including agriculture) in which these changes are taking place. An investigation of the literature and empirical evidence on the DRR-CCA nexus is a significant first step towards developing the framework that could meet the present and future challenges of FS in South Africa. In considering the linkages between FS, CCA and DRR, it is important to recognise that FS is not simply about the provision of food to all people (FAO, 2002), but it is about considering the risks associated with the entire food value chain and trying to reduce the impact through CCA and DRR measures to keep up with the food demand. As many studies given in this chapter demonstrated, it is possible to lower the risk of climate change and disasters on FS if the policies that address them are implemented in a coordinated manner. The argument from this chapter is that when government policies are not harmonised in terms of coordination, implementation, and coverage, the chances of obtaining the desired outcomes are hampered and the policies may be unsuccessful. Therefore, it is of critical importance to make sure that FS, CCA and DRR policies are working in coherence to get the intended results, which is a food secure South Africa.

The following chapter looks at how the content (text) within FS, CCA and DRR policies is utilised to improve coherence in South Africa.

A SUMMATIVE CONTENT ANALYSIS FOR POLICY COHERENCE BETWEEN FS, CCA AND DRR

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Policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa: A summative content analysis approach



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Climate change through extreme weather events threatens food security (FS) and the eradication of poverty. Thus, improving FS will require adapting to the impacts of climate change as well as reducing the risks of disasters. However, the nexus between FS, disaster risk reduction (DRR) and climate change adaptation (CCA) is not always reflected in policies, resulting in fragmented implementation. The purpose of this article is to evaluate if there is coherence in the policies for FS, DRR and CCA in South Africa. A qualitative research design was applied, and data were collected through a summative content analysis on 34 policy and legislative documents and 24 key informant interviews (KII). The study found that there are still incoherencies between the current main policy and legislative documents that address CCA, DRR and FS. This study recommends a review of old policy and legislative frameworks promulgated in the 1990s to incorporate cross-cutting issues such as DRR, CCA and FS. This will enhance and strengthen synergies and interconnections between the three policy areas.

Keywords: climate change adaptation; disaster risk reduction; food security; policy coherence; legislations.

Introduction

Globally, extreme climate and weather events resulting from climate change and variability are on the rise (EMDAT 2021) and are posing an extremely high and increasing disaster risk and food security (FS) challenges (FAO 2021). In most developing countries (where economies are largely agro-based), the recurrence of hydro-meteorological hazards, such as droughts, floods and cyclones, presents FS concerns as they affect agricultural production (Madurapperuma et al. 2020). Food Agriculture Organisation (FAO) (2002) describes FS 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. (p. 49)

To meet the growing demand for FS under increasingly difficult climatic conditions, efforts to improve FS must consider the nexus between climate change adaptation (CCA), disaster risk reduction (DRR) and FS (Habiba et al. 2016). In this light, there have been significant efforts globally to strengthen coherence between DRR, CCA and FS frameworks to build societal resilience to climate change risks and food insecurity, for example, the 2030 Agenda for Sustainable Development Goals (SDG 2) (United Nations [UN] 2015), the Sendai Framework for Disaster Risk Reduction 2015–2030 (paragraph 19 (h) and 30 (j)) (United Nations International Strategy for Disaster Reduction [UNISDR] 2015) and the Paris Agreement on Climate Change (Article 7.1, 8.1 & 8.4) (United Nations Framework Convention on Climate Change [UNFCCC] 2015).

Policy coherence can be described as an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives (Nilsson et al. 2012:396). Building climate resilience in the food sector therefore requires bringing policy coherence to CCA and DRR and management. This helps in bridging the gaps between sectoral organisations for FS, DRR and CCA to share timely and relevant information concerning risks and their management (Habiba et al. 2016). In South Africa, research that supports policy coherence has focused on the alignment of policy objectives (Thow et al. 2018), the need for dialogue (Boatemma, Drimie & Pereira 2018) and integrated institutional arrangements (Pereira & Drimie 2016) as main apparatus needed to foster

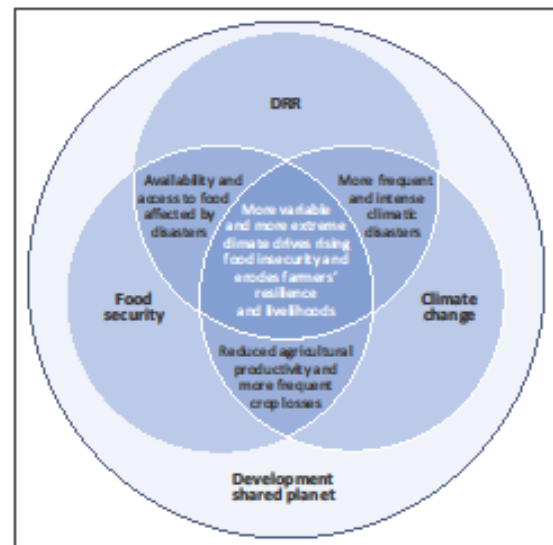
policy coherence. While there have been some efforts to foster policy coherence between DRR, CCA and FS, most frameworks, models and themes have fallen short of focusing on written content in policy and legislations to show the extent to which use of explicit words could create visible synergies that could easily be identified and used by practitioners from various disciplines.

Against this backdrop, this article seeks to evaluate if there is coherence in the policies for FS, DRR and CCA in South Africa. This will be done by exploring the use of content within CCA, DRR and FS policy and legislative documents with the purpose of understanding the meaning and context in which it is used to promote coherence. Understanding written content (text) in policy coherence is crucial for making replicable and valid inferences from data to their context, with the purpose of providing knowledge, new insights, a representation of facts and a practical guide to action (Elo & Kyngas 2008). After this Introduction, the article explores the interlinkages between FS, DRR and CCA. This is then followed by an outline of the methodology used in the study. The findings of the study are then presented and discussed before conclusions are drawn and recommendations made.

Exploring interlinkages between climate change adaptation, disaster risk reduction and food security policy areas

Food security is expected (if not already doing so) to face increasing challenges from climatic risks that are exacerbated by climate change, especially in the developing world (Balaghi et al. 2010). Meanwhile, the relationship between climate change and disasters has become vividly clear. It is well documented that climate change is changing the frequency, intensity and duration of some disasters, particularly those of hydrometeorological origin. The IPCC (2021) states that human-induced climate change is already affecting many weather and climate extremes in every region across the globe. In summary, climate change is a key source of disaster risk (Cubie & Natoli 2022).

Given the interlinkages that exist between climate change and disasters and the impacts they have on FS, it is imperative to identify and act on interlinkages that exist between FS, DRR and CCA. However, the interlinkages between the three are only emerging and continuously evolving, with the nexus between them not yet clear nor well documented. As a result, the interlinkages are poorly reflected in policies, resulting in a lack of shared purpose and fragmented implementation (Habiba et al. 2016). This article heavily draws from the work of Habiba et al. (2016) and FAO (2012) who developed a framework depicting the nexus between FS, DRR and CCA (see Figure 1). The framework explores the CC-DRR nexus, DRR-FS nexus, CC-FS nexus and CC-FS-DRR nexus in the centre of the circles. The literature on the complex interlinkages between CC and disaster risk abounds (Becker et al. 2013; Nemaikonde & Van Niekerk 2017; Nemaikonde et al. 2021). Simply put, CC is



Source: Food and Agriculture Organisation (FAO), 2012, *Reducing disaster risks to food security in southern Africa: Towards integration and co-operation*, REOSA Policy Brief 4, FAO Regional Disaster Risk Reduction and Management Office for Southern Africa (REOSA), Johannesburg.

DRR, disaster risk reduction.

FIGURE 1: Disaster risk reduction, climate change adaptation and food security nexus.

the trigger for extreme events (Madurapperuma et al. 2020). These interlinkages have made the integration of the measures to reduce the risk of disasters (DRR) and adapt to the impacts of climate change (CCA) a priority.

Climate change adaptation and DRR share a common conceptual understanding of the components of risk and the processes of building resilience (Turnbull et al. 2013). Both have conceptual synergies of understanding, monitoring and reducing exposure to hazards, addressing vulnerability, raising societal capacities to mitigate and manage risks, and enhancing coping and adaptive capacity to build community resilience (Rani et al. 2020; Sushchenko & Schwarze 2020). Madurapperuma et al. (2020) point out that CCA, coupled with upscaled DRR, contributes to reducing the negative impacts of extreme events and other socio-economic shocks. Because of the shared objectives, the literature (Kelman et al. 2017; Mitchell & Van Aalst 2008) has suggested the integration/alignment/mainstreaming or bringing coherence to the policy areas. Whereas these words have different meanings, they are used interchangeably to denote the bringing together of the different areas.

The nexus between DRR and FS is centred on the premise that disasters affect food availability and access (Masipa 2017). Disastrous events such as floods, tropical cyclones and other extreme events cause damages and losses to the agriculture infrastructure, assets, crops, inputs and productivity (Madurapperuma et al. 2020) which, in turn, impact food safety, quality, and food and nutrition security (FAO 2013). Moreover, disasters breed poverty which, in turn, increases the prevalence of food insecurity and

malnutrition (Tirivangast 2018). Conversely, DRR is a prerequisite and strongly interconnected with alleviating poverty and hunger (FAO 2013). The CC-FS nexus is centred on the role that climate change has on agricultural production and thus FS. According to FAO (2012), food production is declining and the number of impoverished farmers and their dependents is sinking into chronic food insecurity, which is increasing because of increasing risks of unpredictable rainfall and climate-related disasters. As FAO (2008) indicates, climate change affects all four dimensions of FS. Balaghi et al. (2010) share similar views and state that the four dimensions of FS are climate dependent.

As reflected in the introduction of this article, the three policy areas are connected through the variable and extreme climate events that have direct and indirect effects on food insecurity and eroded the farmers' resilience and livelihoods. In the middle where all three intersect, the overall impact on agriculture-based livelihoods becomes clear and shows the need for an integrated and long-term building of resilience, which could save millions of livelihoods (Habiba et al. 2016). FAO (2012) argues that the nexus between climate variability and change, climate-related disasters, FS and agriculture must be understood and fed into policy development and alignment.

It should, however, be noted that all three issues have component drivers that do not intersect with one another: food insecurity (especially issues of access to food) is driven by numerous socio-economic factors and shocks to the food system; CC has causes and impacts unrelated to DRR and FS; and DRR also includes non-climatic disasters, such as earthquakes and tsunamis (Habiba et al. 2016). Furthermore, FS, DRR and CCA are characterised by different sets of actors at global, regional, national and subnational levels that operate in silos and remain ignorant of the nature and importance of the nexus that exists (Habiba et al. 2016). Besides, the framework presented in this article has revealed strong interdependencies and nexus between FS, DRR and CCA and therefore nations can ill afford to continue implementing them in isolation. According to Madurapperuma et al. (2020), addressing the challenge of food insecurity as a result of an increase in climate variability and extremes and disasters requires coherent policies, strategies and programmes. Whereas it might not be sufficient on its own (Cubie & Natoli 2022), the promotion of coherence is a worthwhile endeavour.

Methods and procedure

In this study, a mixed methods research design was applied with data collected through a comprehensive literature review, content analysis (CA) of policy and legislative documents relating to DRR, CCA and FS in South Africa and key informant interviews (KIIs). Content analysis was used to identify and quantify content from 34 purposively selected policy and legislative documents to understand the contextual use in relation to coherence (Hsieh & Shannon 2005). Furthermore, thematic analysis was used (Terry et al. 2017:17) to present and analyse data collected from CA and the 24 purposively selected key informants from eight institutions (government

sectors and government supported research institutions) during the period September 2019 – December 2019.

Content analysis of policy document

Content analysis describes a family of approaches for systematic examination of text to identify themes, intents and patterns (Hall & Steiner 2020). In this study, both conventional CA and summative CA were conducted. Conventional CA is an inductive approach which focuses on text data, while summative CA involves counting and comparisons of keywords or content, followed by the interpretation of the underlying context (Hsieh & Shannon 2005). Drawing from Hall and Steiner (2020), the approach for CA in this study involves four stages:

- Searching for and gathering policy and legislative documents from government websites
- Development of keywords and identification of preliminary themes through qualitative inductive reading of text
- Using Atlas.ti to describe policy quantitative attribute and trends using keywords
- Evaluating the themes by qualitative deductive comparison with KII findings.

Gathering of national policy and legislative documents

Various policy and legislative documents that address CCA, DRR and FS were identified through searching on government departmental websites. The inclusion criteria for selection were that the following: (1) post-democratic legislation (legislations that dates back from 1994 and are currently used), (2) legislations formulated and published by the South African government, (3) legislations that directly address CCA, DRR and/or FS and (4) other relevant policy documents cited in the legislative documents under review. From the websites, under the legislation section, bills, acts, policies, white and green papers, strategies, and action plans were retrieved and sorted under three categories (CCA, DRR and FS). A total of 34 documents were identified (CCA-12; DRR-8; FS-14).

Content analysis of policy and legislative documents

Several steps were followed when analysing the contents of the policy and legislative documents. Initially, a list of key words was developed to allow standardised analysis. The keywords are derived from the focus and interest of study and included CCA, DRR, FS, coherence, integration, climate resilience, disaster risk management, disaster risk, emergency response, food access, food availability, food production, FS and nutrition, sustainability, environment, environmentally friendly, adaptation, and conservation.

The analysis began with searches for occurrences of the identified keywords, counting the number of times that each keyword is mentioned from the identified documents using Atlas.ti. Atlas.ti was used because it can cope with multiple and overlapping codes without losing the context, enabling the researcher to associate codes with chunks of text, patterns to construct classification of codes that reflect the three

TABLE 1: List of climate change adaptation, disaster risk reduction and food security documents in South Africa analyzed.

Codes	Document name
D1	White Paper Marine Fisheries Policy for South Africa, 1997
D2	National Climate Change Response White Paper, 2011
D3	National Climate Change Response Green Paper 2010, Department of Environmental Affairs briefing, PMG
D4	National Climate Change Adaptation Strategy, 2019
D5	National Environment Management Act-107-of-1998 amended 2013
D6	National Climate Change Response Strategy South Africa, 2004
D7	National Water Act 36, 1998
D8	National Environmental Management Act, 1998 (107): Regulations: Environmental Management Framework, 2010
D9	National Environmental Management Act Air Quality Act of 39, 2004
D10	South African Weather Services Act 8, 2001
D11	Climate Change Bill, 2018
D12	National Forest Act, 1998
D13	Disaster Management Monitoring and Evaluation Framework, 2014
D14	National Disaster Risk Management Education and Training Framework, 2013
D15	Disaster Management Amendment Act, 2015
D16	Disaster Management Urban Search and Rescue Framework, 2014
D17	Disaster risk Management White Paper, 1999
D18	Disaster Risk Management Green Paper, 1998
D19	Disaster Risk Management Policy Framework, 2005
D20	Disaster Risk Management Act 57, 2002
D21	South Africa Agricultural Policy Action Plan, 2014
D22	Gazette-Climate Smart Agriculture Strategy Framework, 2018
D23	Draft Conservation Agriculture Policy, 2017
D24	Department of Agriculture Forestry and Fisheries draft sector IGDP, 2010
D25	Policy on Agriculture in Sustainable Development – 8th Draft
D26	Indigenous Knowledge Systems Strategy, 2008
D27	Rural Development Framework Policy, 2013
D28	Draft Climate Change Sector Plan for Agriculture, 2015
D29	Green Paper Land Reform, 2011
D30	National Policy for Food and Nutrition Security, 2014
D31	Integrated Food Security Strategy, 2002
D32	Mechanization Support Policy Framework, 2014
D33	Fetsa Tlale – Integrative Food Production Initiative, 2013
D34	Household Food and Nutrition Strategy for South Africa, 2013

distinct themes of the analysis (Lewis 2004; Smit 2002). Atlas.ti auto-generated codes for each document using the code 'D' (see Table 1). Furthermore, from the documents loaded on Atlas.ti, codes were generated both inductively and deductively, and were grouped into three code clusters (CCA, DRR and FS). The coding system used reflected the code group, code name and the documents it was extracted from, for example, CCA (code group)-adaptation (code name)-FS (documents extracted from). This process was mainly done to quantify the occurrence of every code in each document. For the coherence variable, the code group was shown followed by code name (CCA-coherence). Lastly, the documents where the keywords are mentioned were thoroughly read and text analysed to verify the context in which the word is used.

Key informant Interviews

In this study, purposive sampling was applied to select respondents. Purposive sampling is a form of sampling that selects participants because they are well informed on and understand the research problem (Creswell 2007). A total of 24 key informants from eight institutions including

Department of Agriculture Land Reform and Rural Development (DALRRD), Department of Environment, Forestry and Fisheries (DEFF) (Climate Change Directorate), Department of Cooperative Governance and Traditional Affairs (National Disaster Management Centre [NDMC]), Agricultural Research Council (ARC), Human Sciences Research Council (HSRC), Water Research Commission (WRC), South African Weather Services (SAWS), and Agri South Africa (AGRISA) participated in the study. Respondents included three senior managers, that is, Chief Directors, Directors and Deputy Directors from each of the eight institutions.

Data were collected through face-to-face interviews, telephonic interviews, virtual or online platforms and emails, allowing participants to choose a platform convenient to them. Interview sessions were recorded with consent granted by the interviewees. The collected data were transcribed verbatim and were analysed and presented using thematic analysis. The analysis followed the six-phase process established by Terry et al. (2017:23–24). The process began with (1) familiarising with the data (browsing through data to get the meaning). Phase 2 and 3 (generating and constructing codes), respectively, were skipped as it was out of scope of the study. Phase 4 and 5 (reviewing potential themes and defining and naming themes) wherein themes that emerged from CA were used to allow for proper comparison of the findings. The themes that emerged from the study are reflected in Table 2.

Findings and discussions

This section presents and discusses the findings from Summative content analysis (SCA) and KIIs on policy coherence between CCA, DRR and FS in South Africa. The presentation focuses on the use of content within CCA, DRR and FS policy and legislations in order to understand the meaning and context in which it is used to promote coherence. The section begins by presenting the interlinkages between DRR, CCA and FS policy and legislations. The subsequent sub-sections present findings on the extent to which DRR, CCA and FS content promote policy coherence and possible challenges and opportunities for not/or using explicit content to promote coherence. Attention is given to the extent in which use of explicit words creates visible synergies that could easily be identified and used by practitioners from various disciplines.

Interlinkages between disaster risk reduction, climate change adaptation and food security policy and legislations in South Africa

As highlighted above, efforts to improve FS under increasingly changing climatic conditions require policies from different sectors that influence FS to be interlinked. In this section, findings on the interlinkages between DRR, CCA and FS policy and legislations in South Africa are presented. The findings are presented under three sub-sections, namely, (1) interlinkages between CCA and FS, (2) interlinkages between CCA and DRR and (3) interlinkages between FS and DRR. The presentation mainly focuses on identifying

keywords that reflect interlinkages between the three policy areas and how KIIs converge or diverge to SCA findings.

Interlinkages between climate change adaptation and disaster risk reduction policy and legislations

Meeting the demand for FS in increasingly extreme climate and weather events will undoubtedly require bringing policy coherence between CCA and DRR. This is because CCA and DRR are connected through the overarching purpose of reducing losses because of climate-related hazards and building communities' resilience against disasters. In this study, the interlinkages between CCA and DRR policy and legislations are summarised in Table 2. As shown in Table 3, only two CCA/DRR codes were found in DRR documents compared to five DRR/CCA codes found in CCA documents. No quotations were found under the codes 'CCA-climate resilience-DRR' and 'CCA-environmentally friendly-DRR'. This implies that these codes are operating in silo, which may complicate efforts to build resilience. Interlinkages were only found in codes 'CCA-sustainability-DRR' (four quotations) and 'CCA-climate change adaptation-DRR' (five quotations). The *Disaster Management Amendment Act* (D15) had a total of five CCA quotations that referred to the need to engage DEFF when responding to climate and disaster risks in South Africa. D13/14/18/19 had each one quotation that recognises climate change as a concept that exacerbates disaster risk if not managed well. However, these codes did not convey the content in clarity on which action to be taken to work in harmony. This lack of clarity may compromise communication

between legislations and implementation of programmes because CCA and DRR have complimenting policy goals that need to be addressed holistically (Lei 2014; Mercer 2010).

Interestingly, almost all the DRR/CCA codes had some connection to DRR issues as shown in Table 2 – DRR-disaster risk-CCA (21 quotations), DRR-rehabilitation-CCA (16 quotations), DRR-disaster risk reduction-CCA (11 quotations), DRR-disaster risk management-CCA (four quotations), DRR-emergency response-CCA (five quotations). Disaster risk reduction/CCA codes particularly D2/4 were used to enhance short-term CCA and planning strategies towards early warning systems and forecasting. Notably, DRR-disaster risk management-CCA code was used as a reference for developing disaster management plans, while DRR-emergency response-CCA code was used as a need for managing inevitable climate change impacts to build environmental resilience. However, the fact that most DRR/CCA codes were found in 2 (D2/4) out of 12 documents shows that other CCA documents are treating DRR issues in silo, which hinder policy coherence. Only documents (D5/6/7) formulated in the 1990s used the DRR-rehabilitation-CCA code and the context it was used did not reflect the need for coherence.

Interlinkages between climate change adaptation and food security policy and legislations

In terms of the interlinkages between CCA and FS policy and legislations, findings from SCA (see Table 4) indicate that all FS/CCA codes analysed for this study and CCA issues are well interlinked to FS. The code 'CCA-climate change-FS' had the highest number (476) of CCA quotations in FS policy and legislation documents followed by the code 'CCA-

TABLE 2: Themes that emerged from the study.

Themes	Sub-themes
Interlinkages between DRR, CCA and FS	Interlinkages between CCA and DRR Interlinkages between CCA and FS Interlinkages between FS and DRR
The extent to which policy and legislative content promote policy coherence	Content in CCA policies and legislation promoting coherence Content in DRR policies and legislations promoting coherence Content in FS policy and legislation promoting coherence
Possible challenges and opportunities for not/or using explicit content to promote coherence	Challenges and opportunities for coherence between FS and CCA policies Challenges and opportunities for coherence between FS and DRR policies Challenges and opportunities for coherences between DRR and CCA policies

CCA, climate change adaptation; DRR, disaster risk reduction; FS, food security.

TABLE 3: Interlinkages between climate change adaptation and disaster risk reduction policy and legislations.

CCA and DRR codes	No. of times codes were mentioned	Total no. of codes
CCA-climate resilience-DRR	0	0
CCA-environmentally friendly-DRR	0	0
CCA-sustainability-DRR	D13 – 1; D18 – 1; D14 – 1; D19 – 1	4
CCA-climate change adaptation-DRR	D15 – 5	5
DRR-disaster resilience-CCA	0	0
DRR-disaster risk reduction-CCA	D2 – 4; D4 – 7	11
DRR-disaster risk-CCA	D2 – 8; D4 – 12; D11 – 1	21
DRR-disaster risk management-CCA	D2 – 2; D4 – 2	4
DRR-emergency response-CCA	D2 – 1; D4 – 4	5
DRR-rehabilitation-CCA	D2 – 1; D5 – 7; D6 – 1; D7 – 6	16

Source: Derived from Smit, B., 2002, 'Atlas for qualitative data analysis', South African Journal of Psychology 20(3), 65–76.

CCA, climate change adaptation; DRR, disaster risk reduction.

TABLE 4: Interlinkages between climate change adaptation and food security policy and legislations.

CCA and FS codes	No. of times codes were mentioned	Total no. of codes
CCA-climate change adaptation-FS	D21 – 1; D22 – 3; D23 – 1; D28 – 10	15
CCA-adaptation FS	D21 – 6; D22 – 49; D23 – 3; D24 – 12; D25 – 2; D26 – 4; D28 – 182	258
CCA-climate change-FS	D21 – 17; D22 – 85; D23 – 6; D24 – 30; D25 – 9; D28 – 317; D30 – 12	476
CCA-climate resilience-FS	D22 – 5; D22 – 1	6
CCA-conservation-FS	D21 – 22; D22 – 15; D23 – 35; D24 – 22; D25 – 24; D26 – 9; D28 – 39; D32 – 2; D33 – 2	
CCA-environment-FS	D23 – 18; D24 – 66; D25 – 50; D26 – 13; D28 – 59; D29 – 2; D30 – 4; D31 – 6; D32 – 8; D33 – 2	226
CCA-sustainability-FS	D21 – 14; D22 – 8; D23 – 5; D24 – 26; D25 – 9; D26 – 2; D28 – 13; D32 – 2; D33 – 2	
FS-food availability-CCA	0	0
FS-food access-CCA	0	0
FS-agriculture-CCA	D2 – 27; D3 – 7; D4 – 22; D5 – 1; D6 – 12; D11 – 1	70
FS-food production-CCA	D2 – 3; D3 – 1; D4 – 1	5
FS-food security and nutrition-CCA	0	0
FS-food security-CCA	D2 – 5; D3 – 2; D4 – 3; D6 – 3	14

Source: Derived from Smit, B., 2002, 'Atlas for qualitative data analysis', South African Journal of Psychology 20(3), 65–76.

CCA, climate change adaptation; FS, food security.

adaptation-FS' with 258 quotations. These results are not surprising given that the term 'climate change' is used to portray threats to the food sector and is a variable that should be addressed to reduce its impact on FS. Most FS documents developed before the year 2000 preferred to use traditional terms such as conservation, sustainability, and environment when referring to climate change risks. After the year 2000, the FS documents started to recognise climate change as an interlinked variable to FS. Codes such as 'CCA-climate change adaptation-FS' and 'CCA-adaptation-FS' scored many quotations in documents that specifically address climate change in DALRRD especially in D28. Mostly, these codes when mentioned referred to the need to work with DEFF to apply CCA measures such as climate smart agriculture (CSA) to improve FS in South Africa.

While in all CCA/FS codes there was good link between FS and CCA, only three FS/CCA codes (FS-agriculture-CCA (70 quotations), FS-food security-CCA (14 quotations) and FS-food production-CCA (5 quotations)) had some mention of FS in CCA documents, as shown in Table 3. The CCA documents (D2/3/4/5/6) that mentioned FS issues recognise the food sector as the most vulnerable sector to climate risks. Therefore, D2/3/4 emphasised the need to preserve small-scale farmers relying mostly on dry land for food production. The fact that 'FS-food security and nutrition-CCA' code did not appear anywhere in the CCA documents showed a lack of focus on the nutrition part of food security in South Africa, which Ruel (2013) argued for further research. Fortunately, the occurrence of 'FS-food security-CCA' code in D2/3/4/6 showed an avenue to promote coherence between FS and CCA legislations. The context in which the code appeared reflected how CCA documents acknowledge the impact of climate risks on FS and advocate for the need to use CSA.

Interlinkages between food security and disaster risk reduction policy and legislations

The findings on interlinkages between FS and DRR policy and legislations are summarised in Table 5. As shown in Table 4, no quotations were found in the 'DRR-disaster risk reduction-FS' code within the FS documents. This shows lack of coherence between DRR and FS legislations given the importance of DRR measures in prevention, response and recovery strategies in the food sector. The remaining DRR keywords (resilience, disaster risk management, disaster risk and emergency response) reflected how the food sector lacks coherence when dealing with climate and disaster risks. This was shown in the context of lack of accessible and reliable information for external engagements and few social platforms to engage civil societies and other relevant stakeholders who advocate for alignment of FS and DRR issues. Arguably, among widely used comprehensive documents such as D30 and D31, no DRR code was recorded. This oversight specifically shows how limited the content in FS legislations is, in terms of lack of direct keywords that help to engage practitioners, sectors and communities who are the end users or implementers of such policies. Such

TABLE 5: Interlinkages between food security and disaster risk reduction policy and legislations.

DRR and FS codes	No. of times codes were mentioned	Total no. of codes
DRR-disaster resilience-FS	D 28 – 2	2
DRR-disaster risk management-FS	D 22 – 1; D28 – 2	3
DRR-disaster risk reduction-FS	0	0
DRR-disaster risk-FS	D 22 – 2; D28 – 3	5
DRR-rehabilitation-FS	D22 – 2; D23 – 2; D24 – 3; D25 – 3; D28 – 6; D33 – 1	17
DRR-emergency response-FS	D 22 – 2	2
FS-food access-DRR	0	0
FS-conservation-DRR	D 14 – 1; D18 – 7	8
FS-food availability-DRR	D18 – 1	1
FS-food production-DRR	0	0
FS-food security and nutrition-DRR	0	0
FS-food security-DRR	D14 – 3; D19 – 6; D18 – 38; D20 – 2	50

Source: Derived from Smit, B., 2002, 'Atlas II for qualitative data analysis', South African Journal of Psychology 20(3), 65–76.

DRR, disaster risk reduction; FS, food security.

circumstances, according to Campbell et al. (2016) and Lipper et al. (2014), brew a fertile ground for incoherencies, which could prohibit a food secure community. Of significance is D33, whereby, regardless of how sensitive food production is to disaster risks in South Africa, did not use DRR codes as terms of references to align with its activities.

Findings from SCA, as shown in Table 4, indicate that DRR documents (FS-food security-DRR code in D14/18/19/20) acknowledge the linkages between FS and DRR. For example, D18 shows that, during its formulation stage, officials from DALRRD, DEFF and other role players were consulted, which could be the reason why the content is inclusive and promotes policy coherence. Correspondingly, D19/20 uses National Disaster Management Advisory Forum (NDMAF) and Intergovernmental Committee on Disaster Management (ICDM) to engage all stakeholders including DALRRD in management of floods and droughts to protect FS. The FS-food availability-DRR code that featured in D18 also seeks to engage DALRRD as a key player in early warning systems of staple foods. The remaining three codes (food access, production, FS and nutrition) did not feature anywhere in the DRR documents because they address FS from a broader perspective rather than its dimensions. FS-conservation-DRR code only appeared in D14/18 to encourage water conservation and drought proofing as a DRR measure that helps to improve FS.

Regarding the KIIs findings, majority of respondents described CCA, DRR and FS as interlinked concepts with similar goals in building resilience and adaptive capacity towards the FS. The following statement by a respondent from HSRC captures the sentiments shared by those who feel that the three policy areas are interlinked:

'CCA, DRR & FS are undoubtedly interlinked and if legislations and technocrats treat them as such, coherence would be inevitable'. (Participant 1, Male, 9 September 2019)

However, respondents from AGRISA, NDMC and Directorate of Climate Change Adaptation (DCCA) argued that the content in some policy and legislations is still influencing a

separation between them, which is compromising the achievement of each other's interlinked goals. For example, one respondent from DALRRD described FS as, 'an outcome of what institutions that address DRR and CCA did or did not do'. A few respondents from NDMC and DCCA confirmed to share responsibility but said that FS policies should state the responsibilities with clarity to invoke their attention and interests to partake in FS issues not the other way round. Moni et al. (2007) also emphasise the importance of presenting the who, what, when, why and how aspects of content when conveying information to external audiences. One respondent from HSRC said that, currently in areas where interlinkages are witnessed, resources are shared and used efficiently, cross-cutting terms such as 'resilience' are being utilised; collective methods, strategies and tools are used to reduce the impact of climate and disaster risk on FS. Finally, the KII findings established that the majority of respondents recognise the interconnectedness of CCA, DRR and FS and in their responses agreed to work on building content that reflects that.

The extent to which disaster risk reduction, climate change adaptation and food security content promote policy coherence

Under this theme, three sub-themes were established to determine the extent in which content in CCA, DRR and FS policy and legislations is promoting policy coherence. The sub-themes are: (1) content in CCA policy and legislations promoting coherence; (2) content in DRR policy and legislations promoting coherence; and (3) content in FS policy and legislations promoting coherence. Codes used to analyse the sub-themes included coherence, coordination, cooperation, collaboration, integration and mainstreaming.

Content in climate change adaptation policies and legislation promoting coherence

Given that climate change is the trigger for extreme events that adversely affect FS, it is important to find out how the content in CCA policies and legislation promotes coherence between CCA, DRR and FS. To determine the extent in which CCA codes were used to promote coherence, various keywords such as coherence, cooperation, and coordination were created. Table 6 summarises the findings on content in CCA policy and legislations that promote coherence. Most content in CCA policies and legislation promoting coherence centred on CCA-coordination (41 quotations) while CCA-integration and CCA-mainstreaming had 29 quotations each. Only three quotations centred on CCA-coherence.

TABLE 6: Content in climate change adaptation policies and legislation promoting coherence.

CCA codes	No. of times codes were mentioned	Total no. of codes
CCA-coherence	D2 – 1; D4 – 2	3
CCA-cooperation	D1 – 12; D2 – 6; D4 – 3; D5 – 2; D6 – 5	28
CCA-coordination	D1 – 1; D2 – 15; D3 – 4; D4 – 4; D5 – 2; D6 – 10; D11 – 5	41
CCA-integration	D1 – 2; D2 – 5; D4 – 1; D5 – 3; D6 – 8; D81 – 1	29
CCA-mainstreaming	D 2 – 1; D4 – 16; D5 – 2	29

Source: Derived from Smit, B., 2002, 'Atlas.ii for qualitative data analysis', South African Journal of Psychology 20(3), 65–76.
CCA, climate change adaptation.

Among CCA documents analysed, D4 used CCA-integration code to specifically emphasise the need to integrate with DRR and FS legislations. While D1/2/3/5/6/9/11 highlighted the need for coherence between DRR and FS, they did not specifically mention the exact institutions by name but rather described them as government sectors or businesses or civil societies. According to Radhaswamy and Zia (2011), words or information that is not clearly phrased is likely to convey a message that is amiss. In this case, the end users, which are DRR, and FS practitioners and communities, might not understand the brevity of CCA content and might decide not to act coherently. In support, KII findings established that lack of explicitness in content gives no clarity around mandates, risking practitioners to duplicate work with limited funds that could be better used. It was also noted that, some documents specifically D1/2/5/31, when referring to coherence, mostly referred to vertical coherence, which limited horizontal engagements. In addition, the CCA content shows no central platform where CCA-, DRR- and FS-related data are shared, which could be the reason legislations are still using different terms, methods and strategies as opposed to Gero, Méheux and Dominey-Howes (2011) bid for a one-stop-shop for cross-cutting information. Thus, the study draws from D4, and argues that there is lack of coherence or coordination between legislations and institutions that are addressing CCA, DRR and FS policy areas. This is so despite the existence of Intergovernmental Committee on Climate Change (IGCCC) and National Committee on Climate Change (NCCC) platforms identified in CCA documents, which are avenues created to ensure stakeholder participation and new partnerships with relevant parties in an integrated manner.

Content in disaster risk reduction policies and legislations promoting coherence

As noted above, disaster risk, climate change and FS are closely connected. Various hazards especially those of hydro-meteorological origin, propelled by climatic change and variability, pose an extremely high and increasing disaster risks to FS. This connection would require policy coherence between FS, DRR and CCA in order to minimise the devastating impacts of disasters on FS. Table 7 summarises the findings on content in DRR policies and legislation that promote coherence between DRR, CCA and FS. As shown in Table 6, most content in DRR that promote coherence centred mostly on coordination (59 quotations) and integration (53 quotations).

TABLE 7: Content in disaster risk reduction policies and legislation promoting coherence.

DRR codes	No. of times codes were mentioned	Total no. of codes
DRR-coherence	0	0
DRR-collaboration	D13 – 1; D14 – 8; D16 – 2; D18 – 3	14
DRR-cooperation	D16 – 5; D18 – 16	21
DRR-coordination	D13 – 8; D14 – 3; D16 – 26; D18 – 22	59
DRR-integration	D13 – 1; D14 – 18; D18 – 6; D19 – 16; D20 – 10	53
DRR-mainstreaming	D 14 – 6; D19 – 1	7

Source: Derived from Smit, B., 2002, 'Atlas.ii for qualitative data analysis', South African Journal of Psychology 20(3), 65–76.
DRR, disaster risk reduction.

The frequency in the use of codes that refer to 'coherence' in the DRR documents shows that there is an effort to promote policy coherence within the sector. However, among the six codes created to determine the extent to which DRR policy and legislations are promoting coherence, the main keyword 'coherence' did not appear in any of the DRR documents. This significant oversight either shows that the concept is still new or evolving as argued by Gero et al. (2011). Briefly, when D13/14/16/18 mentioned DRR-collaboration code, the emphasis was to collaborate with the Weather Bureau, Water Affairs, Department of Education and other relevant stakeholders to improve early warning systems. In like manner, the context in which DRR-cooperation code was used referred to the need for cooperation with relevant stakeholders but did not explicitly mention institutions by name, which in a way reduces the sense of obligation to DRR issues. In addition, the way coordination and integration keywords were used in D6 was to reveal the lack of coordination between DRR and CCA/FS activities. In terms of D16, there is lack of coordination in information dissemination, focal points to provide direction for implementation and lack of systematic set of guidelines and standards that should be adhered to between institutions. Finally, DRR-integration featured in a way that encourages rapid integration of information from different data sources and channels that reaches decision makers promptly. Although, some DRR codes seek to promote coherence using NDMAF and other platforms as cited in D19/20, the extent in which the content is used requires revision in terms of altering 'quarterly' to 'regular' meetings to strengthen the readiness of external stakeholders whenever an emergency event arises.

Content in food security policy and legislation promoting coherence

The nexus between FS and disasters as highlighted above would require that FS policy and legislation recognise that it should be connected to CCA and DRR policies and legislation in order to effectively deal with FS challenges. Table 8 presents the findings on content in FS policies and legislation that promote coherence between FS, DRR, and CCA. As shown in Table 7, most content centred on mainstreaming (66 quotations), coordination (61) quotations, and integration (45 quotations) while only five quotations centred on FS-coherence.

The codes created to determine the extent to which FS policy and legislations are promoting coherence reflected a silo

TABLE 8: Content in food security policies and legislation promoting coherence.

FS codes	No. of times codes were mentioned	Total no. of codes
FS-coherence	D22 – 1; D23 – 1; D25 – 1; D28 – 1; D29 – 1	5
FS-collaboration	D21 – 5; D22 – 12; D23 – 3; D24 – 6; D26 – 4; D28 – 5; D29 – 1	36
FS-cooperation	D21 – 1; D22 – 2; D25 – 1; D24 – 7; D26 – 5; D28 – 3; D31 – 1	24
FS-coordination	D21 – 6; D22 – 26; D24 – 8; D26 – 2; D28 – 4; D29 – 1; D30 – 1; D31 – 3; D32 – 2; D34 – 8	61
FS-integration	D21 – 9; D22 – 15; D23 – 2; D24 – 4; D25 – 4; D26 – 2; D28 – 5; D29 – 2; D30 – 1; D31 – 1	45
FS-mainstreaming	D 22 – 63; D25 – 63; D28 – 2	66

Source: Derived from Smit, B., 2002, 'Atlas for qualitative data analysis', South African Journal of Psychology 20(3), 65–76.
FS, food security.

mentality towards CCA and DRR. For example, the context in which the coherence keyword was used in D21/23/28/25/29 showed that there is lack of coherence between FS and DRR/CCA. However, collaboration, coordination and cooperation keywords were used as drivers to engage external agencies to establish integrated approaches to climate change, indigenous knowledge systems and institutional support networks. Twenty-four quotations from D21/22/24/25/26/28/29 showed that weak institutional support networks that relate to disaster management systems and lack of a structured system that deals with FS disasters are always a hindrance to effective coherence. While some documents used the integration code to refer to integration with other government sectors, D30/29/26/28/31/21/22 mainly emphasised for internal integration within the food sector. These documents described the food sector as an entity that lacks integration because of weak governance structures and fragmented content that does not explicitly refer to other FS legislations. Therefore, Boatemma et al. (2018) and Pereira and Drimie (2016) advocated for internal coherence between FS policies first before external alignments with CCA and DRR policies.

However, findings from KIIs have shown two different positions in the way they view the extent to which content is promoting coherence. Majority of respondents from DALRRD, DCCA and NDMC said that the content in their legislations is promoting coherence to a greater extent because they have created vast of policies that address CCA, DRR and FS concepts. On the other hand, few respondents from WRC, ARC, South African Weather Services (SAWS) and HSRC discussed how the creation of vast standalone documents has negatively replaced the use of relevant content that is needed to drive coherence between sectors. One respondent from AGRISA expressed this concern like this:

'The fact that we have policies that directly address CCA, DRR& FS doesn't mean the legislations have the right content that promote coherence because ... a policy, in itself is not discernible, but the actual written words in the document'. (Participant 15, Male, 27 September 2019)

Although some respondents from DALRRD, DCCA and NDMC gave guidelines and procedures that government sectors follow when formulating policy and legislations in South Africa, one respondent from HSRC argued that, with absolute silence in other documents especially the leading ones, does not reflect the inclusivity and transparency advocated by such guidelines. The same HSRC respondent finally gave a recommendation for the need to focus more on the written content in policies rather than policies themselves.

Possible challenges and opportunities for not/or using explicit content to promote coherence

Under this theme, three sub-themes were created to present analysis of challenges and opportunities that could be brought by not/or using explicit CCA, DRR and FS terms to promote coherence. These include challenges and opportunities for coherence between FS and DRR policies; challenges and opportunities for coherences between DRR

and CCA policies; and challenges and opportunities for coherence between CCA and FS policies.

Challenges and opportunities for coherence between food security and climate change adaptation policies

Challenges that have been drawn from D22/25/28 included culture and language barriers whereby people or farmers could be sensitive to certain new words used to drive coherence, which could cause resistance to CSA messages. In support, KIIs findings showed that this could be influenced by people or farmers who are still accustomed to key terms that were used in the 1990s legislations such as conservation farming or rehabilitation practices. Again, the fact that these documents are still functional currently raises a lot of concerns in terms of need for imminent review to create avenues for coherence.

Challenges and opportunities for coherence between food security and disaster risk reduction policies

The challenge that emanated from this sub-theme was rooted from the way policy content is designed and the people or institutions that sits at the table during the process. This came about after observation from DRR legislations that do not use the word 'coherence' in their content, which in a way complicates understanding of the need for coherence across the FS sector. In the same manner, both SCA and KII findings have shown the challenges of turf problems with DALRRD and FS policies whereby they are establishing policies that address CCA and DRR independently instead of reviewing the content in their policies to integrate terminology that drives coherence with relevant stakeholders. Organisation for Economic Cooperation and Development (2018) referred to such challenges to be caused by political context in which these policies exist whereby politicians are more concerned with distribution of policy benefits during implementation than on broad ends of policies as they are designed. Such a scenario questioned the whole policy-making process in South Africa regarding who have a say in the choice of policy content and recommended it for further research.

Challenges and opportunities for coherences between disaster risk reduction and climate change adaptation policies

This sub-theme has shown areas of convergences between SCA and KII findings whereby they indicated opportunities that were brought by using explicit terms in both legislations especially in D15. Majority of respondents from KIIs agreed that content matters because most humans respond and act on things they see. This means that, if nothing is mentioned or seen in the content, no one would know, let alone feel obligated to act. One respondent from NDMC said that:

'... [A]s DRR was evolving since 1994, there was no mention of CCA in any of our legislations ... once it was added in DMAA of 2015, it automatically created an opportunity for CCA legislations to cite the Act and align their activities with it'. (Participant 10, Female, 25 September 2019)

While other respondents from DCCA expressed that it is not a matter of mentioning of words or terms but the context in which it is mentioned, a few respondents from NDMC agreed

that, although that may be the case, the fact that it is mentioned in a legislation shows a degree of accepting the connection between legislations and that alone can be used as an avenue for policy coherence. Although respondents from HSRC, SAWS and ARC described the use of explicit content as a way needed to clarify roles and responsibilities between sectors, they also cited a possibility of organisational turf problems when it comes to sharing of resources. Finally, this argument brought majority of respondents to recommend the need to incentivise institutions that are promoting coherence.

Conclusion

Bringing coherence between DRR, CCA and FS policy areas is espoused as one of the strategies to sustain FS. Despite the interlinkages identified between these policy areas, many policies have not yet picked up the button bringing synergy between related policies. Ultimately, addressing the risk and impacts of disasters including climate risks on FS coherently remains a challenge. The findings of this study have revealed that there are incoherencies between the main policies and legislation that address DRR, CCA and FS in South Africa despite some level of synergies in the contents of some policy documents despite some minor differences, there is convergence between the findings of CA and the findings from KII.

This article submits that bringing coherence in the three policy areas will require explicit and precise contents of the policy documents to acknowledge the interlinkages that exist between the policy areas. This will require a review of the policy documents and amendments of the legislative documents. This is because legislation and policy frameworks play an important role in promoting actions to reduce the risks of disasters and adaptation to the impacts of climate change. Ultimately, this will help bridge the gaps that exist between the institutions that are responsible for ensuring FS. In policy areas where the interlinkages between DRR-CCA, DRR-FS, and CCA-FS are visible and the policy content is precise, KII findings showed that there is coordination, sharing of resources, clarity on mandates, roles and responsibilities, and collective use of methods, tools and strategies. This assists in reducing duplication and efficient use of resources. This article further submits that bringing coherence between the three policy areas will require officials with knowledge and understanding of the interlinkages to influence the policy processes during the review period. The major limitation of the study is that interviews were conducted with officials from government departments and research institutions funded by government only, thus neglecting cross-cutting agencies such as civil societies, private sectors, business and industry. Another limitation is the focus on national level policy and legislative frameworks only. It is also likely that these kinds of policy incoherence also manifest at the provincial and local level. Further areas of research could focus on the efficacy of institutional mechanisms needed to promote coherence between CCA, DRR and FS policies in South Africa.

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Authors' contributions

A.Z. was responsible for conceptualisation, methodology, formal analysis, writing original draft and investigation. L.D.N. and P.C. were responsible for review and editing, supervision.

Ethical considerations

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Data availability

All data codes generated or used during the study are available on special request from the corresponding author (A.Z.).

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References

- Boatemma, S., Dzinie, S. & Pereira, L., 2018, 'Addressing food and nutrition security in South Africa: A review of policy responses since 2002', *African Journal of Agricultural and Resource Economics* 13(311-2019-687), 264-279.
- Belaghi, R., Badjeck, M.C., Bakari, D., De Pauw, E., De Wit, A., Defourny, P. et al., 2010, 'Managing climatic risks for enhanced food security: Key information capabilities', *Procedia Environmental Sciences* 1, 313-323.
- Becker, P., Abrahamsson, M. & Hagelsteen, M., 2013, 'Parallel structures for disaster risk reduction and climate change adaptation in Southern Africa', *Jambs: Journal of Disaster Risk Studies* 5(2), 1-5.
- Campbell, B.M., Vermeulen, S.J., Aggarwal, P.K., Corner-Dallhoff, C., Givertz, E., Loboguerrero, A.M. et al., 2016, 'Reducing risks to food security from climate change', *Global Food Security* 11, 34-43. <https://doi.org/10.1016/j.gfs.2016.06.002>
- Cresswell, J.W., 2007, *Qualitative inquiry and research design: Choosing among five approaches*, 2nd edn., Sage Publications, Inc., Thousand Oaks.
- Cubie, D. & Ntoli, T., 2022, 'Coherence, alignment and integration: understanding the legal relationship between sustainable development, climate change adaptation and disaster risk reduction', in S. Flood, Y.J. Columbie, M. Le Tissier & B. O'Dwyer (eds.), *Creating resilient futures*, pp. 45-64, Palgrave Macmillan, Cham.
- Elo, S. & Kyngäs, H., 2008, 'The qualitative content analysis process', *Journal of advanced nursing* 62(1), 107-115.
- EM-DAT, 2021, *The OFDA/CRED International Disaster Database* UCL-Brussels Belgium, viewed 22 November 2021, from <http://www.emdat.be/natural-disasters-trends>.

- Food and Agriculture Organisation (FAO), 2002, *The state of food insecurity in the world 2002*, FAO, Rome.
- Food and Agriculture Organisation (FAO), 2008, *Climate change and food security: A framework document*, FAO, Rome.
- Food and Agriculture Organisation (FAO), 2012, *Reducing disaster risks to food security in southern africa: Towards integration and co-operation*, REOSA Policy Brief, 4, FAO Regional Disaster Risk Reduction and Management Office for Southern Africa (REOSA), Johannesburg.
- Food and Agriculture Organisation (FAO), 2013, *Resilient livelihoods: Disaster risk reduction for food and nutrition security*, Emergency and Rehabilitation Division, Food and Agriculture Organization of the United Nations, Rome.
- Food and Agriculture Organisation (FAO), 2021, *The state of food security and nutrition in the world 2021: Transforming food systems for food security, improved nutrition, and affordable healthy diets for all*, FAO, Rome. <https://doi.org/10.4060/cb4474en>
- Gero, A., Méheux, K. & Dominey-Howes, D., 2011, 'Integrating disaster risk reduction and climate change adaptation in the Pacific', *Climate and Development* 3(4), 310-327. <https://doi.org/10.5194/nhess-11-101-2011>
- Holsti, O.R., 1969, *Content analysis for the social sciences and humanities*, Addison-Wesley, Reading, MA.
- Hsieh, H.F. & Shannon, S.E., 2005, 'Three approaches to qualitative content analysis', *Qualitative Health Research* 15(9), 1277-1288. <https://doi.org/10.1177/1049731505276687>
- Habiba, U., Abedin, M.A. & Shaw, R., 2016, 'Food security, climate change adaptation, and disaster risk', in Ulto & Shaw (eds.), *Sustainable development and disaster risk reduction*, pp. 87-101, Springer, Tokyo.
- Hall, D.M. & Steiner, R., 2020, 'Policy content analysis: Qualitative method for analysing sub-national insect pollinator legislation', *Methods X*, 7, 100787.
- Intergovernmental Panel on Climate Change (IPCC), 2021, 'Summary for policymakers', in V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Pisan, S. Berger, et al. (eds.), *Climate Change 2021: The Physical Science Basis, Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.
- Kelman, I., Mercer, J. & Gaillard, J.C., 2017, *The Routledge handbook of disaster risk reduction including climate change adaptation*, Routledge, New York.
- Lei, Y., 2014, 'A preliminary discussion on the opportunities and challenges of linking climate change adaptation with disaster risk reduction', *Natural Hazards* 71(3), 1587-1597. <https://doi.org/10.1007/s11069-013-0966-6>
- Lewis, R.B., 2004, 'NVivo 2.0 and ATLAS.ti 5.0: A comparative review of two popular qualitative data-analysis programs', *Field Methods* 16(4), 439-464.
- Lipper, L., Thornton, P., Campbell, B.M., Baedeker, T., Brimoh, A., Bwalya, M.P. et al., 2014, 'Climate-smart agriculture for food security', *Nature Climate Change* 4(12), 1068-1072. <https://doi.org/10.1038/nclimate2437>
- Mercer, J., 2010, 'Disaster risk reduction or climate change adaptation: Are we reinventing the wheel?', *Journal of International Development: The Journal of the Development Studies Association* 22(2), 135-141. <https://doi.org/10.1002/jid.1677>
- Moni, R.W., Hrych, D.H., Poronnik, P. & Moni, K.B., 2007, 'Using explicit teaching to improve how bioscience students write to the lay public', *Advances in Physiology Education* 31(2), 167-175. <https://doi.org/10.1152/advan.00111.2006>
- Madurapperuma, S.J.K., Amarasinga, D. & Haigh, R., 2021, 'Disasters, climate change and development nexus: Food security sector in Asia', in D. Amarasinga, R. Haigh & N. Dias (eds.), *Multi-Hazard early warning and disaster risks*, pp. 111-128, Springer, Cham.
- Masipa, T., 2017, 'The impact of climate change on food security in South Africa: Current realities and challenges ahead', *Jamba: Journal of Disaster Risk Studies* 9(1), 1-7.
- Mitchell, T. & van Aalst, M., 2008, *Convergence of disaster risk reduction and climate change adaptation: A review for DFID*, vol. 44, pp. 1-22, Institute of development studies, Brighton.
- Nilsson, M., Zamperutti, T., Petersen, J.E., Nykvist, B., Rudberg, P. & McGuinn, J., 2012, 'Understanding policy coherence: Analytical framework and examples of sector-environment policy interactions in the EU', *Environmental Policy and Governance* 22(6), 395-423. <https://doi.org/10.1002/etp.1589>
- Nemakonde, L.D. & van Niekerk, D., 2017, 'A normative model for integrating organisations for disaster risk reduction and climate change adaptation within SADC member states', *Disaster Prevention and Management: An International Journal* 26, 361-376.
- Nemakonde, L.D., van Niekerk, D., Per Becker & Khosa, S., 2021, 'Perceived adverse effects of separating government institutions for disaster risk reduction and climate change adaptation within the Southern African Development Community Member States', *International Journal of Disaster Risk Science* 12(1), 1-12.
- Organisation for Economic Cooperation and Development (OECD), 2018, *Policy coherence for sustainable development: Towards sustainable and resilient societies*, Organisation for Economic Cooperation and Development, Paris.
- Pereira, L. & Dzinie, S., 2016, 'Governance arrangements for the future food system: Addressing complexity in South Africa', *Environment: Science and Policy for Sustainable Development* 58(4), 18-31. <https://doi.org/10.1080/00139157.2016.1186438>
- Radhaswamy, P. & Zia, A., 2011, 'The importance of communication', *IUP Journal of Soft Skills* 5(4), 52-56.
- Ruel, M., 2013, 'Food security and nutrition: Linkages and complementarities', in M. Eggen, D. K. Kraemer, M. van Ameringen, H.K. Biesalski, M. Bloem, J. Chen, et al. (eds.), *The road to good nutrition*, pp. 24-38, Karger Publishers.
- Rani, W.N.M.W.M., Kamarudin, K.H., Razak, K.A. & Asmawi, Z.M., 2020, 'Climate change adaptation and disaster risk reduction in urban development plans for resilient cities', in IOP Conference Series: Earth and Environmental Science, 409(1), 012024.

- Smit, B., 2002, 'Atlas. II for qualitative data analysis', *South African Journal of Psychology* 20(3), 65–76.
- Sushchenko, O. & Schwarze, R., 2020, *Economics and finance of disaster risk reduction and climate change adaptation: Main gaps identified in arising alignment opportunities for the EU Green Deal*, Work Package 3, Helmholtz Centre for Environmental Research – UFZ Leipzig, viewed 22 November 2021, from <https://www.placard-network.eu/wp-content/PDFs/PLACARD-Economics-and-finance-of-CCA-DRR.pdf>.
- Terry, G., Hayfield, N., Clarke, V. & Braun, V., 2017, 'Chapter 2: Thematic analysis', in C. Willig & W.S. Rogers (eds.), *The Sage handbook of qualitative research in psychology*, pp. 17–37, Sage, London.
- Thow, A.M., Greenberg, S., Hara, M., Friel, S. & Sanders, D., 2018, 'Improving policy coherence for food security and nutrition in South Africa: A qualitative policy analysis', *Food Security* 10(4), 1105–1130. <https://doi.org/10.1007/s12571-018-0813-4>
- Tirivangasi, H.M., 2018, 'Regional disaster risk management strategies for food security: Probing Southern African Development Community channels for influencing national policy', *Jòmbd: Journal of Disaster Risk Studies* 10(1), 1–7.
- Turnbull, M., Sterrett, C. & Hilleboe, A., 2013, *Toward resilience: A guide to disaster risk reduction and climate change adaptation*, Practical Action Publishing, Warwickshire.
- United Nations (UN), 2015, *Sustainable Development Goals (SDGs) Goal No. 2*, United Nations, viewed 21 February 2021, from <https://sdgs.un.org/goals/goal2>.
- United Nations Framework Convention on Climate Change (UNFCCC), 2015, *Paris agreement on climate change*, viewed 07 February 2021, from http://unfccc.int/paris_agreement/items/9485.php.
- United Nations International Strategy for Disaster Reduction (UNISDR), 2015, *Sendai framework for disaster risk reduction*, viewed 07 February 2021, from <https://www.unisdr.org/we/coordinate/sendai-framework>.

CHAPTER 4: ARTICLE 2

INSTITUTIONAL MECHANISMS FOR COHERENCE

Institutional mechanism for policy coherence between climate change adaptation, disaster risk reduction and food security in South Africa.

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Abstract: Incoherence in coordination between institutions that address climate change adaptation (CCA), disaster risk reduction (DRR) and food security (FS) policy areas exacerbates FS challenges in most developing countries, including South Africa. To address such incoherencies, this article seeks to develop a coordination mechanism that could help in aligning FS functions undertaken by FS, CCA and DRR institutions. The coordination mechanism was developed using aspects from the functional resonance analysis method (Input, Time, Preconditions, Resources, Control, and Output) and data gathered from conventional content analysis and key informant interviews. The coordination mechanism allows for simultaneous participation of relevant stakeholders through a systematic characterisation of FS functions. It also allows policy-makers and practitioners to identify variabilities, challenges, and opportunities that should be considered before an activity is executed.

Keywords - climate change adaptation, coordination mechanism, disaster risk reduction, food security, institutions.

1. Introduction

In many countries, climate change adaptation (CCA), disaster risk reduction (DRR) and, food security (FS) structures in governments have largely been developed in parallel, and as a result, they have been operating in isolation with little coordination (Becker et al., 2013; Nemaconde and Van Niekerk, 2017). Faced with growing risk of climate change and disaster risk, a lack of coordination between institutions that address FS, CCA and DRR policy areas continues to compromise the capacity of food sectors to achieve Sustainable Development Goal (SDG) No. 2 - achieving food security by 2030 (United Nations [UN], 2015). According to the Food and Agriculture Organization (FAO) (2006, p.1), food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Meanwhile, the International Panel for Climate Change (IPCC) (2018, p.542) defines adaptation in human systems as the process of adjustment to actual or expected climate and its effects on moderate harm or exploiting beneficial opportunities. For the UN (2016, p.16), DRR aims to prevent new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and, thus, attaining sustainable development. This study views CCA and DRR as conceptual frameworks that seek to prevent or moderate the adverse impacts of climate and natural hazards on sustainable development, including FS (IPCC, 2007; United Nations International Strategy for

Disaster Reduction [UNISDR], 2009). In this way, the interdependencies between FS, CCA and DRR which, when coordinated effectively, could avoid duplication of efforts, repetitive tasks and conflicts become clear (Thomas et al., 2015).

However, most developing countries, including South Africa, are still treating FS, CCA and DRR as separate developmental issues, which is compromising the alignment of CCA and DRR measures towards FS (Seidler et al., 2018; Thomas et al., 2015; Van Zyl, 2013). This separation is causing disintegration and diversions in interpreting FS from the perspective of CCA and DRR, which is needed to confront climate and disaster risks based on the agricultural context in which they exist (Gero et al., 2011; Seidler et al., 2018). To enhance coordination between FS, CCA and DRR, three global frameworks, namely the Sendai Framework for Disaster Risk Reduction (SFDRR) (2015-2030) (UNISDR, 2015), the Paris Agreement for Climate Change (United Nations Framework Convention on Climate Change [UNFCCC], 2015) and the Agenda 2030 for Sustainable Development, were adopted in 2015. Specifically, paragraphs 19 (h) and 30 (j) of the Sendai Framework (UNISDR, 2015, p.26); Articles 7.1, 8.1 & 8.4 of the Paris Agreement for Climate Change (UNFCCC, 2015) and SDG No. 2, target 2.4 (UN, 2015, p.25) all address FS concerns.

The ability of institutions or policy areas to facilitate or coordinate the implementation of risk reduction measures on the food sector will probably minimise loss of assets, crops, and livestock yields (Nemakonde and Van Niekerk, 2017). This is so because coordination mechanisms are operational tools essential for achieving coherence among several organisations (Martinez and Jarillo, 1989). Gero et al. (2011) identified the benefits of coordination between FS, CCA and DRR policy areas and/or institutions. These include the collective use of DRR and CCA resources (human, finance, and natural), which in return can increase efficiency towards FS; enhanced sustainability and effectiveness of CCA and DRR approaches to FS; one-stop-shop systems for stakeholders to share information and have knowledge of where to disseminate it and how. However, attaining these benefits is difficult as most FS, CCA and DRRFS initiatives are often framed according to an institution's framework/s, which usually creates a barrier for respective practitioners trying to implement them holistically (Gero et al., 2011). Such failure points to the need to reflect on the range of available FS, CCA and DRR institutions (Ahrens and Rudolph, 2006) and changing how they coordinate their activities.

Whereas the three global frameworks adopted in 2015 refer to each other in efforts to promote coordination, the South African government seems to have adopted them in parallel, without configuring how to address the fragmented responsibilities in harmony. The government has placed FS, CCA and DRR institutions in different ministries and departments with different policy and legislative frameworks, budgets, channels to disseminate information, and administrative structures. This separation makes it more difficult for FS, CCA and DRR institutions to coordinate their activities, especially when responding to food security disasters (Van Zyl, 2013). In addition, the current policy and legislative documents that contribute to FS, CCA and DRR have failed to comprehensively and operationally establish a coordination mechanism that enforces institutions to work together when carrying out FS tasks (Boatemma et al., 2018; Department of Environmental Affairs [DEA], 2017). According to Thomas et al. (2015), coordination problems are more pronounced when multiple actors are engaged in several interdependent activities while distributed across geographical locations.

This complexity prompted this study to develop a coordination support mechanism that promotes coherence of activities between FS, CCA and DRR policy areas. The study intends to do this in four stages, firstly to carry out a conventional content analysis (CA) to identify

significant areas of overlap (where institutions have similar functions that might lead to duplication or conflicts) in FS, CCA and DRR institutional roles and responsibilities towards FS in South Africa. This helps in investigating how policy documents enforce coordination of FS, CCA and DRR activities when addressing FS. Secondly, to use a thematic analysis of data gathered from key informant interviews (KIIs) to understand how identified institutions interact, challenges they encounter and recommendations they offer to change or transform the ways they coordinate for more coherent results. Thirdly, to develop a coordination mechanism using aspects from the functional resonance analysis method (FRAM), and findings from CA and KIIs to align various FS functions undertaken by FS, CCA and DRR institutions to produce a joint outcome. Finally, conclusions, limitations, and recommendations on the proposed coordination mechanism are drawn.

2. Methods and procedure

The study draws from a qualitative research design, including a thorough literature review, CA of policy documents relating to FS, CCA and DRR, and KIIs. The CA explored how FS, CCA and DRR policy documents promote coordination when responding to FS issues in South Africa. The primary data was gathered through KIIs during the period of September 2019 to December 2019. The researchers purposively selected a total sample of 24 respondents from eight institutions (government sectors and government-supported research institutions) as shown in Table 1. A thematic analysis was performed to understand how FS, CCA and DRR institutions interact, challenges they encounter and recommendations they could give to ensure effective coordination of FS functions. Both thematic analysis and CA were informed by the “game theory” approach, which suggests that relationships between institutions should be described as processes and not entities, whereby the unit of analysis should be based on interactions and services provided (Cousins, 2002). Therefore, all four themes used in the presentation and analysis of results reflected major FS functions offered by CCA, DRR and FS institutions. Both CA and thematic analysis were used to complement each other, whereby CA focused on manifest and latent contents from the policy documents and thematic analysis provided a rich and a complex interpretation of what was found in CA. The procedures used to collect and analyse data for CA and KIIs are detailed below.

2.1 Document collection

To obtain relevant policies on FS, CCA and DRR, the researchers conducted a document search on the South African government websites by combining the search term “policy” with terms like “climate change adaptation”, “disaster risk reduction” and “food security”. From these combinations, most of the results identified three key policy documents, which then became the sample for the study. These include the National Disaster Management Framework (NDMF) of 2005, the National Policy on Food and Nutrition Security (NPFNS) of 2014, and the National Climate Change Adaptation Strategy (NCCAS) of 2019. Subsequently, a CA was applied to the sampled documents. CA is employed in conjunction with a research design that aims to describe a phenomenon (Hsieh and Shannon, 2006, p.1279), in this case how FS, CCA and DRR policies coordinate FS functions in South Africa. CA was used because it allows the categories, names, and codes to flow from the data so that new insights could emerge (Kondracki and Wellman, 2002).

Reading all the sampled policy texts several times to establish immersion and a sense of the totality (Tesch, 1990) was the first step in data analysis. Then each policy document was read carefully word-by-word to derive codes (Morse and Field, 1995) by first highlighting

the text that appeared to identify institutions, roles and responsibilities, or a keyword or a phrase that seemed to capture how FS, CCA and DRR policies coordinate FS activities. Next, the coding system was developed by combining all related FS activities from NDMF, NCCAS and NPFNS and grouped them into four categories. Under each category, activities and institutions that were required to drive the function were identified and explored to discover areas of overlap that could cause conflicts or duplication of tasks and assess how the policies enforce coordination. Finally, results from CA were compared to KII findings to observe areas of divergences and convergences that could inform a coordination mechanism that aligns FS, CCA and DRR activities.

2.2 Key Informant Interviews (KIIs)

To find out how FS, CCA and DRR institutions interact when carrying out FS functions, the KIIs were conducted with senior specialists (chief/deputy directors, senior managers, and researchers) who were purposively selected from eight institutions presented in Table 1. Data was collected from key informants using a variety of platforms, including e-mails, face-to-face interviews, virtual/online platforms, and telephonic interviews allowing respondents to choose the platform that was most convenient for them. The interviewees gave their approval for the researcher to record their sessions.

The responses of KII were transcribed verbatim and read in their entirety using Corbin and Strauss' "beginner's mind" technique (2008). The data from KIIs was analysed using thematic analysis, which followed Terry et al. (2017, p. 23-24) six-phase's process. The procedure begins with becoming acquainted with the data (browsing through data to get the meaning). Phases ii and iii (code generation and construction) as well as phases iv and v (reviewing potential themes and defining and naming themes) used the codes and themes determined by CA as it was first conducted. Again, these themes guided the collection of KIIs to present a complete picture of respondents' experiences when coordinating FS functions. Like CA, KIIs findings helped to usher in effective comparisons to CA, which informed the development of a coordination mechanism. Finally, the sixth phase (producing the final report) was presented in the findings section.

2.2.1 Table 1: FS, CCA and DRR institutions and respondents interviewed

Institutions	Total number of respondents
Directorate of Climate Change Adaptation (DCCA) within the Department of Environment, Forestry and Fisheries (DEFF)	3
National Disaster Management Centre (NDMC) within the Department of Corporate Governance and Traditional Affairs (CoGTA)	5
Department of Agriculture, Land Reform and Rural Development (DALRRD)	3
South African Weather Services (SAWS)	3
Agricultural Research Council (ARC)	3
Water Research Council (WRC)	3
Council for Scientific and Industrial Research (CSIR)	1
Agri South Africa (Agri SA)	3
Total	24

3 Findings

This section presents the findings from CA and KIIs.

3.1 Findings from CA and thematic analysis

The findings from CA below seek to review how the policy documents influence effective coordination between FS, CCA and DRRFS institutions that provide FS functions. This is crucial because various institutions provide similar functions to the food sector, which, when the process of implementation is not clarified within policy documents, might lead to duplication of tasks and conflicting goals. Further, findings from KIIs reflect respondents' experiences in terms of interactions, challenges and recommendations associated when carrying out the FS function in South Africa. The study derived four major categories and seven codes from CA, as presented in Table 2 below.

3.2 Table 2: Categories and codes from CA and KIIs

Categories	Codes
Responding to climate and disaster risks that affect FS	-Setting up of national standard response management systems -Establishing institutional arrangements to coordinate response -Preparation of disaster management plans and contingency plans for effective response
Provision of early warning systems (EWS)	-Detecting, mapping, and interpreting of EWS -Dissemination and managing of EWS
Research and capacity building for FS	Investment in research and capacity building
Building FS resilience	-CCA, DRR and FS measures for FS resilience

3.3 Responding to climate and disaster risks that affect food security

Responding to climate change and disaster risks entails providing assistance or intervention during or shortly after a disaster to ensure that people's lives are preserved and basic subsistence needs are met (CoGTA, 2005, p.47). The study explored this category under three codes, namely setting up of a national response management system, establishing of institutional arrangements for response and development of disaster management plans, and contingency plans for an effective response as presented below.

3.3.1 Setting up of a national standard response management system

Under this code, the NDMF (CoGTA, 2005, sections 1.1:6, 1.3:15-16) has identified three institutions (NDMC, DEFF and DALRRD) that participate in responding to FS disasters in South Africa. Specifically, the NDMF (CoGTA, 2005, section 4.3.2) describes NDMC's responsibilities as that of initiating and establishing a national standard response management system (NSRMS) that establishes clear duties and procedures for tactical, strategic, and operational guidance for all participating institutions when responding to disasters. This system is used as a control mechanism to ensure that familiar language is used, protocols for media liaison are understood, partnerships between agencies involved are done to enhance capacity and clarity on responsibilities (CoGTA, 2005, section 1.1: (6), section 1.3: (15-16). Although NCCAS (DEFF, 2019, section 4.3 (1.1.10-15)) does not recognise NSRMS by name, it gives DEFF responsibility to capacitate and operationalise NDMF by participating to improve proactive climate change readiness, response, and recovery capabilities in case of FS disasters. Thus, somehow DEFF recognises NDMC's coordination responsibility in response events while it shows willingness to take part in the disaster response process jointly. On the other hand, the food emergency management and FS information management systems identified under NPFNS (DALRRD, 2014, sections 7 and 12) do not use NSRMS as terms of reference when responding to climate and disaster risks, which affect the coordination of FS activities across relevant stakeholders.

Meanwhile, findings from KIIs reveals that while most respondents from NDMC seemed to indicate how NSRMS has helped them to minimise conflicts when responding to emergency FS disasters, respondents from the Directorate of climate change adaptation (DCCA)

expressed that the preconditions in terms of guidelines and procedures from NSRMS are not clear, especially when dealing with climate-related disasters, which usually lead to duplication of work. One respondent from DCCA expressed his frustration in this way:

I wonder how NDMC expects us to coordinate FS functions whilst its NDMF has not yet provided the implementation framework to engage DCCA when dealing with climate-related disasters regularly

This response prompted a discussion among institutions to further describe the challenges they are facing when carrying out the FS functions. These ranged from a lack of clarity on which institution should play a coordinating role during disaster events such as floods and drought, poor management of food storage and distribution, complacency in handling post-disaster projects to make sure the affected people access food safety nets until they are self-sustained, and interference of political personalities during disaster events for media attention. Regarding political interference, one respondent from NDMC said:

We don't know how to deal with political leaders who just show up during disaster events for media attention without following the media liaison protocols used for coordinating participating actors as illustrated in NDMF.

Other respondents from DALRRD and DCCA shared the same sentiments while describing political interference as an element that disrupts coordination of events during disasters. They also expressed their frustration in the way they disappear after giving speeches without mapping the way forward for resilience building.

3.3.2 Establishing institutional arrangements to coordinate response

This code looked at various institutional arrangements established by NCCAS, NDMF and NPFNS to coordinate FS response activities between various institutions. Specifically, NDMF (CoGTA, 2005, sections 1.3.1.1, 1.1.1) identified the Intergovernmental Committee on Disaster Management (ICDM) and National Disaster Management Advisory Forum (NDMAF) as arrangements that have power to give effect to cooperative governance and coordinate DRR measures between relevant stakeholders when responding to significant events or disasters. A point often overlooked is that the fact that both ICDM and NDMAF are convened quarterly can in some way make them feel not obligated to put FS issues on every agenda, which could affect coordination of activities, especially during emergency disaster situations.

One of the FS activities identified in NCCAS (DEFF, 2019, sections 7.2.1, 7.2.2) is the establishment of Intergovernmental Committee on Climate Change (IGCCC), Inter-Ministerial Committee on Climate Change, and the National Committee on Climate Change (NCCC) that bring together representatives from relevant stakeholders, including DALRRD and NDMC, to discuss climate change issues that affect FS. DALRRD under NPFNS (2014, sections 10, 12) has established the National Food and Nutrition Advisory Committee (NFNAC) to engage relevant stakeholders, including DEFF, when responding to FS disasters. However, the committee takes no notice of NDMC's leading role in overseeing all extreme weather events in South Africa. Again, the institutional arrangements mentioned above seem to be stand-alone structures without any form of communication or any central platform they report to when coordinating FS activities.

The KIIs findings revealed that such a lack of interactions is jeopardising adequate sharing of resources and proper coordination of tasks between sectors. Therefore, many of the respondents from NDMC (CoGTA), DEFF and DALRRD have agreed that to manage

disaster events, one institutional mechanism between NDMAF, IGCCC, NFNAC and NSRMS should play a coordinating role considering it is strategically positioned, with convening power to summon all relevant stakeholders to harness adequate technical advice and resources for effective disaster response. One challenge pointed out by one respondent from NDMC is how most departments sent juniors to represent them in these mechanisms, which usually results in decisions that have less impact on policy interaction.

3.3.3 Preparation of disaster management plans and contingency plans for response

Under this code, the NDMF (CoGTA, 2005, section 3.1.1.2) established that every sector vulnerable to climate and disaster risks should develop disaster management plans (DMPs) and contingency plans for every known hazard. In doing this, NDMC would specify clear preconditions in the form of guidelines, operational procedures, and steps to be followed by relevant stakeholders when developing DMPs and responding to the hazard for coordination. These DMPs act as control mechanisms that help NDMC to understand and coordinate multi-sectoral hazards in one place. In support, NCCAS (DEFF, 2019, section 4.3-1.1.10-15) uses NDMF as terms of reference when developing DMPs for uniformity. However, NPFNS (DALRRD, 2014) mentions nothing regarding DMPs in its entire document, although Sections 1.3 and 9.1 recognise the impact of climate and disaster risks on FS. Instead, the NPFNS (DALRRD, 2014, section 9.1) uses a comprehensive Food and Nutrition Security and Vulnerability analysis to monitor FS data to ensure that food needs of the country are protected against shocks and disasters without engaging NDMC or DEFF experts, thus compromising coordination efforts by NDMF and NCCAS.

KIIs findings did not reveal a lot of information under this code; however, one respondent from NDMC raised a concern on how sectors are providing “Copy and Paste” DMPs that do not reveal detailed information on certain hazards, and how they communicate with other sectors that deal with similar hazards.

3.4 Provision of early warning systems

Early warning systems notify areas, communities, families, and people to an impending major event or disaster so that they can take the required precautions to prevent or mitigate the risk and prepare for a successful reaction (CoGTA, 2005, p.112). Under this function, two codes were developed, namely detecting, mapping, and interpreting of EWS, and Dissemination and managing of EWS.

3.4.1 Detecting, mapping, and interpreting EWS

Regarding this code, NCCAS (DEFF, 2019, sections 4.3, 5.2, 5.3) has identified seven institutions (SAWS, CSIR, DEFF, DALRRD, NDMC, WRC, Agri SA, and ARC) that detect, map and interpret climate change projections of potential hazards using various systems. Specifically, sections 5.2 and 5.3 have identified the SAWS and CSIR as institutions that take part in the provision of EWS to the food sector using various systems, such as the Advanced Fire Information system, Wide Area Monitoring Information System (WAMIS), Severe Weather Warning System (SWWS), and the South African Flash Flood Guidance system (SAFFG). These systems provide real-time information on seasonal predictions, farming or yield future projections, and extreme weather events such as fires, floods and droughts that inform adaptation planning and DRR measures. Under section 5.3 of NCCAS, it identified the ARC as an institution that informs the food sector on drought-resistant crops and climate smart agriculture (CSA), while Agri SA helps with the interpretation of EWS in non-professional language to its members.

NCCAS section 4.3 describes the WRC as an institution that warns the food sector of water availability per farming season through its online drought portal. At the same time, it describes DEFF and NDMC responsibility for managing and interpreting climate related EWS. Although NDMF (CoGTA, 2005, section 4.1) acknowledges NDMC's responsibility on facilitating the development of standard EWS for the vulnerable sector, it does not give operational guidelines to engage DEFF and DALRRD to check for EWS consistency across all sectors. Another limitation in mapping EWS between CCA, DRR and FS is that there is no central structure that combines all the data to check for accuracy and consistency.

The most interesting evidence is the absence of EWS information within NPFNS, which results in difficulties in aligning FS functions with CCA and DRR measures. Further, the NCCAS (DEFF, 2019, section 2.1.6-19) describes DRR and CCA early warning systems as the input that signals the beginning of the farming seasons, gives information on potential hazards that could affect the food sector, and ways to reduce their impacts on FS (CoGTA, 2005).

However, one respondent from DALRRD said that *“Most figures provided by SAWS and CSIR do not explain the severity of extreme events and the expected impact on the food sector”*.

In agreement, various respondents from DALRRD, CoGTA and DEFF expressed challenges of interpreting EWS to non-professional language, in which they must always keep referring to CSIR or SAWS for clarification. Such KIIs findings revealed a lack of technical expertise within government departments that is breeding inconsistency and inaccuracy when providing EWS to the food sector.

3.4.2 Dissemination and managing of EWS

Regarding this code, NCCAS (DEFF, 2019, section 5.3) identified the ARC as an institution that disseminates EWS through the Umlindi/Watchman newsletter system, which has over 300 subscribers, while Agri SA uses e-mails and radio to its members. NCCAS (DEFF, 2019, section 4.3 - 1.1.27) also identified the WRC's drought portal as the main platform for sharing drought EWS with relevant sectors. According to NCCAS (DEFF, 2019, section 5.2), SAWS disseminates general weather forecast and relevant climate information through television, radio, newspapers, and other relevant platforms across South Africa. NCCAS also utilises the provincial Early Warning committees and climate change early warning and vulnerability networks (DEFF, 2019, sections 2.1.10; 5.3:32) to disseminate EWS. NDMF (CoGTA, 2005, section 4.1.1) established that NDMC disseminates EWS through television, radio, and electronic and print media, although it does not clarify a coordination mechanism with other institutions providing similar information. Another problem of coordinating dissemination of EWS comes through NPFNS, which fails to recognise both NCCAS and NDMF's contribution to FS EWS regardless of how time sensitive they are to the food sector. It also comes from the use of separate platforms by FS, CCA and DRR institutions when disseminating EWS to DALRRD.

This is confirmed in the KIIs findings where many respondents from DEFF, DALRRD, CoGTA and Agri SA described limited avenues for dissemination of information as the biggest challenge affecting farmers, especially small-scale farmers in rural areas that cannot access EWS in time to prepare for farming seasons. While a few respondents from the SAWS, CSIR and Agri SA indicated an equal balance in difficulties and success, most respondents described their experiences negatively. For example, one respondent from DALRRD shared that:

Most institutions use different channels to disseminate EWS to their members without consulting DALRRD first, which often leads to disintegration of information that is late in terms of time or lacks consistency and accuracy across sectors.

Regarding the above statement, respondents from CoGTA and DCCA suggested the need for a central information database within DALRRD that stores, provides, monitors and coordinates EWS so that all stakeholders, including farmers, can get accurate and verified similar information to respond in time. Another point raised by the Agri SA respondent showed a lack of avenues and finances to reach subsistence farmers in the rural areas. Finally, all respondents recommended DALRRD to create committees at local level that interpret EWS accurately into non-professional language, while engaging them on a face-to-face basis, especially to those farmers who cannot read and write. Again, provide hard copies in the form of newsletters to those who cannot access the Internet, radio, or television so that no farmer is left behind.

3.5 Research and capacity building

This function creates a risk-averse culture among stakeholders by equipping role players with knowledge and skills through integrated research and capacity-building programmes based on scientific evidence (CoGTA, 2005, section 6). For a brief discussion, one code was developed, namely Investment in research and capacity building.

3.5.1 Investment in research and capacity building

Under this code, the NDMF (CoGTA, 2005, section 6.2.2) and NCCAS (DEFF, 2019, sections 13-2.1.3) have established technical advisory boards or councils to promote development and dissemination of DRR and CCA knowledge and research to various institutions, including DALRRD (2019, section 8.3-5.1.5). However, both policies argued that there is a lack of expertise within DRR and CCA fields and advocated for capacity building through the implementation of training programmes for government officials and politicians. Another argument put forward by DEFF (2019) and (DALRRD, 2014, section 1.3) is the lack of a central database that manages and shares research data from various sectors for easy access and coordination by relevant stakeholders.

Regarding KIIs findings, respondents from the ARC, DALRRD and CoGTA described their experiences with research as an effective way to build capacity to reduce the impact of climate and disaster risks on FS. While DALRRD, CoGTA and DCCA respondents described their functions to range from giving bursaries and grants to tertiary and research institutions to finding solutions on gaps within their sectors, the ARC and WRC respondents described their functions as mostly on training new agricultural technologies to farmers, such as climate modelling, and research on drought-resistant seeds. However, challenges cited by respondents from the ARC and WRC were that the research bursaries offered by CoGTA, DALRRD and DEFF do not clarify preconditions in terms of specific areas of research to be undertaken by students, which result in having research output that does not address complex issues in the food sector. Another challenge cited was that of sectors choosing their own researchers internally, which usually leads to biased results. Equally important, one respondent from DCCA said that,

The most challenge across sectors is not how research is done, but lack of a central database that coordinates research output from different institutions for easy access and effective research uptake.

Therefore, with this statement, all respondents recommended the need to bring all research work under one structure in the form of a database for easy access and better coordination across sectors.

3.6 Building food security resilience

The study described resilience as the ability of an ecological, social, or economic system to absorb disruptions while maintaining the same basic structure and ways of functioning, as well as the capacity for self-organisation and the ability to adapt to stress and change (DEFF, 2019, p.4). Forthwith, one code was developed, namely FS, CCA and DRR measures for FS resilience.

3.6.1 FS, CCA and DRR measures for FS security resilience

Under this code, the NCCAS (DEFF, 2019, section 4.3-1.1.10) shows that DEFF engages in a plethora of FS activities, such as supporting small-scale farmers and fishers to become more climate resilient using climate-smart and conservation agricultural practices that use water more sustainably. Under sections 3.2, 4.3, 7.2 and 7.3, the NCCAS acknowledges the contribution of private sectors in funding and implementation adaptation activities, such as building of ecological and water infrastructure and climate resilient farming practices (DEFF, 2019). The NCCAS (DEFF, 2019, section 5.3:32-33) has also identified the role of Agri SA in helping affected farmers to develop their own safety nets by connecting them with insurance companies, while the ARC fosters innovation and technological transfer in the form of climate-smart agriculture, the production of drought-resistant seeds and soil conservation techniques to support the agricultural sector. Another role identified by NCCAS (DEFF, 2019, section 4.3-1.1.27) is that of the WRC, which empowers communities through informed water decision-making that is directed by science and technology research and development.

The NCCAS (DEFF, 2019, section 4.2) has identified the Department of Water, Agriculture and Disaster Risk Reduction as priority sectors that need to adopt adaptation measures to boost their resilience. In support, NPFNS (DALRRD, 2014, section 12) gives DALRRD the responsibility to maximise food gardens for nutritious food, promote irrigation schemes that save water, create food assistance programmes for the affected, invest in research and green technology. The most important point to realise under this code is that most activities identified in NCCAS and NPFNS are similar, but there are no guidelines established in terms of how resources are shared, and procedures followed to avoid incomplete projects. In addition, the NDMF (CoGTA, 2005, section 4.5) has viewed the process of rehabilitation and reconstruction as independent responsibilities of primary agencies to the task using own frameworks, responsibilities that should be carried out independently by primary agencies with their own terms of references and performance indicators. One of the most frequently expressed sentiments by most respondents, including NDMC, was to regard resilience building as an independent FS function that does not require coordination among relevant sectors. One respondent from DALRRD had this to say:

This silo mentality of institutions has resulted in vast incomplete food security projects around the country due to lack of resources.

Another respondent from the ARC supported the above statement, saying:

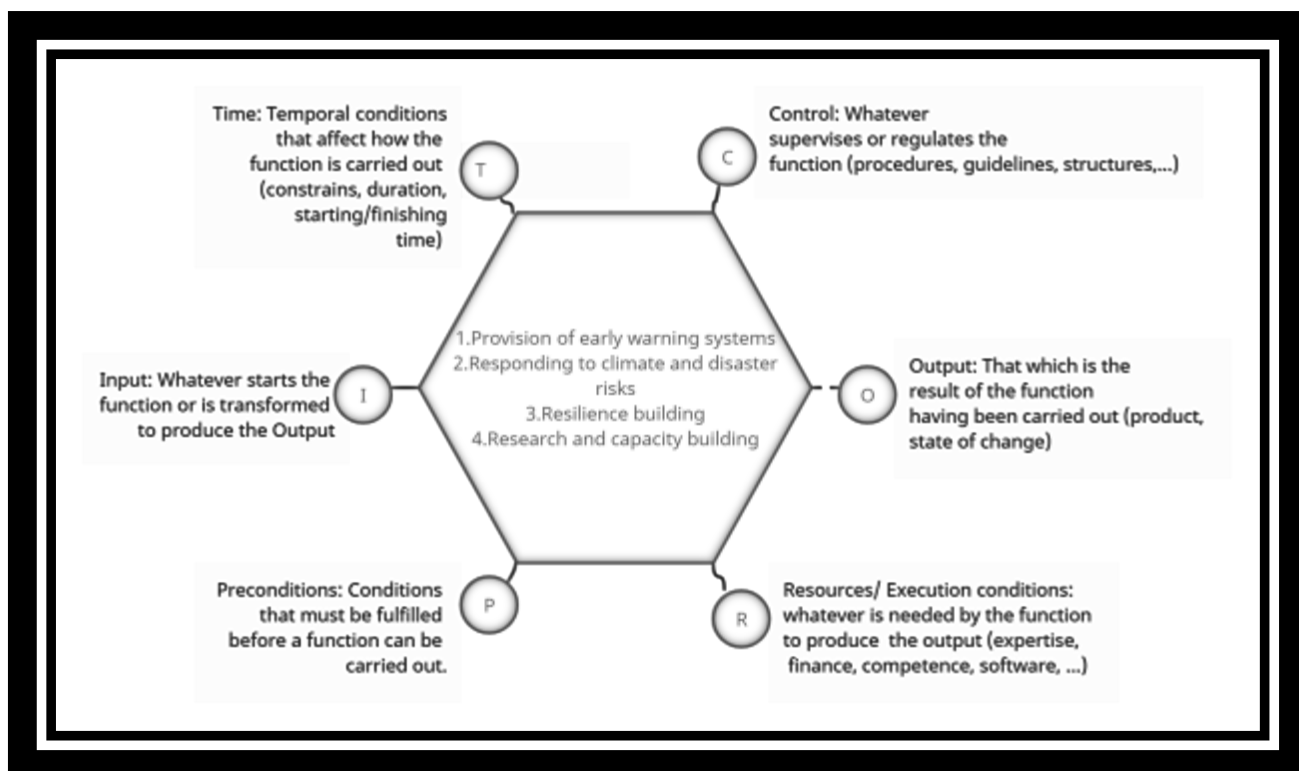
The problem with all institutions is that they all want to undertake enormous projects independently, instead of combining resources from all relevant sectors and focus on one project at a time to further their agenda.

All respondents agreed that resources are a major factor in building FS resilience. Therefore, the solution put forward was that for every FS project, one agency with adequate knowledge of the task could be selected to gather all the needed resources from all participating agencies and funders to maximise the use of resources, while at the same time ensuring effective coordination of activities.

4. Development of a coordination mechanism

Findings from both CA and KIIs have established four major themes, namely provision of EWS to the food sector; responding to climate and disaster risks; building food security resilience, and research and capacity building. The convergence of the literature, CA and KIIs findings helped the study to identify areas of overlap in terms of conflicts and duplication of work between FS, CCA and DRR activities and pointed to a need to develop a coordination mechanism that aligns them. In doing so, six aspects from FRAM were utilised to reduce this coordination problem. According to Hollnagel (2018), FRAM is used to analyse how something has been done (accidents/disaster events) or how something could be done (safety management) to produce a representation of it systematically. In doing this, the events are defined from a functional standpoint, where a function refers to the activities that are required to create a specific result (Patriarca and Bergstrom, 2017). This entails articulating what an agent (person, group, organisation) does in accordance with the six basic aspects, which include pre-conditions (P), input (I), time (T), resources (R), control (C), and output (O) (Hollnagel, 2018; Patriarca and Bergstrom, 2017) (see Figure 1).

The study decided the choice to use aspects from FRAM based on how CCA, DRR and FS activities are interlinked or highly dependent on each other, whereby one task might affect the performance of the other task. In such a case, FRAM aspects allow for simultaneous participation of relevant stakeholders whereby they provide a systematic way to coordinate activities through characterisation or setting parameters of functions before any activity is carried out. Another advantage is that the description of functions is straightforward, which allows policy-makers or practitioners to identify variabilities, challenges, and opportunities that should be considered before an activity is executed (Hollnagel, 2013). Thus, the coordination mechanism's main purpose is to give technocrats and/or practitioners an effective way to coordinate FS, CCA and DRR functions in a systematic manner to reduce challenges, conflicts, and duplication of work, while embracing possible opportunities determined by Gero et al. (2011) (see Section 1) to achieve the intended output.



4.1. Figure 1: A graphical representation of FRAM's six aspects

(Source: Hollnagel, 2018, p.11)

The FRAM aspects illustrated in Figure 1 show four themes derived from CA and KIIs as major FS functions carried out by FS, CCA and DRR institutions. The six points around the hexagon show the six aspects (Preconditions, Input, Resources, Control, Time, and Output) that are used to set parameters in which the four functions within the hexagon should be analysed. The CA and KIIs findings determined where the coordinating problem was emanating from, and FRAM aspects were used to show what they could do to reduce such coordination challenges. To illustrate how policy-makers and/or practitioners could use the FRAM aspects to coordinate functions, a detailed discussion is given below.

4.2 Responding to climate and disaster risks and the effects of a lack of coordination on FS

Regarding this function, CA and KIIs results have shown that NCCAS, NDMF and NPFNS have set up systems, institutional arrangements and plans to coordinate response activities. However, they are operating in isolation of each other, resulting in duplication of tasks and conflicting goals. To avoid such duplications, Hollnagel (2018) suggests that before a function is carried out, **Preconditions** and **Input** aspects should be established, such as standard guidelines and procedures to be followed by relevant agents. In support, Kumar Panday (2006) argues that for any response task to be carried by any institution, they are achieved if policy-makers state operational guidelines that provide enough detail for implementers to understand what is expected of them to coordinate all activities effectively. Where the impacts of climate and disaster risks exceed FS, a review could be done to check if guidelines had been adhered to for accountability. Another challenge indicated by CA is a poor engagement of technical expertise across sectors by NPFNS through NFNAC.

Using the **Resource** aspect to avoid such challenges, it should clarify all institutions and expertise required in the policy documents, including their roles and responsibilities before

the response function is carried out. In terms of managing the function, both CA and KIIs findings showed that there is a lack of clarity on which institutions or structures should play a coordinating or supervisory role during significant events or disasters. Here, policy-makers could utilise the **Control** aspect to determine who or what should supervise or regulate the function depending on who has adequate resources, the mandate to summon relevant stakeholders, and who are strategically positioned to assume primary responsibilities of the function. Further, the **Control** aspect could also act as the **Time** aspect in determining the duration of an activity and the resources needed for the function to be carried out within the time limits to prevent severe fatalities. Finally, policy-makers or practitioners could use the **Output** aspect as a performance indicator to determine successes or failures associated with the function.

4.3 Provision of Early Warning Systems (EWS) and the effects of a lack of coordination on FS

Findings from KIIs have shown that most satellite weather systems provide data that does not explain the severity of extreme events and their expected impact on the food sector. To reduce such challenges, **Preconditions**, according to Hollnagel (2018), advocate that all conditions are adhered to before an activity starts. Here, satellite weather services (SWWS, WAMIS, SAFFG and AFIS) should be checked or monitored continuously by FS, CCA and DRR practitioners to provide exact real-time climate and weather figures before the function is carried out. The **Resources (R)** aspect determines expertise or agencies needed to carry out the function. Regarding CA and KIIs findings that show difficulties in the interpretation of EW data to non-professional language, the **Resources** aspect could be used by practitioners to either select people with the right qualifications or encourage training for government or non-state officials to ensure accurate interpretation of data. This process could also act as an **Input (I)** aspect of the function, whereby data is transformed into non-technical language for easy understanding across sectors. Therefore, for both **Resource** and **Input** aspects, institutions (CSIR, SAWS, Agri SA, ARC, DCCA, NDMC, DALRRD and WRC), should establish who does what and when to avoid conflicts and duplication of tasks.

On EWS dissemination, both CA and KIIs findings have recommended the use of a central database as the solution to improve timing and consistency in EWS dissemination. The **Time** aspect determines temporal conditions that could affect the function. Here, relevant practitioners must make sure EWS shows duration (start/finishing time) of significant events or disasters so that farmers respond accordingly. CA and KIIs findings have shown inconsistency of EWS across sectors as a challenge caused by a lack of data supervision and control. The **Control** aspect under any function should determine structures or agencies needed to supervise the function. Here, a central database within the primary institution that manages FS EWS as suggested by KIIs findings should verify, monitor, and coordinate all EWS from different institutions to achieve the intended **Output (C)**, which is accurate, consistent, and timeous EWS. Gero et al. (2011) support this suggestion of a one-stop shop for information sharing to promote easy access and dissemination of data within time limits to the relevant stakeholders.

4.4 Using research and capacity building and the effects of a lack of coordination to FS

Regarding this function, both CA and KIIs findings established a lack of a central database that coordinates research outputs from different institutions as the major drawback to effective research uptake by users. Therefore, practitioners could use the database to act as the **Control** aspect that manages and supervises all relevant research work on one site for easy access and verification of adequate scientific writing that is ethically acceptable. To reduce bias and research that does not address critical FS, CCA and DRR issues as identified in KIIs findings, **Preconditions** and **Resource** aspects could ensure that funding is availed to qualified independent researchers to address research gaps that are needed to solve real complex problems. There is no information relating to the **Input** aspect, but the **Output** aspect variable could be determined by the knowledge uptake by individuals, groups, or relevant stakeholders across the sectors.

4.5 Importance of building FS resilience

Under this function, both CA and KIIs findings have shown a lack of resources as the major hindrance to building resilience, which is caused by the way institutions and policies plan resilience building projects using their own frameworks and terms of references. Hollnagel (2018) describes resources as finite or always limited, whereby the way they are utilised, or their availability determines the success or failure of a function. Under this scenario, the **Resource** aspect should identify adequate expertise, finance, equipment, competence, and many others required to carry out the projects. If resources are not sufficient, practitioners must use the **Control** aspect to gather and coordinate resources across relevant stakeholders to prevent incomplete projects, as recommended in KIIs findings. Along similar lines, Kumar Panday (2006) argues that if policies or institutions do not delegate responsibilities or resources when carrying out cross-cutting projects, there should be a certain amount of room for negotiation between the participating agencies to share resources before the function begins. Information regarding **Preconditions**, **Input or Time** aspects was not identified in CA and KIIs findings, as most resilience building projects are long term and ongoing endeavours. According to Hollnagel (2018), if there is no information regarding an aspect, it should be clarified. Finally, the **Output** aspect in this function would determine how the projects are strengthening the resilience of the food sector.

5. Conclusion

Drawing from CA and KIIs findings, the study established that there are a lot of inconsistencies in how the WRC, ARC, DCCA, NDMC, SAWS, Agri SA, DALRRD, and CSIR carry out the FS functions in South Africa. Although most institutions seem to understand their roles towards FS, these functions are coupled with challenges that emanate from a lack of clarity in the policy and legislative documents that address FS, CCA and DRR. On those roles that are articulated in such documents, there seem to be a lack of implementation plans that coordinate who should do what, when and where to avoid duplication of tasks and conflicting goals. In terms of EWS, research, and capacity building, the study established that a central database should be established that could be accessed by all stakeholders to ensure consistency in EWS and research output across sectors. The study also concluded that, to avoid a plethora of unfinished resilience building FS projects, institutions should combine resources and work on one project at a time to achieve the intended results. Both CA and KIIs findings pointed to the establishment of a coordination mechanism that aligns FS, CCA and DRR functions to work coherently.

It is expected that the proposed mechanism of coordination will provide insights for policy-makers and practitioners who would like to coordinate FS, CCA and DRR functions to improve FS. The mechanism is comprehensive because it characterises all aspects of a function before it is carried out to avoid duplication of tasks by institutions performing similar functions. The mechanism is also generic in the sense that it is not tailored to specific functions but could be applied to any simple or complex functions. In implementing the mechanism, it may not clearly illustrate some aspects in legislation, guidelines, or plans, therefore, practitioners could indicate that no information is available. Such characterisation could help the supervisory team to investigate it and call for a review of a policy. The creation of this mechanism should be considered as a continuous process, as it is vital to analyse the mechanism's success and failures on a regular basis and make changes as needed. The study acknowledges that despite creating a coordination mechanism that brings functions of FS, CCA and DRR together, there might still be a problem even at regional and international levels as these institutions have independent mandates. However, this study argues that the setting up of this mechanism should not be a pseudo-indicator for success, but an enabler to coordinate FS, CCA and DRR functions.

6. References

- Ahrens, J. and Rudolph, P.M. (2006). The Importance of Governance in Risk Reduction and Disaster Management. *Journal of Contingencies and Crisis Management*, Vol.14, No. 4, pp. 207-220.
- Becker, P., Abrahamsson, M. and Hagelsteen, M. (2013). Parallel Structures for Disaster Risk Reduction and Climate Change Adaptation in Southern Africa. *Jamba: Journal of Disaster Risk Studies*, Vol. 5, No. 2. pp. 1-5. <https://doi.org/http://doi.org/10.4102/jamba.v5i2.68>.
- Boatemma, S., Drimie, S. and Pereira, L. (2018). Addressing Food and Nutrition Security in South Africa: A Review of Policy Responses Since 2002. *African Journal of Agricultural and Resource Economics*, Vol. 13, No (311-2019-687), pp. 264-279.
- Corbin, J. and Strauss, A. (2008). Strategies for Qualitative Data Analysis. *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory* 3. <https://dx.doi.org/10.4135/9781452230153.n4>.
- Cousins, P.D. (2002). A Conceptual Model for Managing Long-term Inter-organisational Relationships. *European Journal of Purchasing & Supply Management*, Vol. 8, No. 2, pp. 71-82.
- Department of Agriculture, Land Reform and Rural Development (DALRRD) South Africa. (2014). National Policy on Food and Nutrition Security (NPFNS), Pretoria: Government Printer.
- Department of Corporate Governance and Traditional Affairs (CoGTA) South Africa. (2005). National Disaster Management Framework (NDMF), Pretoria: Government Printers.
- Department of Environment, Forestry and Fisheries (DEFF) South Africa. (2019). National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printers.
- Department of Environmental Affairs (DEA) (South Africa). (2017). National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printers.
- Food and Agriculture Organization (FAO). (2006). *Food Security: Policy Brief: Division of Food Agriculture and Developmental Economics*. <http://www.fao.org/es/esa/>
- Gero, A., Méheux, K. and D Dominey-Howes, D. (2011). Integrating Disaster Risk Reduction and Climate Change Adaptation in the Pacific. *Climate and Development*,

- Vol. 3, No. 4, pp. 310-327. <https://doi.org/https://doi.org/10.5194/nhess-11-101-2011>.
- Hollnagel, E. (2013). An Application of the Functional Resonance Analysis Method (FRAM) to Risk Assessment of Organisational Change. Strålskyddsnämnden (SSN), Stockholm.
- Hollnagel, E. (2018). The Functional Resonance Analysis Method: A Brief Guide on how to use the FRAM. (Accessed 08 November 2021) <https://functionalresonance.com/onewebmedia/Manual%20ds%201.docx.pdf>.
- Hsieh, H.F. and Shannon, S.E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, Vol. 15, No. 9, pp. 1277–1288. <https://doi.org/https://doi.org/10.1177/1049732305276687>.
- Intergovernmental Panel for Climate Change (IPCC). (2007). *Climate Change: Impacts, Adaptation and Vulnerability Summary for Policymakers*. (IPCC). https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg2_full_report.pdf.
- Intergovernmental Panel for Climate Change (IPCC). (2018). Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty [Masson-Delmotte, V., Zhai, P., Pörtner, H.-O. Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Ignor, M. and Waterfield, T. (eds.)]. In Press.
- Kondracki, N.L. and Wellman, N.S. (2002). Content Analysis: Review of Methods and their Applications in Nutrition Education. *Journal of Nutrition Education and Behaviour*, Vol. 34, pp. 224-230.
- Kumar Panday P. (2006). Central-local Relations, Inter-organisational Coordination and Policy Implementation in Urban Bangladesh. *Asia Pacific Journal of Public Administration*, Vol. 28, No. 1, pp. 41-58.
- Martinez, J.I. and Jarillo, J.C. (1989). The Evolution of Research on Coordination Mechanisms in Multinational Corporations. *Journal of International Business Studies*, Vol. 20, No. 3, pp. 489-514.
- Morse, J.M. and Field, P.A. (1995). *Qualitative Research Methods for Health Professionals*. Second edition ed. Thousand Oaks, CA: Sage.
- Nemakonde, L.D. and Van Niekerk, D. (2017). A Normative Model for Integrating Organisations for Disaster Risk Reduction and Climate Change Adaptation within SADC Member States. *International Journal of Disaster Prevention and Management*, Vol. 26, No. 3, pp. 361-376
- Patriarca, R. and Bergström, J. (2017). Modelling Complexity in Everyday Operations: Functional Resonance in Maritime Mooring at Quay. *Cognition, Technology & Work*, Vol. 19, No. 4, pp. 711-729.
- Seidler, R., Dietrich, K., Schweizer, S., Bawa, K.S., Chopde, S., Zaman, F., Sharma, A., Bhattacharya, S., Devkota, L.P. and Khaling, S. (2018). Progress on Integrating Climate Change Adaptation and Disaster Risk Reduction for Sustainable Development Pathways in South Asia: Evidence from Six Research Projects. *International Journal of Disaster Risk Reduction*, Vol. 31, pp. 92-101.
- Terry, G., Hayfield, N., Clarke, V. and Braun, V. (2017). *Thematic Analysis. The Sage Handbook of Qualitative Research in Psychology*. Edited by C. Willig and W. Stainton-Rodgers. 2 Ed. Sage Publications, London.
- Tesch, R. (1990). *Qualitative research: Analysis Types and Software Tools*. Bristol: Falmer.

- Thomas, G, Botha, R.A. and Van Greunen, D. (2015). Understanding the Problem of Coordination in a Large Scale Distributed Environment from a Service Lens View—Towards the South African Public Sector e-Administration Criteria for Coordination Support. *Government Information Quarterly*, Vol.32, No. 4, pp. 526-538.
- United Nations (UN). (2015). Sustainable Development Goals (SDGs) Goal No. 2. UN. (Accessed 21 February 2021). <https://sdgs.un.org/goals/goal2>.
- United Nations (UN). (2016). Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology Relating to Disaster Risk Reduction". Seventy-first Session, Agenda item 19 (C). UN: Geneva
- United Nations Framework Convention on Climate Change (UNFCCC). (2015). Paris Agreement on Climate Change. (Accessed 7 February 2021). http://unfccc.int/paris_agreement/items/9485.php.
- United Nations International Strategy for Disaster Reduction (UNISDR). (2009). UNISDR terminology on Disaster Risk Reduction. UNISDR. (Accessed 21 February 2021). https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf.
- United Nations International Strategy for Disaster Reduction (UNISDR). (2015). Sendai Framework for Disaster Risk Reduction. (Accessed 7 February 2021). <https://www.unisdr.org/we/coordinate/sendai-framework>.
- Van Zyl, K. (2013). *Disaster Management, Mitigation and Adaptation to the Right to Food and Food Security: food Security and Disasters in South Africa for Centuries*. Agri SA (South Africa).

CHAPTER 5: ARTICLE 3
PRACTICAL EXAMPLES, EXPERIENCES AND TOOLS USED TO BRING
COHERENCE TO FS, CCA AND DRR POLICIES IN SOUTH AFRICA

Using technology to bring coherence between climate change adaptation and disaster risk reduction for food security in South Africa

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Abstract

As disasters and climate change risks such as droughts and floods continue to affect food security (FS) globally, most governments, including South Africa, have resorted to the use of technology to incorporate climate change adaptation (CCA) and disaster risk reduction (DRR) to address FS issues. This is because most institutions and policies that address CCA, DRR and FS operate in parallel, which usually leads to polarisation of interventions and conflicting objectives, thus leaving the issue of FS unresolved. The purpose of the study was to investigate how FS projects are incorporating CCA and DRR using technology. A qualitative research design was applied; whereby in-depth interviews were conducted with ten project participants from two projects, while ten key informants were purposively selected from government and research institutions. The main findings of the study revealed that both projects incorporate CCA and DRR measures in most of their food value chains. Although the projects are different in nature, they still face similar challenges, such as a lack of expertise, resources, funding, and an inadequate regulatory environment to improve their farming practices. The study brings in the practical side of addressing coherence between FS, CCA and DRR through technology and recommends a review of policies that support agriculture innovation to accommodate CCA and DRR measures.

Key words: climate change adaptation, disaster risk reduction, food security, Sentinel-2 Earth Observation technology, hydroponics farming technology

1. Introduction

Many least developed countries (LDCs), including South Africa, have been seeing a rising adverse impact of climate change and disaster risk on their agricultural sectors in recent years (Bandara & Cai, 2014; Kahsay & Hansen, 2016; Roudier *et al.*, 2011). Reduced output is one of the most direct ways that climate change and disasters influence the food sector. This results in direct economic losses for farmers, which can ripple across the value chain, limiting agricultural growth and rural lifestyles (Conforti *et al.*, 2018; Garschagen *et al.*, 2015; Israel & Briones, 2012). Climate change and disaster risks manifest themselves in a variety of ways, including rising temperatures, erratic and heavier rains, and prolonged and frequent droughts (Akinagbe & Irohibe, 2015; Chepkoech *et al.*, 2018), all of which have a significant impact on the agricultural sector, particularly in Sub-Saharan Africa (SSA),

where rain-fed agriculture is the norm. According to the Intergovernmental Panel on Climate Change (IPCC) (2007), agricultural productivity in SSA will fall from 21% to 9% by 2080. Furthermore, according to Liliana (2005), by 2025, roughly two-thirds of Africa's agricultural land is likely to be lost due to a shortage of rainfall and drought. This means that South Africa is not immune to the detrimental effects of climate change and variability, as well as the threat of disasters (Masipa, 2017).

The Long-Term Adaptation Scenarios (LTAS) (2013-2014) (DEA, 2017) estimate a 25% reduction in annual maize yields and a shift for growing areas of field crops (e.g. Sugarcane, wheat, barley, sorghum, maize, and soybean) by 2050. The LTAS further estimate possible land degradation, population increase and loss of growing areas to development in South Africa by 2050 (DEA, 2017:46). In light of this, major efforts have been made around the world to improve the coherence of FS, CCA, and DRR themes, strategies, and frameworks in order to create resilience against the expected impacts of disasters and climate change on FS (GIDRM/GIZ, 2019; OECD, 2018). However, of all strategies, frameworks and themes that have been developed to interlink both FS, CCA and DRR policies and practices, very few have looked at the synergies from a technological perspective in South Africa. The existing literature focuses mainly on the theoretical elements of merging FS, CCA, and DRR, with much attention paid to commonalities, differences, convergence points, and limitations associated with addressing these issues in coherence (FAO, 2012; Habiba *et al.*, 2016), thus neglecting the practical actions, such as the use of technology or innovations that could help in bringing the policy areas or mechanisms together. Hence, attempts to develop food security must take into account the issue of technology in order to meet its growing demand for FS under increasingly severe climatic change (Fomunyam, 2019) while bringing coherence to FS, CCA and DRR. Against this backdrop, various technologies were developed world-wide, including South Africa, that are heavily dependent on weather forecasts to overcome extreme weather events and climate change disasters to improve FS (Fomunyam, 2019). The most prominent FS projects adopted in South Africa include the Sentinel-2 Earth Observation technology and hydroponics technology farming which incorporate CCA and DRR measures to improve FS. These projects were adopted because of their relevance to the South African environment (arid-semi arid region) (Winter, 2018), including the context of affordability, accessibility, and applicability (Lee, 2017). Although these technologies are still at the inception stage, this study firstly investigated how the projects are incorporating CCA and DRR measures in addressing FS in South Africa. Second, the study explored the experiences of respondents in terms of challenges and opportunities associated with the technologies in their respective areas, and lastly, discussions and conclusions of the research are given.

2. Agriculture technology used to incorporate CCA and DRR measures in FS

The use of agriculture technology as part of climate-smart agriculture as a response to climate change has recently gained traction (Asfaw & Lipper, 2016) and is helping in making the interlinkages between FS, CCA and DRR easier through the sharing of information across sectors (Campbell *et al.*, 2014). The findings from the World Bank's World Development Report (2016) have shown that the use of technology could bridge the gaps in communication and connectivity between sectors, thus improving interaction and access to information to farmers to improve their farming practices. Lee (2017) explains that the use of agriculture technology has birthed a single unit system that carries other sub-systems for optimum performance, namely farm machinery, seedling, farm management, forecasting, vegetation and hazards monitoring, and irrigation. These technologies bring

synergy between all units on the farm, which helps to address a broad spectrum of all agricultural issues, including CCA and DRR. This technical advancement is argued to be the underlying driver of economic and social growth, and it is projected to drive global economic and social revolution (World Economic Forum, 2017). For example, by combining FS, CCA and DRR information under one platform for easy access. Use of technology during the fourth industrial revolution (4IR) is predicted to improve living standards, raise agricultural output, and promote consumption and per capita income (Makridakis, 2017).

The 4IR is a term coined by Klaus Schwab (2015) who describes it as a term that integrates computation, networking and physical processes that include Internet communication infrastructure, Big Data, 3D/4D printing, Big Data, and robotics. This endeavour was aggravated by the need to bring synergy between all units on the farm, which helps to address a broad spectrum of all agricultural issues (Fomunyan, 2019), including CCA and DRR measures. However, the adoption of agricultural technology and its application in SSA, including South Africa, has been inconsistent, yielding only limited economic and social transformation (The Africa Competitiveness Report, 2017). Hensengerth (2018) and Olawuyi (2018) argue that this is due to a lack of enabling regulatory environments, economic and social environment cost, and a paucity of risk-takers (entrepreneurs) capable of driving radical innovation to bring technologies into the market for the agricultural industry's growth (Naudé, 2017).

The success of the adoption of technology in South Africa has been centred on the ability of the technology to incorporate CCA and DRR measures in its practices (Thamaga-Chitja & Morojele, 2014). Therefore, in this study more focus was put on how the Sentinel-2 Earth Observation technology and hydroponics farming technology are incorporating CCA and DRR measures when addressing FS. As a point of departure, Sentinel-2 Earth Observation technology is discussed.

2.1 Sentinel-2 Earth Observation technology

Sentinel-2 is a European Space Agency earth observation satellite mission designed as part of the Copernicus Program to make terrestrial observations in support of a variety of services, including agriculture (Vuolo *et al.*, 2018:122). The Sentinel-2 mission creates more opportunities for regional to global agriculture surveillance through a 10-20m spatial resolution, a 5-day revisit frequency, a global coverage, and its interoperability with Landsat missions (Vuolo *et al.*, 2018). Studies that have looked at the use of the Sentinel-2 Earth Observation technology in agriculture have observed that the technology provides data on vegetation phenology and growth (Immitzer *et al.*, 2016), burned areas, and active fires (Roteta Otaegui *et al.*, 2019). It can also monitor agricultural activities to strengthen food production information and market transparency (Bontemps *et al.*, 2015), while improving crop types and classification in both commercial and smallholder farmers (Vogels *et al.*, 2019; Vuolo *et al.*, 2018). The technology helps to bridge the gaps in communication and connectivity between sectors or farmers to improve their farming practices (World Bank World, 2016). The report given in 2016 by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (Lee, 2017), emphasises that the transformation of the food sector using agriculture technology that uses satellites has helped farmers to share a close connection, especially with those in climate and disaster infested areas. In South Africa, Thamaga-Chitja and Morojele (2014) argue that the use of satellites could help farmers that practise rain-fed subsistence agriculture to have access to

information that could boost their lots when it comes to agricultural production. Lee (2017) also indicates that the use of technology that integrates computation, networking and physical processes could birth a single unit system that carries other sub-systems for optimum performance, namely farm machinery, seedling, farm management, forecasting, vegetation and hazards monitoring, and irrigation. This means that incorporation of CCA and DRR measures into FS would be made easier.

However, the setbacks of Sentinel-2 could be the difficulties to take images acquired for monitoring purposes if the weather is cloudy (Escolà *et al.*, 2017). Such drawbacks could delay or affect a whole series of data that most countries including South Africa depend on. In addition, the technology presents the challenge of data interpretation by farmers who have no knowledge of satellites. Thus, Fomunyam (2019) suggests the need for training farmers and relevant stakeholders who benefit from the technology.

2.2 Hydroponics farming technology

According to De Anda and Shear (2017), hydroponics farming technology has the capability of reducing the carbon footprint while offering the possibility for sustainable food production for the coming years, especially in urban areas. This technology was influenced by the growth of the population in urban areas, the need to grow food near the consumers (Lakkireddy *et al.*, 2012) and to provide city markets with fresh agricultural products to achieve FS (Orsini *et al.*, 2013). Hydroponics agriculture can be characterized as a system of production that uses various artificial structures to protect crops from the effects of climate change and natural disasters (De Anda & Shear, 2017). In South Africa, hydroponics farming was introduced in the late 1970s by Don Bilton through the “Nutrient Film Technique” (NFT), which uses gravel in plastic-lined beds instead of pure nutrient solutions (Du Plooy *et al.*, 2012). Hydroponics farming is effective under diverse climatic conditions mostly associated with droughts, floods, and extreme weather events. It increases the yields, quality, and availability of food (Du Plooy *et al.*, 2012; Maboko *et al.*, 2009) through incorporating CCA and DRR measures such as water saving irrigation technology, reduces evaporation and limits water run-off while using less/no chemicals that could affect the groundwater table (Senyolo *et al.*, 2018). Research by Rosa-Rodriguez *et al.* (2020) has shown that hydroponics in a protective system is a good alternative for the preservation of water resources and the reduction of pollution to open-field farming systems. Other studies by Freidberg and Goldstein (2010) and Hampwaye *et al.* (2007) have found that hydroponics farming influences direct marketing networks for small and mid-sized farmers as alternatives to mainstream channels and they form part of multi-livelihood strategies for urban survival without clearance of vegetation, thus adding green elements to cities. Unless operators can find a way to self-sustain through use of renewable energy, De Anda and Shear (2017) suggest that the cost of running the facilities to keep the growing temperature right for the crop and deliver water to plants is likely to outweigh the cost of running a regular farm. In addition, De Anda and Shear (2017) claim that the farming technology is not yet capable of producing various types of fruit and vegetables; while the need for highly trained professionals and the cost of land in urban areas are always a challenge to achieve the intended economic return.

3. Methodology

3.1 Case selection

The study was conducted with FS projects within the Johannesburg Metropolitan City and Western Cape Province in South Africa. The selection of these two cases was because they are locations with higher populations compared to other parts of South Africa, with increased food consumption and their susceptibility to disasters and climate change (Hetz, 2016). Specifically, Johannesburg is in Gauteng Province, the industrial and commercial heartland of South Africa, with a population of around 5,635 million (2019) (Basera *et al.*, 2020) and a source of 33% of South Africa's Gross Domestic Product (GDP) (Hetz, 2016). The city is characterised by unequal access to land, urban poverty, rising unemployment, inadequate housing, and basic services, which is a fundamental legacy of racial segregation history (Kroll *et al.*, 2012). Additionally, Johannesburg is prone to climate change and disaster risks such as flood risks that occur frequently caused by heavy precipitation events, which are projected to further increase in magnitude and frequency (Hetz, 2016). In the end, climate change has affected the ability of people to engage in urban economy (e.g. destruction of crops and infrastructure used to transport food to the cities), resulting in a lack of access to food (Hetz, 2016). On the other hand, the projections of an increase in climate change impacts in the Western Cape Province by Midgley *et al.* (2005) and Pasquini *et al.* (2013) motivated the study to focus on the area. The Western Cape is biophysically unique in comparison to the rest of South Africa, mainly due to its Mediterranean-type climate (Midgley *et al.*, 2005). The area is subject to climate extremes such as floods (Holloway *et al.*, 2010) and droughts (Mukheibir & Ziervogel, 2007), which have affected the food sector (Holloway *et al.*, 2010). For example, the hailstorm that occurred in August 2006 destroyed seven farms and 389 hectares of fruit trees were damaged, resulting in 9.4 million Rands direct damage costs (Holloway *et al.*, 2010). Noticing the negative effects of climate change and disaster risks on agriculture, which would have serious implications in ensuring FS in the two regions (Zwane, 2019), it was necessary to investigate their primary agriculture strategies in order to provide lessons that could be applied by other provinces and the country at large.

3.2 Data Collection and analysis

The study utilised a qualitative research design, including a literature review relating to Sentinel-2 Earth Observation and hydroponics farming technology in general and South Africa in particular. In addition, in-depth interviews with respondents from the Western Cape FS project using Sentinel-2 Earth Observation and the Urban Agricultural Initiative (UAI) FS project using hydroponics technology projects were conducted. The selection of respondents was based on purposive and snowball sampling, whereby purposive sampling was used to select three project managers from each project. Snowball sampling was achieved when the identified managers would be requested to recommend two suitable project beneficiaries (Creswell, 2015).

Further, key informant interviews (KIIs) were conducted with 24 purposively selected respondents from eight institutions, including the Department of Agriculture, Land Reform and Rural Development (DALRRD), National Disaster Management Centre (NDMC), Water Research Council (WRC), Agriculture Research Council (ARC), Agri SA, and the Department of Environment, Forestry and Fisheries (DFFE), the Human Sciences Research Council (HSRC), and the South Africa Weather Services (SAWS) during the period of September 2019 to December 2019. The significance of interviewing government and research institution officials was a deliberate choice to get an external perspective of how

the FS projects are performing in terms of incorporating CCA and DRR measures. Virtual/online platforms, E-mails. Telephonic interviews, and face-to-face interviews were used for both in-depths and KIIs, allowing participants to choose the most convenient platform for them. The interviewees gave their permission for their conversations to be recorded.

Interview responses from in-depths interviews and KIIs were transcribed verbatim, while thematic analysis was used to analyse them. The analysis followed the six-phase process established by Terry *et al.* (2017:23-24). The process commences with (i) getting familiar with the data (browsing through data to get the meaning). Phases ii and iii (constructing and generating and codes) were skipped during the analysis because they were out of the scope of the study. Phases iv and v (reviewing potential themes and naming and defining themes) were established based on the FS projects under study, followed by sub-themes that looked at how the projects are incorporating DRR and CCA measures, including the challenges and opportunities encountered. Finally, the sixth phase produced the final report as presented below.

4. Findings

4.1 Western Cape food security project using Sentinel-2 Earth Observation technology

4.1.1 Project overview

The Western Cape FS project is operated from the Department of Agriculture in Elsenburg in Sandringham. The project is handled at a provincial level in order to unlock the full potential of agriculture to enhance the ecological, economic, and social well-being of the people of the Western Cape. The project uses the Sentinel-2 Earth Observation technology to incorporate CCA and DRR measures when addressing FS. The technology is used to detect and leverage agriculturally relevant satellite data using the Sentinel-2 portal and remote sensing tools, which have multi-spectral data with 13 bands, spatial resolution of 10 m and 20 m, 290 km field of view and revisit time of five days (Bontemps *et al.*, 2015:4185). The Department is actively experimenting with some of these cloud-based services in their geographic information system (GIS) and online application, CapeFarmMapper (CFM). This project was influenced by the need to achieve the agri-renaissance (understanding of the role of agriculture in the development process) following the 4IR initiative through the use of technology in South Africa.

4.1.2 Project problem

Traditionally, the only way to get satellite imagery was to search through picture catalogues, pick cloud-free photos, and then download and archive each image, including all of its multi-spectral wave bands. This was a time-consuming and data-intensive operation, and the subsequent analytical workflows needed specialised knowledge and costly software. To address this issue, the Western Cape Department of Agriculture has established a sentinel portal and remote sensing technologies that will take advantage of the vast amount of agricultural satellite data available in an integrated platform that hides the technicalities from non-expert users. Again, the integrated platform gives the farmer or advisors the chance to follow the crop development, make management decisions (i.e. irrigation, fertilisation, and crop protection), have feedback of the performed operations and predict yields (Escolà *et al.*, 2017). To bring coherence to CCA and DRR, Bontemps *et al.* (2015) argue that the Sentinel-2 Earth Observation technology provides rapid access to near real-time information

on both crop conditions, vegetation (veld), and resource use; easy information flow and better decision-making that can be used in studying climate change. Through the judicious use of technology, the department is promoting sustainable farming while creating a food secure province by making these instruments available.

4.1.3 Incorporation of CCA measures in the project

The qualitative findings established that the sole purpose of using Sentinel-2 in the Western Cape Province was because of the prevalence of climate change and variability and its impacts on FS, including a lack of climate change information. To address such challenges, most respondents acknowledged that the technology has helped to make relevant data available that helps to monitor climate change hazards and extreme weather events that affect their crop seasons. One of the Sentinel-2 respondent's views are encapsulated in the following statement:

“The data provided by the technology has helped us incorporate climate change factors such as weather forecasting, comparing cropping seasons to see how crops are progressing to climate change.” (Sentinel-2, management)

The same respondent went on to say that the longer they keep tracking climate change and agricultural data for the project like that, they start building up time series of data to look at the impacts of climate change on FS over the time series. Therefore, to ensure FS in the province, it will be a question of seeing how your seasons are progressing and identifying zones or sub-regions that are underperforming that might have an impact on food supply in the season. In response to the growing pressure of climate change on FS, one Sentinel-2 respondent asserted that the technology has offered better monitoring capabilities to strengthen synergies in all food value chains, including food production information and market transparency to improve decision-making during climate-related disasters. Meanwhile, KIIs findings established that it is still early to evaluate the success of the technology in incorporating climate change adaptation issues. In doing this, the respondents referred to the water shortages reported in the province and how the technology seeks to address it. Such sentiments indicated a lack of knowledge on how Sentinel-2 works; however, the project beneficiaries asserted that the technology could give information on the extent of how water shortages could affect crops, thereby helping farmers to plan.

4.1.4 Incorporation of DRR measures into the project

Regarding the ways in which the project is incorporating DRR measures, findings from the in-depth interviews reviewed that they have used the technology in monitoring vegetation and crops to determine the extent of drought and its impact on FS in the province. Consequently, the information has helped them to make decisions on drought relief programmes in the form of cattle feed and the use of drought-resistant crops as a DRR measure. One Sentinel-2 respondent gave an example of how they incorporate DRR when dealing with veld fires:

“We have successfully used the Sentinel-2 satellite imagery in the Western Cape area to demarcate the areas affected by fires in 2017, and this helped us advise farmers to avoid such vulnerable areas.” (Sentinel-2, management)

Upon following up on how they are using the technology to monitor flood hazards to reduce the impact on FS in the province, the response from the Sentinel-2 project team was that they have not used the technology yet to track floods but have agreed to monitor the hazard

as it also affects FS in the province. KIIs findings under this section have applauded the work the technology is doing in reducing the impacts (monitoring of droughts and other extreme events to improve farmers' decisions on crop types) of disasters on the food sector. However, the NDMC and DFFE expressed concerns on the need to capture data for the whole country so that all farmers could benefit from it.

4.1.5 Challenges and opportunities

Regarding this section, findings from in-depth interviews established that Sentine-2 is helping farmers to optimise their production by planning to be able to produce as best as they can when facing changing climate conditions, such as erratic rainfall or other extreme weather events. Again, the respondents asserted that farmers or any stakeholder can use the technology to see straightaway any part of a particular farm or region that is underperforming, and the farmer can adjust the crop estimate and plan accordingly. For example, when dealing with international markets, one Sentinel-2 interviewee alluded that the technology could inform the provincial or national government to plan or budget on what they are going to import or export for a certain period. One of Sentinel-2 respondent's views are encapsulated in the following statement:

“The most significant opportunity brought by this technology is that the access to data is free and can be available to any stakeholder or any farmer in real time. Again, this data can be stored for up to 10 or more years, which helps in decision-making of comparing farming seasons.” (Sentinel-2, management)

Another opportunity established by the study is captured in the following remarks:

“We can use this technology in a day-to-day farm operation and the good thing is we can compare notes through close links with other farmers, which aid the conduct and facilitation of agricultural business.” (Sentinel-2, beneficiary)

However, the challenges alluded to by the respondents included a lack of knowledge about satellites, especially understanding different colour images and their meanings in terms of vegetation cover and crop performance. In this regard, respondents from DALRRD gave an external perspective for the need to train farmers, including rural ones or relevant stakeholders, on the issue of satellites using programmers who could interpret the data into the vernacular of the area to embrace the benefits of the technology. Finally, while most respondents from DALRRD, NDMC and DEFF pointed out that the process could be costly in terms of human and financial resources, a few from the HSRC and ARC described it as a worthy endeavour because the data provided by the technology helps to reduce the impacts of climate change and disaster risk on FS in the region and the country at large.

4.2 Urban Agricultural Initiative (UAI) food security project using hydroponics technology



Figure 1: Rooftop farm situated on Chamber of Mines building in Johannesburg (Business Tech, 2017:1)

Figure 1 above shows one of the rooftop farm on Chamber of Mines building in Johannesburg owned by one of the UAI respondent. This project was funded by the Chamber of Mines as a pilot project to assess the feasibility of growing herbs and vegetables hydroponically on the rooftops of innercity buildings as well as providing space for the farm.

4.2.1 Project overview

The Johannesburg Inner City Partnership (JICP) developed the UAI with the collaboration of the Department of Small Business Development, the City of Johannesburg, Wouldn't It Be Cool (WIBC), the Small Enterprise Development Agency (SEDA), and SAB Kickstart. The project is in the inner city of Johannesburg and is constituted of hydroponics farms that are situated on skyscraper rooftops around the central business district. The purpose of the project is to promote job creation through the development of agricultural entrepreneurial ecosystems supporting young black, urban farmers. The recipients are mainly WIBC incubator graduates, a programme that aims to transform young individuals aged 18 to 35 into entrepreneurs. To be included in the project, they must submit a business concept, including the target market, before receiving their start-up packs, which include pots, seedlings, pumps, and irrigation systems in order to receive financial assistance from the WIBC. If approved, all equipment and crops are made available to them and are monitored for up to one year until the farmers are self-sustained. For effective returns, the small-print farms are managed in a protective artificial environment that allows plants to access all the nutrients, protect them against extreme weather events such as hailstorms, and high and cold temperatures using plastic roof tunnels.

4.2.2 Project problem

The increasing population in Johannesburg has intensified the food demand, creating food access problems due to an increasing unemployment rate, and high level of poverty (Stats SA, 2014). Again, poor drainage systems and hard slippery ground together with heavy rainfalls have precipitated the flow of water causing frequent floods in the city. As Johannesburg is more concentrated with industries and commercial activities, agricultural business is not popular in the area, as land is expensive and is mostly used for residential and commercial purposes. In this regard, the UAI sought to reduce the problems of food access by locating itself within the city close to consumers, turn the sloppy hard ground into small farms to reduce the flow of water in the city that causes floods, and introducing green areas into the city through agriculture business that lowers pollution in the city, while at the same time empowering the disadvantaged to participate in the economics of the country.

4.2.3 Incorporation of CCA measures into the project

The findings from in-depth interviews have shown that the major purpose of UIA was to introduce green areas to the city considering the amount of pollution produced in Johannesburg due to its concentrated industries and commercial activities. In addition, respondents asserted that the hydroponics farming project has the potential to bring agriculture production closer to where the largest consumption masses are and start addressing FS challenges that most consumers face. One UAI respondent explained this in detail:

“Bringing food production to the city was a way to solve some climate change issues such as food miles that are caused by transportation of food from long distance, which contributes to emission of greenhouse gases in the region.” (UAI, beneficiary)

Again, the respondents shared that in case of extreme weather events, such as hailstorms and cold in winter, their production system is done under a protective environment, and they use that to protect their crops while getting more returns by producing out of season. For example, one respondent mentioned that they grow basil in winter while no one is growing it across the region, which in the end brings more profit, as there will be a high demand from retailers.

Sentiments emphasised by some of the in-depth interviewees suggest that there was more to gain when using hydroponics farming in a protective environment than in a natural environment, such as open-field farming. In contradiction, one respondent from the DEFF reiterated that:

“We cannot feed the whole nation with produce from greenhouses, what about staple foods such as maize and wheat. What do you suggest we do?” (DFFE, key informant)

The answer to the question prompted a discussion from both government and research institution officials. These officials argued that although the incorporation of CCA measures in open-field farming would require more resources on agriculture innovations, including a turnaround strategy on the entire agricultural system to achieve this, the adoption is long overdue. In addition, respondents from the HSRC and ARC suggested that more attention and resources should be put into the agriculture industry to design innovations that are affordable at a larger scale. Although this study did not collect much data on open-field farming, the emphasis of the above assertions was on the need to strengthen policies on the

agriculture industry or innovation as suggested by FAO, IFAD, UNICEF, WFP and WHO (2017), Lee (2017), and Fomunyan (2019), where hydroponics farming technology lies.

4.2.4 Incorporation of DRR measures into the project

Under this section, in-depth interviews reviewed that the UIA project incorporates DRR measures through the slowing down of running water because what was hard surface or slope rooftop is now turned into agriculture and can now consume or reduce the flow of water, which could have instigated floods in the city. Again, on the issue of protecting crops from disasters events such as drought and storms, the respondents asserted that in the event of drought, their water loss does not increase that much, so they are able to maintain full productive output amid high drought conditions as compared to open-field farming. However, findings from KIIs established that the incorporation of DRR measures is more feasible at a small-scale farming like the UIA, where the cost is low, unlike when the project is done at a larger scale. The following statement reflects the response to that argument:

“Hydroponic farming technology seems to be effective at a small-scale rather than at commercial level as the equipment used is expensive to someone with more than one hundred hectares of land.” (DALRRD respondent)

One respondent from the UAI agreed with the assertion above but gave a suggestion that commercial farmers should start incorporating CCA and DRR measures from one hectare going further using the available resources. The same respondent went on to say that the environment is changing, and it is high time that all farmers, both commercial and subsistence, incorporate CCA and DRR measures into addressing FS in South Africa.

4.2.5 Challenges and opportunities

This section presents findings that reflected the opportunities and challenges experienced by the UAI project. Findings from in-depth interviews established that the UAI gives opportunity to young black people, turning them into entrepreneurs to establish new agriculture value chains in places where agriculture is not active or not private. Another opportunity recognised by respondents was the projects’ ability to recycle waste from their farms and turn it into bioenergy so that the project is eco-friendly and renewable in nature to reduce the emission of greenhouse gases. Conforming to this assertion, DALRRD, NDMC and DEFF respondents applauded the UAI for the initiative of contributing to the food system in Johannesburg where the food demand is high, especially with its high population and increasing informal settlements. In-depth interviewees described another opportunity brought by the UAI to the city as bringing “green” to the city considering the amount of pollution produced from industries, thus making farming a significant contributor to the reduction of greenhouse gas emissions from the city.

However, the in-depth interviews revealed that the challenge that still exists is market access, which is engraved in traditional marketing channels that are built for what was the 17th century agriculture system that favoured commercial farmers. Both KIIs and UAI respondents shared that the problem with that system is that it contributes to food miles whereby farmers travel long distances to one centralised market contributing to air pollution. Thus, one UAI respondent had this to say:

“There is need for decentralisation of market access whereby farmers can access markets in their own regions to reduce greenhouse gasses emitted while transporting food.” (UAI, beneficiary)

Another challenge cited, like the Western Cape FS project, was the costs associated with incorporating CCA and DRR measures into the projects. The costs included training of people to familiarise them with the technologies. One respondent from the UAI asserted that it takes one full year to train individuals to know how to use the technology. To make matters worse, the UAI respondents alluded that the lack of support from government through funding or supporting policies that promote agricultural innovation makes incorporation CCA and DRR measures difficult and more expensive as they end up funding themselves. Such a scenario was argued by Amankwah-Amoah *et al.* (2018) as something that SSA governments, including South Africa, are failing to prioritise innovation and technology in their national development policy frameworks, thus limiting agriculture business (Morifi *et al.*, 2017).

5. Discussion and conclusion

The findings presented in this paper showed that both the Western Cape FS project and the UAI project, although different in nature, are incorporating CCA and DRR measures to reduce the impacts of climate change and disaster risk on FS. The use of the technologies has revealed that, when considering the linkages between FS, CCA and DRR, it is important to realise that FS is not simply about the provision of food to all people (FAO, 2002), but it is about considering the risks associated with it by trying to reduce the impact through CCA and DRR measures to keep up with the food demand. Both KIIs and in-depth interview findings established in this paper have convincingly showed that both projects are at the high end of considering CCA and DRR measures in most food value chains.

The findings highlighted that while the Western Cape Sentinel-2 project is mostly focused on reducing climate change and disaster risk impacts on food production, its area of divergence from hydroponics farming is its unique digital technology feature, which has a bonus for economic expansion (Braun *et al.*, 2018), by increasing farmers' access to market through e-commerce, which in the long run could reduce food insecurity. However, reports from the UAI showed struggles in the food supply system due to the centralisation of markets, whereby most respondents called for decentralisation of markets to include smallholder farmers into the food supply system. Findings further showed areas of convergences where the Western Cape project bridges gaps in communication and connectivity between farmers through sharing of CCA and DRR information through one database, while the UAI brings synergies across all farming units, which help to address a broad spectrum of all agricultural issues, including CCA and DRR measures. Although it is too early to evaluate the success or failure of the projects, the ability to incorporate CCA and DRR measures into one platform (dataset or farm unit) has been regarded by Gero *et al.* (2011) as the best way to solve incoherence issues between FS, CCA and DRR.

While both projects use different tools to bring CCA and DRR issues together, the Western Cape Sentinel-2 respondents illuminated that the integrated online platform has given farmers the chance to detect extreme events, such as droughts and veld fires, follow crop development and seasons, and make decisions regarding irrigation fertilisation and predicting yields. Findings from the UAI respondents revealed that the hydroponics farming technology is a system that focuses more on creating structures that are optimised for agricultural systems to unite DRR and CCA measures in production (sustainable water use, reduction of land degradation through the use of soilless systems, using plastic tunnels to protect crops in harsh weather), distribution (reduction of food miles by locating close to

markets), and consumption (providing fresh and nutritious food and using the waste for bioenergy to maintain economic return, as suggested by De Anda and Shear (2017).

However, the findings cited in this study revealed that both projects experience similar challenges, such as a lack of financial or human resources, institutional capacity, and information, the cost of training farmers to use the technology, and a lack of policies to support the initiatives. These challenges have also been identified by various scholars (Asfaw & Lipper, 2016; Gandure *et al.*, 2013; Grainger-Jones, 2011) who stressed the need to analyse them before the adoption of any technology for successful implementation. In addition, findings further revealed that the current policies do not support agriculture innovation in terms of localisation of the agriculture industry, funding upcoming entrepreneurs, which in a way could make the country a net importer if the sector is not responding to the changing environment. In the end, the study recommended a review of policies that address the agriculture industry in South Africa to create inclusion, efficiency and integrated innovation with policies that address CCA and DRR. The limitations of the study were that the technologies are still new, thus evaluation of the success from external perspectives was limited. Therefore, there is need for further research that could evaluate the successes and failures of the projects.

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References

- Akinagbe, O.M. and Irohibe, I.J. 2015. Agricultural Adaptation Strategies to Climate Change Impacts in Africa: A review. *Bangladesh Journal of Agricultural Research*, 39(3):407–418. <https://doi.org/10.3329/bjar.v39i3.21984>
- Amankwah-Amoah, J. Osabutey, E.L.C. and Egbetokun, A. 2018. Contemporary Challenges and Opportunities of Doing Business in Africa: The Emerging Roles and Effects of Technologies. *Technological Forecasting and Social Change*, (131):171–174.
- Asfaw, S. and Lipper, L. 2016. Managing Climate Risk Using Climate-smart Agriculture. FAO, Rome Italy.
- Bandara, J.S. and Cai, Y. 2014. The Impact of Climate Change on Food Crop Productivity, Food Prices and Food Security in South Asia. *Economic Analysis and Policy*, 44(4):451–465. <https://doi.org/10.1016/j.eap.2014.09.005>
- Bontemps, S., Arias, M., Cara, C., Dedieu, G., Guzzonato, E., Hagolle, O., Inglada, J., Morin, D., Rabaut, T., Savinaud, M. and Sepulcre, G. 2015. Sentinel-2 for Agriculture”: Supporting Global Agriculture Monitoring. In 2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) (4185-4188). IEEE.

- Braun, A., Colangelo, E. and Steckel, T. 2018. Farming in the Era of Industries 4.0. *Procedia CIRP*. (72):979-984.
- Campbell, B.M., Thornton, P., Zougmore, R., van Asten, P. and Lipper, L. 2014. Sustainable Intensification: what is its role in climate smart agriculture? *Curre. Opin. Environtal Sustainability*. 8:39-43. <http://dx.doi.org/10.1016/j.cosust.2014.07.002>
- Chepkoech, W., Mungai, N.W., Stöber, S., Bett, H.K. and Lotze Campen, H. 2018. Farmers' Perspectives: Impact of Climate Change on African Indigenous Vegetable Production in Kenya. *International Journal of Climate Change Strategies and Management*, 10(4): 551–579. <https://doi.org/10.1108/IJCCSM-07-2017-0160>
- Conforti, P., Ahmed, S. and Markova, G. 2018. Impact of disasters and crises on agriculture and food security, FAO, Rome (Italy).
- Creswell, J.W. 2015. A concise introduction to mixed methods research, Thousand Oaks, CA: Sage Publications
- De Anda, J. and Shear, H. 2017. Potential of Vertical Hydroponic Agriculture in Mexico. *Sustainability*, (9):140. doi: 10.3390/su9010140
- Department of Agriculture, Land Reform and Rural Development (DALRRD) South Africa. (2014) National Policy on Food and Nutrition Security (NPFNS), Pretoria: Government Printer.
- Department of Corporate Governance and Traditional Affairs (CoGTA) South Africa. (2005) National Disaster Management Framework (NDMF), Pretoria: Government Printers.
- Department of Environment, Forestry and Fisheries (DEFF) South Africa. (2019) National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printers
- Department of Environmental Affairs (DEA). (2017). National Climate Change Adaptation Strategy (NCCAS), South Africa. Pretoria: Government Printer.
- Du Plooy, C.P., Maboko, M.M., Van den Heever, E. and Chiloane, S. 2012. Research and Technology Transfer by the Agricultural Research Council to sustain the South African Hydroponic Industry. *Acta Horticulture*. (947):147-152.
- Escolà, A., Badia, N., Arnó, J. and Martínez-Casasnovas, J.A. 2017. Using Sentinel-2 Images to Implement Precision Agriculture techniques in Large Arable Fields: First Results of a Case Study. *Advances in Animal Biosciences*, 8(2):377-382. <https://doi.org/10.1017/S2040470017000784>.
- Fomunyan, K.G. 2019. Ending Hunger in Africa: The Fourth Industrial Revolution to the Rescue. *International Journal of Civil Engineering and Technology*, 10(7):228-234.
- Food Agricultural Organization, International Fund for Agricultural Development, United Nations International Children's Emergency Fund, World Food Programme, & Organisation, World Health Organization. 2017. The State of Food Security and Nutrition in the World 2017. Building Resilience for Peace and Food Security. Rome, FAO. Accessed 11 January 2021 from <http://www.fao.org/3/a-17695e.pdf>.

Food and Agriculture Organisation (FAO). 2012. Reducing Disaster Risks to Food Security in Southern Africa: Towards Integration and Co-operation. REOSA Policy Brief, 4. FAO Regional Disaster Risk Reduction and Management Office for Southern Africa (REOSA), Johannesburg, South Africa.

Food and Agriculture Organisation (FAO), 2008. Climate change and food security: A Framework Document. FAO, Rome.

Food and Agriculture Organisation (FAO). 2002. The State of Food Insecurity in the World 2001. FAO, Rome.

Freidberg, S. and Goldstein, L. 2010. Alternative Food in the Global South: Reflections on a Direct Marketing Initiative in Kenya. *Journal of Rural Studies*, 27(1):24-34.

Gandure, S., Walker, S. and Botha, J.J. 2013. Farmers' Perceptions of Adaptation to Climate Change and Water Stress in a South African Rural Community. *Environmental Development*, (5):39e53.

Garschagen, M., Hagenlocher, M., Kloos, J., Pardoe, J., Lanzendörfer, M., Mucke, P., Radtke, K., Rhyner, J., Walter, B., Welle, T. and Birkmann, J. 2015. World Risk Report 2015. Bündnis Entwicklung Hilft and UNU-EHS. 74 p.

Gero, A., Méheux, K. and Dominey-Howes, D. 2011. Integrating Disaster Risk Reduction and Climate Change Adaptation in the Pacific. *Climate and Development*, 3(4):310-327. <https://doi.org/10.5194/nhess-11-101-2011>

Global Initiative Disaster Risk Management (GIDRM)/Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). 2019. Guidance Note: Coherence Concepts and Practices. (DIDRM/GIZ).

Grainger-Jones, E. 2011. Climate-smart Smallholder Agriculture: What's Different? In: IFAD Occasional Paper 3.

Habiba, U., Abedin, M.A., and Shaw, R. 2016. Food Security, Climate Change Adaptation, and Disaster Risk. In Uitto, J.I and Shaw, R (eds.), *Sustainable Development and Disaster Risk Reduction*, (87-101). Springer, Tokyo.

Hampwaye, G., Nel, E. and Rogerson, C.M. 2007. Urban Agriculture as Local Initiative in Lusaka, Zambia. *Environment and Planning C: Government and Policy*, 25(4):553-572.

Hensengerth, O. 2018. South-South Technology Transfer: Who Benefits? A Case Study of the Chinese-built Bui Dam in Ghana. *Energy Policy* 114 (C):499–507.

Hetz, K. 2016. Contesting Adaptation Synergies: Political Realities in Reconciling Climate Change Adaptation with Urban Development in Johannesburg, South Africa. *Regional Environmental Change*, 16(4):1171-1182.

Holloway, A., Fortune, G. and Chasi, V. 2010. Risk and Development Annual Review for the Western Cape, Disaster Mitigation for Sustainable Livelihoods Programme. South Africa, Peri Peri Publications, University of Cape Town.

Immitzer, M., Vuolo, F. and Atzberger, C. 2016. First Experience with Sentinel-2 Data for Crop and Tree Species Classifications in Central Europe. *Remote Sensing*, 8(3):166.

- Intergovernmental Panel on Climate Change (IPCC). (2007). Intergovernmental Panel on Climate Change Fourth Assessment Report, Cambridge University Press, Cambridge, UK.
- Israel, D.C. and Briones, R.M. 2012. Impacts of natural disasters on agriculture, food security, and natural resources and environment in the Philippines (No. 2012-36). PIDS discussion paper series.
- Kahsay, G.A. and Hansen, L.G. 2016. The Effect of Climate Change and Adaptation Policy on Agricultural Production in Eastern Africa. *Ecological Economics*, (121):54–64. <https://doi.org/10.1016/j.ecolecon.2015.11.016>
- Kroll, F., Rudolph, M., Ruysenaar, S. and Dlamini, T. 2012. The State of Food Insecurity in Johannesburg. *AFSUN Food Security Series*, (12).
- Lakkireddy, K.K.R., Kasturi, K. and Sambasiva Rao, K.R.S. 2012. Role of Hydroponics and Aeroponics in Soilless Culture in Commercial Food Production. *Res. Rev. J. Agriculture. Science. Technology*. (1):26–35.
- Lee, H.J. (ed.). 2017. The Fourth Industrial Revolution and the Future of Agriculture. Smart Farm and Shared Economy. Rep. of Korea: Science and Technology Policy Institute; 2017: 200.
- Liliana, H. 2005. The Food Gaps: The Impacts of Climate Change on Food Production: A 2020 Perspective, Universal Ecological Fund, Alexandria, VA, USA.
- Maboko, M.M., Du Plooy, C.P. and Bertling, I. 2009. Comparative Performance of Tomato on Soilless vs. In-soil Production Systems. *Acta Horticulture*, (843):319-326.
- Makridakis, S. 2017. The Forthcoming Artificial Intelligence (AI) Revolution: Its Impact on Society and Firms. *Futures*, (90):46–60.
- Masipa, T.S. 2017. The Impact of Climate Change on Food Security in South Africa: Current Realities and Challenges Ahead. *Jàmbá: Journal of Disaster Risk Studies* 9(1):a411. <https://doi.org/10.4102/jamba.v9i1.411>
- Midgley, G.F., Chapman, R.A., Hewitson, B., Johnston, P., De Wit, M., Ziervogel, G., Mukheibir, P., Van Niekerk, L., Tadross, M., Van Wilgen, B.W. and Kgope, B. 2005. A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-economic Effects of Climate Change in the Western Cape. CSIR Environmentek, Stellenbosch.
- Morifi, R.R., Maponya, P.I. and Van Niekerk, J.A. 2017. The Sustainability in Training Hydroponic Production to Smallholder Farmers in the Tshwane Area of Gauteng Province in South Africa. *Unpublished Manuscript*. University of the Free State, South Africa.
- Mukheibir, P. and Ziervogel, G. 2007. Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town. *Environment and Urbanization*, 19(1):143-158. doi:10.1177/0956247807076912
- Naudé, W. 2017. Entrepreneurship, Education, and the Fourth Industrial Revolution in Africa. *IZA Discussion Papers*, No.10855.
- Olawuyi, D.S. 2018. From Technology Transfer to Technology Absorption: Addressing Climate Technology Gaps in Africa. *Journal of Energy & Natural Resources Law*, 36(1):61–84.

- Organisation for Economic Co-operation and Development (OECD). 2018. Policy Coherence for Sustainable Development: Towards Sustainable and Resilient Societies. Paris: OECD.
- Orsini, F., Kahane, R., Nono-Womdim, R., and Gianquinto, G. 2013. Urban Agriculture in the Developing World: A Review. *Agron. Sustainable Development*, (33):695–720.
- Pasquini, L., Cowling, R.M. and Ziervogel, G. 2013. Facing the Heat: Barriers to Mainstreaming Climate Change Adaptation in Local Government in the Western Cape Province, South Africa. *Habitat International*, (40):225-232.
- Rosa-Rodriguez, R.D.L., Lara-Herrera, A., Trejo-Tellez, L.I., Padilla-Bernal, L.E., Solis-Sanchez, L.O. and Ortiz-Rodriguez, J.M. 2020. Water and Fertilisers Use Efficiency in Two Hydroponic Systems for Tomato Production. *Horticultura Brasileira*, (38):47-52.
- Roteta Otaegui, E., Bastarrika Iriarte, A., Padilla, M., Storm, T. and Chuvieco, E. 2019. Development of a Sentinel-2 Burned Area Algorithm: Generation of a Small Fire Database for Sub-Saharan Africa., *Remote Sensing of Environment*, 222:1-17
- Roudier, P., Sultan, B., Quirion, P. and Berg, A. 2011. The Impact of Future Climate Change on West African Crop Yields: What does the recent literature say? *Global Environmental Change*, 21(3):1073–1083.
<https://doi.org/10.1016/j.gloenvcha.2011.04.007>
- Schwab, K. 2015. The Fourth Industrial Revolution: What it Means and How to Respond. Accessed from <http://www.foreignaffairs.com/articles/2015-12-12/fourth-industrialrevolution>
- Senyolo, M.P., Long, T.B., Blok, V. and Omta, O. 2018 How the Characteristics of Innovations Impact their Adoption: An Exploration of Climate-smart Agricultural Innovations in South Africa. *Journal of Cleaner Production*, (172):3825-3840.
- Terry, G., Hayfield, N., Clarke, V. and Braun, V. 2017. Thematic Analysis. The Sage Handbook of Qualitative Research in Psychology. 2. London: Sage.
- Thamaga-Chitja, J.M. and Morojele, P. 2014. The Context of Smallholder Farming in South Africa: Towards a Livelihood Asset Building Framework, *Journal of Human Ecology*, 45(2):147-155. DOI: 10.1080/09709274.2014.11906688
- The Fourth Industrial Revolution and Agriculture. 2016. Rep. of Korea: Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry; 2016.
- The Africa Competitiveness Report. 2017. Addressing Africa's Demographic Dividend. The World Economic Forum with the Support of the International Bank for Reconstruction and Development/ the World Bank and the African Development Bank.
www.weforum.org/acr.
- Vogels, M.F., De Jong, S.M., Sterk, G., Douma, H. and Addink, E.A. 2019. Spatio-temporal Patterns of Smallholder Irrigated Agriculture in the Horn of Africa Using GEOBIA and Sentinel-2 imagery. *Remote Sensing*, 11(2):143.
- Vuolo, F., Neuwirth, M., Immitzer, M., Atzberger, C. and Ng, W.T. 2018. How Much Does Multi-Temporal Sentinel-2 Data Improve Crop Type Classification? *International Journal of Applied Earth Observation and Geoinformation*, (72):122-130.

- Winter, K. 2018. Crisis proofing South Africa's water security. *The Conversation*.
- World Bank Group. 2016. World Development Report: Digital Dividend. Washington, DC. The World Bank.2016. Accessed 25 January 2020.
- World Economic Forum. 2017. The Future of Jobs and Skills in Africa Preparing the Region for the Fourth Industrial Revolution. Doha: World Economic Forum.
www3.weforum.org/doc/WEF_EGW_FOJ_Africa.pdf.
- Zwane, E.M. 2019. Impact of Climate Change on Primary Agriculture, Water Sources and Food Security in Western Cape, South Africa. *Jàmbá: Journal of Disaster Risk Studies*, 11(1):1-7.

CHAPTER 6: ARTICLE 4
COHERENCE FRAMEWORK FOR FOOD SECURITY, CLIMATE CHANGE
ADAPTATION AND DISASTER RISK REDUCTION

Article 4: A policy coherence framework for food security, climate change adaptation and disaster risk reduction in South Africa.

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Abstract

Food security (FS), climate change adaptation (CCA), and disaster risk reduction (DRR) have all evolved in isolation at the global, national, and subnational levels, employing various conceptual and institutional frameworks, response strategies, and plans. As a result, attempts to ensure food security through DRR and CCA efforts are unevenly dispersed. The purpose of this research is to propose a novel framework for bringing FS, CCA, and DRR policies in South Africa into alignment. Data was gathered from eight institutions through content analysis of three FS, CCA and DRR policy documents, as well as 24 face-to-face and virtual/online key informant interviews (KIIs). The findings revealed inconsistencies in the objectives specified by FS, CCA and DRR policies, as well as a lack of coordination throughout implementation and insufficient monitoring systems that tie the policies together. Therefore, this study presents a paradigm for achieving policy coherence between the three policy areas.

Keywords climate change adaptation; disaster risk reduction; food security; policy coherence.

1. Introduction

In many countries, food security (FS), climate change adaptation (CCA), and disaster risk reduction (DRR) policies and structures have been largely developed in parallel (Habiba *et al.*, 2016). Consequently, these policies and structures have been operating in isolation (Habiba *et al.*, 2016) resulting in a lack of coherence in coordination between institutions that address FS, CCA and DRR policy areas (FAO, 2012). Due to incoherencies between FS, CCA and DRR policies, there have been conflicting motives, intentions, goals, and redundancy in FS interventions (Forster and Stokke, 2013; Nilsson *et al.*, 2012) in many countries, including South Africa. In this light, the need for coherence between FS, CCA and DRR has been emphasized in global frameworks such as the Sustainable Development Goals (SDGs) No. 2 (UN 2015, p.25), Sendai Framework for Disaster Risk Reduction (UNISDR, 2015, p.26), and Paris Agreement for Climate Change (UNFCCC, 2015). Towards this end, authors such as Scobie (2016) and Nilsson *et al.* (2012) have developed policy coherence frameworks using several indicators to determine setting and prioritising of objectives and coordination of implementation and monitoring mechanisms between policies. Furthermore, the OECD (2002) has focused on policy coherence using criteria such as knowledge management, stakeholder involvement, and commitment and leadership. However, these studies focused more at a regional to international level without pinpointing proper stages to be followed at a national level. As a result, at the national level, less focus has been placed on providing instruments to facilitate the integration process (Nemakonde and Van Niekerk, 2017). According to Habiba *et al.* (2016), there is a need to explore potential ways in which FS, CCA and DRR policies and structures for implementation work more efficiently and effectively in a holistic manner. Thus, effectuating these implementation mechanisms from oratory to practice is contingent on coherent policies and institutional mechanisms.

This paper therefore aims to address the lack of policy coherence by proposing a policy coherence framework that aligns FS, CCA and DRR objectives, implementation, and monitoring mechanisms at national level using South Africa as a case in point. To develop the framework, firstly a conventional content analysis was carried out on three FS, CCA and DRR policies; second, key informant interviews were conducted to determine how officials from FS, CCA, and DRR institutions interact-from policy formulation, implementation and monitoring to influence policy coherence; and lastly, findings from content analysis and KIIs informed the discussion and the development of the policy coherence framework.

2. Theoretical underpinnings of policy coherence

Generally, the term policy coherence is described as an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives (Nilsson *et al.*, 2012, p.396). In this study it is described not only as an approach to integrate policy definition and planning, but also implementation and monitoring mechanisms across FS, CCA and DRR sectors to achieve effective and efficient common goals. Different terms, including synergy, integration, mainstreaming, convergence, and linking, and have been used in the literature to describe the coming together of FS, CCA and DRR (Gero *et al.*, 2011; Habiba *et al.*, 2016). The term policy coherence was used for this study because it is a key pillar of effective governance and as a concept; it represents both a normative value and a governing process (Jordan and Lenschow, 2010). Since the 1990s, policy coherence has increasingly become an important objective in governance (Nilsson *et al.*, 2012) and attempts for better coherence have been manifested through the 2030 Agenda for Sustainable Development

Goal 17, Target 13 (enhance global macroeconomic stability including through policy coordination and policy coherence), Target 14 (enhance policy coherence for sustainable development), and the impact assessment procedure in the European Union, and more various “road maps” (CEC, 2011). To bring coherence between FS, CCA and DRR policies, this study draws its literature from Forster and Stokke (2013), Nilsson *et al.* (2012) and Scobie (2016) who illustrated what, why and how policy coherence can be pursued between related policy areas.

The policy coherence notion has been influenced by policy coherence for development, which is a framework that is used to detect linkages and interactions between diverse sectors that either undermine or support development policy objectives (Koff *et al.*, 2020). In this way, Forster and Stokke (2013) suggest that coherence should be conceived with a rational choice approach, whereby objectives should be formulated in clear terms and harmonized, strategies and mechanisms should be attuned to the objectives and, as a minimum, not conflict with them or the intentions and motives on which they rest, and the outcomes should correspond with intentions and objectives or, as a minimum, not conflict with them. To achieve such alignment of objectives, mechanisms, strategies and outcomes, Nilsson *et al.* (2012) illustrate where policy coherence should occur or be delineated from other processes such as integration (*see Figure 1*). Policy coherence, according to Nilsson *et al.* (2012), focuses more on policy outputs (decisions on objectives and instruments to achieve policy goals), policy implementation (arrangements by authorities and other actors to put policy instruments into action), and outcomes (societal behavioural changes and responses or impacts (the environmental and other effects resulting from the outcomes)). In this study, the ‘double boxes’ highlighted in blue in Figure 1 show where policy coherence should occur and the elements that should be focused on. These include policy objectives and instruments and policy implementation. Policy coherence, according to Nilsson *et al.* (2012), should occur in highlighted boxes to illustrate links across policies, with a greater emphasis on outputs (including policy objectives, policy design, and tools for achieving them) and implementation techniques (at different levels).

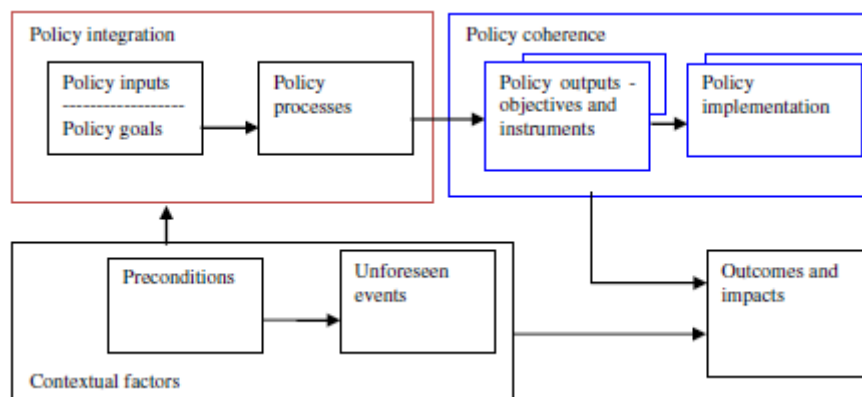


Figure 1: Policy coherence in a policy –analytical framework
(Sources: Dunn (2003) and Nilsson *et al.* (2009))

Most importantly, Scobie (2016) developed a three-tier framework (Figure 2) that directs how policy coherence could be pursued using elements identified by Nilsson *et al.* (2012), Forster and Stokke (2013), and Koff *et al.* (2020).

Scobie (2016) argues that to achieve policy coherence, three stages should be followed: setting and prioritising objectives, coordinating implementation policy, and monitoring,

reporting and analysis. From these stages, Scobie (2016) identified indicators that should be considered, which were used as steps in the study to determine the degree of coherence between FS, CCA and DRR policies in South Africa.

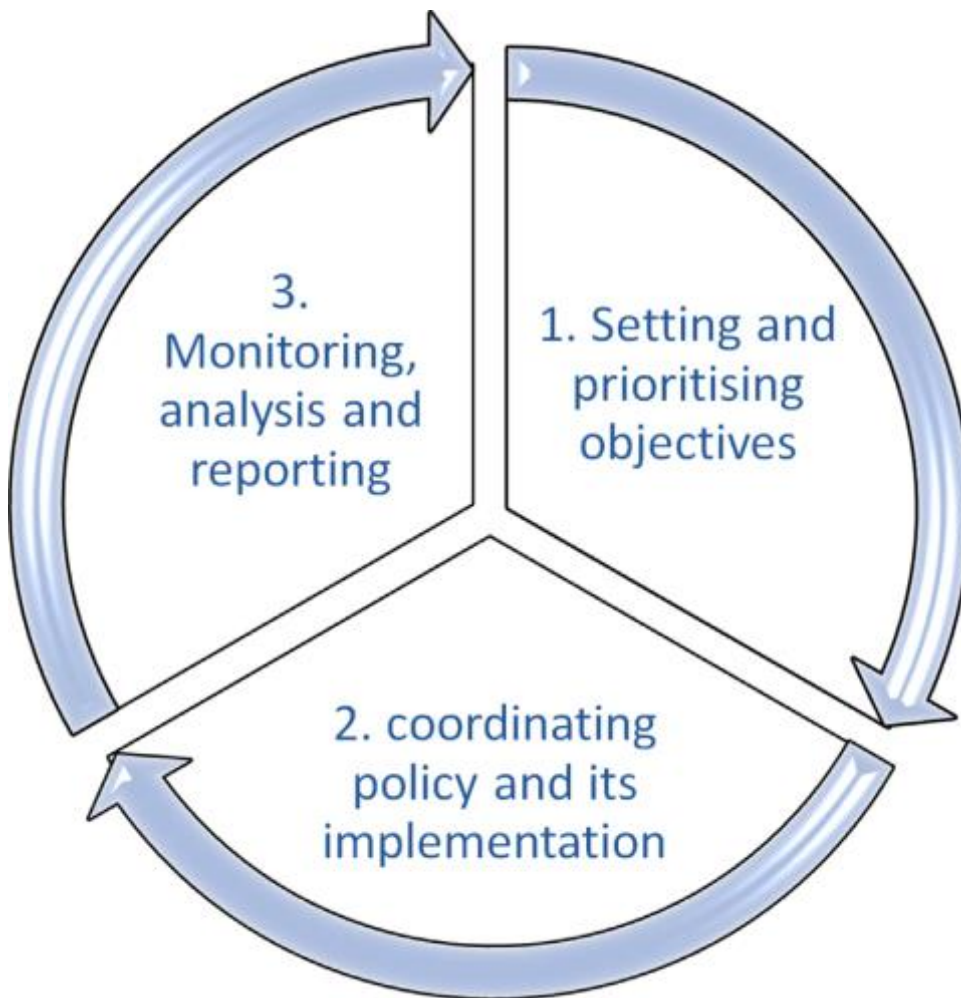


Figure 2: Framework for policy coherence
(Source: Scobie, 2016, p.19)

2.1 Setting and prioritising objectives

In this stage, various elements are considered when pursuing policy coherence. These include attempting to discover and resolve unintended negative impacts of sectoral responses (OECD, 2012), again balancing priorities where planned policies have conflicting cross-sectoral impacts (Makkonen *et al.*, 2015). In addition, contradictory global norms that could limit policy coherence are identified and addressed at all levels (Kalaba *et al.*, 2014). Further, clear, measurable, time-bound targets are imbedded in policy and targets are linked to available resources within timelines set in the objectives; capacity gaps for implementation are discovered and the policy addresses building capacity to resolve these gaps (Clarvis *et al.*, 2014). There are mechanisms in place to allow the public to see progress toward policy coherence; flexibility is built into the policy to allow local actors to make changes/adapt policy if unexpected challenges arise. Finally, according to Boecher (2013), policy coherence works when financial support is rationalised to avoid duplication between funders, sectors, and policies, the public is engaged and informed about how policy coherence is to be achieved, and progress is made, allowing for greater transparency and progress (Scobie, 2016). All these elements act as guidance or framework to help

practitioners and policy-makers when setting and prioritising objectives of related policies to promote policy coherence.

2.2 Coordinating policy and its implementation

Regarding this stage, several studies have found that when there are collaborative processes, connections, or networks (Clarvis *et al.*, 2014) spanning scales, departments, levels of authority, and sectors for policy implementation, coherent policy outputs occur (Makkonen *et al.*, 2015). Furthermore, processes to foster debate among significant actors on policy coordination and participatory platforms for knowledge sharing that promote multilevel participation in governance must be in place (Chandra and Idrisova, 2011). According to Clarvis *et al.* (2014), coordination increases efficient resource usage during implementation such that one action benefits several levels and sectors at the same time. The purpose of policy coordination and execution is to encourage all stakeholders to participate in transparent and accountable procedures, forums, committees, and councils that are required for policy coherence (Scobie, 2016).

2.3 Monitoring, reporting and analysis (MRA)

The third stage includes various indicators to be considered when pursuing policy coherence. Firstly, monitoring tools must have clear protocols and indicators to measure outcomes (Pintér *et al.*, 2012). Secondly, analysis tools must have flexible designs that allow implementers at local scales to make changes. Third, policy design incorporates opportunities for policymakers to examine and revise their decisions. MRA works best when there are established processes and mechanisms in place for regular monitoring, evaluation, and analysis (every 5–10 years). It also works better when reporting templates include possible reasons for poor outcomes, periodically evaluating whether a policy is still relevant, and have built-in systems to identify areas of resource and effort duplication, as well as systems to ensure legislative and regulatory frameworks are adequate for policy objectives. MRA should have systems to improve data collection, sharing, and usage for policy systems that link new FS, CCA, and DRR data into policy; and systems for transparent and regular public reporting, such as through parliament (Clarvis *et al.*, 2014; Scobie, 2016). In the end, policies that provide frameworks for cross-sectoral collaboration, actual stakeholder involvement, and resources for monitoring and analysis for continuous policy development make policy coherence easier and more realistic (Scobie, 2016).

3. Methods and procedure

This study applied a qualitative research design, with data collected through conventional content analysis (CA) of policy documents relating to FS, CCA and DRR in South Africa and key informant interviews (KIIs). The goal of a conventional approach to content analysis was to evaluate ways in which policy coherence is promoted in the FS, CCA, and DRR policy documents (Hsieh and Shannon, 2005, p.1279). Additionally, thematic analysis (Terry *et al.* (2017, p.17) was utilised to present and analyse data acquired from CA and the 24 purposively selected key informants from eight institutions (government sectors and government-supported research institutions) from September 2019 to December 2019.

3.1 Conventional content analysis of policy documents

Hall and Steiner (2020) have described CA as a family of approaches for the systematic examination of text to identify themes, intents, and patterns. In this study CA was conducted

on various policy documents, which were used as the guiding documents to determine if there is coherence between FS, CCA and DRR in South Africa. The approach to CA followed three stages:

- Searching for and obtaining policy documents from government websites.
- Using qualitative inductive reading of material, develop keywords and themes from current literature and policy.
- Comparing the themes to the findings of the KIIs in a qualitative deductive manner.

3.1.1 Gathering of national policy documents

To get relevant policies on FS, CCA and DRR, a document search was conducted on the South African government websites by combining the search term “policy” with terms like “climate change adaptation”, “disaster risk reduction” and “food security”. From these combinations, the majority of the results pointed out three key policy documents, which then became the sample for the study. These include the National Disaster Management Framework (NDMF) of 2005, the National Climate Change Adaptation Strategy (NCCAS) of 2019, and the National Policy on Food and Nutrition Security (NPFNS) of 2014. Subsequently, a CA was employed on the sampled documents. Unlike directed CA that follows a structured process (Hickey & Kipping, 1996), CA allows the categories, names, and codes to flow from the data so that new insights could emerge (Kondracki & Wellman, 2002).

Data analysis began with repeated readings of all sampled policy documents to achieve absorption and a sense of the totality (Tesch, 1990), much like reading a novel. Then, each policy document was read carefully word-by-word to derive codes (Morse & Field, 1995) by first highlighting the text that referred to alignment in setting of objectives, coordination in implementing policy and linkages in monitoring, reporting and analysis between FS, CCA and DRR policies. Next, combining related highlighted segments from NDMF, NCCAS and NPFNS and grouping them into four categories developed the coding system. Under each category, a set of activities that indicate how coherence is pursued or promoted between FS, CCA and DRR policies were explored to discover gaps and areas of synergies. Finally, results from CA were compared to KIIs findings to identify areas of divergences and convergences that could inform the development of a policy coherence framework.

3.2 Key informant interviews (KIIs)

The study used purposive sampling, which is described as a deliberate choice of a participant who is proficient and well informed with a phenomenon of interest (Etikan *et al.*, 2016) to select respondents. The study included 24 key informants, including three senior managers from each of the eight institutions, such as Chief Directors, Directors, and Deputy Directors. The institutions included the South African Weather Services (SAWS), Department of Agriculture Land Reform and Rural Development (DALRRD), Human Sciences Research Council (HSRC), Department of Forestry, Fisheries and Environment (DFFE) (Climate Change Directorate), Department of Cooperative Governance and Traditional Affairs (CoGTA) (National Disaster Management Centre), Agri South Africa (Agri SA), Water Research Commission (WRC), and Agricultural Research Council (ARC).

Face-to-face, telephonic, online, and e-mail interviews were used to collect data, allowing participants to choose the most convenient platform for them. The interviewees gave their consent for their interviews. The data was verbatim transcribed, then analysed and presented

using thematic analysis following the six-phase process established by Terry *et al.* (2017, pp.23-24). The procedure began with becoming acquainted with the data (browsing through data to get the meaning). Phase's ii and iii (creating and constructing codes, respectively) were omitted from the study since they were out of scope. Phases iv and v (reviewing prospective themes and defining and naming themes) followed, in which standard content analysis themes were utilised to allow for accurate comparison with the KIIs findings.

Table 1 reflects the topics that arose from the study that are consistent with Scobie (2016)'s framework for policy coherence.

Table 1: Themes that emerged from the study

Themes	Sub- themes
Setting and prioritising objectives between FS, CCA and DRR policies	- Alignment of objectives between global frameworks and national policy - Alignment of FS, CCA and DRR national policy objectives -Use of content (text) when setting and prioritising objectives
Coordinating FS, CCA and DRR policy and its implementation	-Coordination of FS, CCA and DRR institutional mechanisms - Use of technology and innovation for policy coherence
Monitoring, reporting and analysis	-Flexible processes and systems for regular monitoring, reporting and analysis

4. Findings

The presentation of findings in this study focuses on three themes highlighted in Table 1. In presenting the findings, attention is given to the convergence or divergence of policy content analysis documents and KIIs interviews.

4.1 Setting and prioritising objectives between FS, CCA and DRR policies

As reflected in Table 1, the findings in this theme are grouped into three sub-themes. The sub-themes are alignment of objectives between global frameworks and national policy, alignment of FS, CCA and DRR national policy objectives, and use of content (text) when setting and prioritising objectives.

4.1.1 Alignment of objectives between global frameworks and national policy

The findings from CA indicated that although all policies have identified FS, CCA and DRR as global problems, they differ in the approaches they use to link national and international objectives. Specifically, the NDMF section 1.4.5 indicates that climate change and disasters are global problems requiring global strategies and solutions, but do not give reference to Hyogo Framework for Action (HFA), which is the overall framework that regulated DRR at the international level that time. This might be because the NDMF predates both the HFA and the SFDRR in that it was adopted in 2005, the same year that the HFA was also adopted. CA findings have also shown that the National Policy on Food and Nutrition Security (NPFNS) does not align its objectives with the international SDG No. 2 (Achieving food security). This lack of alignment is because the policy was developed before the SGDs were

adopted in 2015, thus deterring the DRR fraternity responsible for NPFNS learning from international best practices and to be able to contribute to global thinking on DRR and FS issues. Further, CA findings established that the NCCAS used the Paris Agreement for Climate Change as the direct link in terms of international obligations in respect of climate change (NCCAS, Section 6.1). This is because the strategy was adopted in 2019, after the development of the Paris Agreement. Thus NCCAS recognises the fundamental priority in safeguarding FS while recognising the relevance of DRR to CCA, at national level. The CA and KIIs findings point to the need to review the policies that predates 2015 to be in line with international frameworks.

Meanwhile, findings from KIIs indicated that although CA has shown inconsistencies in alignment of objectives between national and international policies, more blame should be put on how objectives, which are encouraging duplication and jurisdictional disputes across governmental sectors, are structured at global level. Again, the KIIs findings have shown capacity gaps in implementing policy coherence, whereby the policy objectives do not clarify how the objectives are to be achieved and with what resources. The statement below from one of the respondents encapsulates this idea.

... While the three global frameworks seem to align their objectives in writing, they do not explain how to achieve and sustain cross-sectoral coherence and coordination between CCA, DRR and FS in practice. (Respondent, 1)

According to Schipper and Pelling (2006), such revelations are the source of inertia in relating to CCA and DRR integration to the development agenda, particularly when the objectives do not specify how, by whom, or with what finance the integration efforts must be realised. In addition, Fowler (1991) argues that the lack of alignment at national level is due to scepticism among developing countries that most international frameworks have a hidden agenda (e.g. impose foreign dogmas), resulting in their exclusion from policy-making and goal setting. Finally, KIIs findings revealed that, while policy direction and alignment with global frameworks is crucial, as is legitimacy, the departments' ultimate commitment is to ensuring the effectiveness of national policies in how they respond to the most vulnerable individuals, households, and communities.

4.1.2 Alignment of FS, CCA and DRR national policy objectives

Findings from CA have shown that there is no alignment of objectives between the FS, CCA and DRR policies in South Africa. Specifically, the NPFNS (Section 3) strategic goal is phrased as: “to ensure the availability, accessibility and affordability of safe and nutritious food at national and household levels”, while that of NCCAS (section 3.3) is: “to build resilience and enhance adaptive capacity to respond to climate change risks and vulnerabilities; whilst providing guidance on the integration of climate change responses into current and future development objectives through optimizing coherence between policy, planning, implementation and adaptation actions”. Moreover, the objective of NDMF is “to address such needs for consistency across multiple interest groups, by providing 'a coherent, transparent, and inclusive policy on disaster management appropriate for the Republic as a whole” (CoGTA, 2005:1). It is evident from these policy objective statements that they do not make any reference to the risks of disasters and climate risks and the impacts that they might have on FS. Several scholars have argued that the lack of alignment in policy objectives may result in conflicting motives, intentions, goals, and redundancy in interventions, which compromise coherence (Forster & Stokke, 2013; Nilsson *et al.*, 2012).

Meanwhile, the findings from KIIs concur with CA findings that there is no alignment of objectives between NCCAS, NDMF and NPFNS. This convergence is evident in the following statement from one of the respondents.

... The fact that FS, CCA and DRR policy areas are situated in different ministries, officiated by different technocrats with different budget has influenced a separation between objectives as each is designed to serve a particular ministry to achieve set goals.
(Respondent, 6)

Although DFFE, DALRRD and NDMC respondents recognised the need for policy coherence between the relevant policy areas, they argue that legislation is framed in a way to address certain departmental problems; hence objectives are channelled towards the achievement of the intended outcomes. The findings from KIIs exposed the causes of misalignment of objectives between FS, CCA and DRR policies, which seem to be on going unless interventions start from global to national levels. Such misalignment is likely to be influenced by different beliefs rooted in silo mentality and a lack of political will to endorse policy coherence (Thow *et al.*, 2018). OECD (2018) attributes this mentality to the political context in which these policies are implemented, in which policymakers are more concerned with the distribution of policy benefits during implementation than with the broad ends of policy objectives as they are established.

4.1.3 Use of content (text) when setting and prioritising objectives

The CA findings have shown that the use of different terms or content in policy and legislative objectives is a hindrance to the achievement of coherence between FS, CCA and DRR policy areas. With reference to NCCAS, NDMF and NPFNS, CA findings have shown that they all use different terms to refer to objectives. For example, NCCAS uses “strategic focus”, while NPFNS uses “strategic goal” and NDMC uses “objectives”. The usage of diverse terminology, according to Zembe *et al.* (2022), is a barrier to attaining policy coherence because it prevents reproducible and valid data inferences, which are required to provide a representation of facts, knowledge, and practical guidance in practice. Furthermore, Zembe *et al.* (2022) propose that using specific terms or explicit content in objectives might produce visible synergies that practitioners from various disciplines could easily identify and apply.

The findings from KIIs pointed out that the problem of policy coherence is not correctly framed because it does not clarify what the problem is, and how policies or legislation intend to address it. One respondent from NDMC shared that:

... As long the framing of policy coherence is not clarified across sectors and there is no explicit content that encourage visibility, objectives will remain separated while the issue of coherence unresolved. (Respondent, 8)

While Campbell *et al.* (2016) describe the lack of the use of direct words in communication across sectors and communities as fertile ground for incoherencies, the majority of key informants from HSRC, ARC and WRC recommended a review of the main FS, CCA and DRR policy objectives to use universal words such as resilience.

4.2 Coordinating FS, CCA and FS policy and its implementation

Under this theme, two sub-themes (coordination of FS, CCA and DRR institutional mechanisms and the use of technology and innovation for policy coherence) were created to present and analyse ways in which policy coherence is pursued during implementing FS, CCA and DRR measures in South Africa.

4.2.1 Coordination of FS, CCA and DRR institutional mechanisms

The CA findings have shown that there are incoherencies in the way NDMF, NCCAS, and NPFNS influence coordination of institutional mechanism needed to promote policy coherence across sectors. This is because FS, CCA and DRR institutions are placed in different geographical locations, different ministries and departments with different policy and legislative frameworks, budgets, and administrative structures. On one hand, CA findings established that NDMF (CoGTA, 2005, Sections 1.3.1.1 and 1.1.1) utilises the Intergovernmental Committee on Disaster Management (ICDM) and National Disaster Management Advisory Forum (NDMAF) as platforms that can promote coherence between FS, CCA and DRR policy areas. These platforms are structured to convene quarterly with other relevant sectors, including DALRRD and DFFE to discuss short, medium to long-term disaster-related issues. On the other hand, NCCAS (DFFE, 2019, Sections 7.2.1 and 7.2.2) use the Intergovernmental Committee on Climate Change (IGCCC), Inter-Ministerial Committee on Climate Change, and the National Committee on Climate Change (NCCC) to enforce policy coherence by bringing together representatives from relevant stakeholders, including DALRRD and NDMC, to discuss climate change issues. Finally, CA findings have shown that NPFNS (DALRRD, 2014, Sections 10 and 12) has established the National Food and Nutrition Advisory Committee (NFNAC) to engage relevant stakeholders, including DFFE, in a bid to enforce coherence with relevant sectors. The CA findings established that although there are collaborative processes across scales, sectors, authorities, and departments for the implementation of policies, the participatory platforms mentioned above seem to be stand-alone structures as there is no evidence that shows connection to each other, including in the KIIs findings.

The KIIs findings shared the same sentiments and revealed the lack of interactions between FS, CCA and DRR practitioners and policy-makers, which is needed to encourage debates among major actors on policy coordination. The key informants further revealed that the lack of interaction is hindering effective sharing of resources, proper coordination during implementation of similar tasks and achievement of common goals. One respondent commented:

Establishing central platforms for knowledge sharing and avenues for coherence is a commended act, but if the platforms operate independent of each other cancels the whole point of creating them in the first place. (Respondent, 10)

However, the majority of respondents applauded the existing structures that are enforcing coherence between FS, CCA and DRR institutions, but suggested that among the institutions, one institutional arrangement (e.g. NDMAF) should assume an overall coordinating role to convene relevant stakeholders, expertise, and resources so that one activity benefits several levels and sectors simultaneously without conflict. In support, Hollnagel (2018) emphasises the need to characterise the inputs, outputs, resources, pre-conditions, and time and control aspects of any FS, CCA and DRR function before any activity begins to allow simultaneous participation by relevant stakeholders.

4.2.2 The use of technology and innovation for policy coherence

Content analysis findings have established that NDMF (CoGTA, 2005, Section 6.2.2), NCCAS (DFFE, 2019, Sections 13 - 2.1.3) and NPFNS (DALRRD, 2014, Section 1.3) have been promoting innovation and the use of technology as tools to promote policy coherence between FS, CCA and DRR. However, evidence from CA has shown that there is a lack of expertise within FS, CCA and DRR fields and advocated for the implementation of training programmes for government officials and politicians to acquaint themselves with trending innovations. Such training would allow for the incorporation of new research and technology related to FS, CCA and DRR to be included during policy-making. Furthermore, CA findings have shown the lack of a central database that coordinates research output from different institutions for easy access and effective research uptake. To close this gap, KIIs findings revealed that there are technologies that are used to incorporate FS, CCA and DRR information under one platform, such as the Sentinel-2 Earth Observation technology and hydroponics farming, which incorporate the three concepts in practice. Although the use of technology can be expensive, respondents from the HSRC, ARC, Agri SA, DALRRD, and NDMC considered it necessary, especially with the changing environment. One respondent from ARC shared that

Information and technology is essential in this era; if all departments could invest in the technologies policy coherence will be inevitable. (Respondent 15)

KIIs findings further revealed that there is a lack of investment by the government in research and technology, which leaves access to information unresolved. Again, the area of convergence between CA and KIIs findings identified a lack of experts to use the technology, thus training was recommended. In support, Fomunyam (2019) and Lee (2017) also recommend the need to strengthen policies on agriculture industry and innovation where the technology lies.

4.3 Monitoring, reporting and analysis (MRA) between CCA, DRR and FS

Efforts to bring policy coherence between FS, CCA and DRR require adequate monitoring, reporting and analysis. The findings on MRA are presented under one sub-theme: flexible processes and systems for regular monitoring, reporting and analysis across FS, CCA and DRR sectors.

4.3.1 Flexible processes and systems for regular monitoring, reporting and analysis

CA findings revealed that NCCAS, NDMF and NPFNS make provision for the establishment of monitoring, reporting and analysis processes that are independent of external engagements, thus compromising avenues for coherence across sectors. Specifically, the NDMF has four key performance indicators (KPIs) and three enablers that address disaster institutional arrangements, planning, assessments, response and recovery, education and training, information management and communication, and funding. However, each KPI and enabler has not provided monitoring tools nor is their clear protocols and indicators to measure outcomes emanating from other sectors. Furthermore, the NDMF lacks reporting templates that incorporate plausible causes for poor outcomes as well as a periodic assessment of a policy's continued relevance. Meanwhile, the NPFNS (DALRRD, 2014, Section, 6.2) has various indicators to measure FS, including food price levels, food inflation indices, including an economic review of FS, which add other factors like climate change that impact on national FS. However, the policy lacks a dynamic policy design with built-in chances for policymakers to examine and revise it. It also makes no mention of having processes in place for transparent and regular public reporting on the country's FS

status. CA findings have further reflected NCCAS' MRA as inclusive of other sectors in terms of systems for transparent and regular reporting on vulnerability/resilience implementation, as well as monitoring and evaluation of all strategic objectives of the NCCAS, including finance. However, linking the NCCAS' MRA is still a challenge because of the inconsistencies within NPFNS and NDMF policies.

Overall, there is a level of convergence between CA and KIIs findings regarding inconsistencies in how MRA are promoting coherence between FS, CCA and DRR in South Africa. Specifically, the KIIs conducted clarified this dichotomy, where one respondent from NDMC asserted that:

... Most monitoring, reporting and analysis referred to in policies are almost appendages that are not easy to use, and most departments do them when it is required as a condition for funding or for policy reviews. (Respondent, 20)

Regarding policy reviews scheduled from 5 to 10 years for each policy, a respondent from DFFE argued that the reviews are not followed accordingly, giving an example of NPFNS where civil societies asked for a review since its conception in 2014, but as of 2022, nothing has happened. Again, the KIIs findings show that the review for NDMF is overdue since it was adopted in 2005, so that it can be in line with international frameworks including CCA and FS national policies. This delay is compromising the pursuing of coherence across FS, CCA and DRR sectors because there is no direct link or systems that allows for external engagement to discover areas of duplication of resources and efforts. Further, a lack of communication ties could jeopardise programme execution, as FS, CCA, and DRR all have complementary policy aims that must be handled holistically (Habiba *et al.*, 2016).

Following the presentation of the findings in the preceding part, the following section examines the findings in the form of a novel framework for bringing FS, CCA and DRR in South Africa into alignment.

5. Discussion: Framework for policy coherence between CCA, DRR and FS

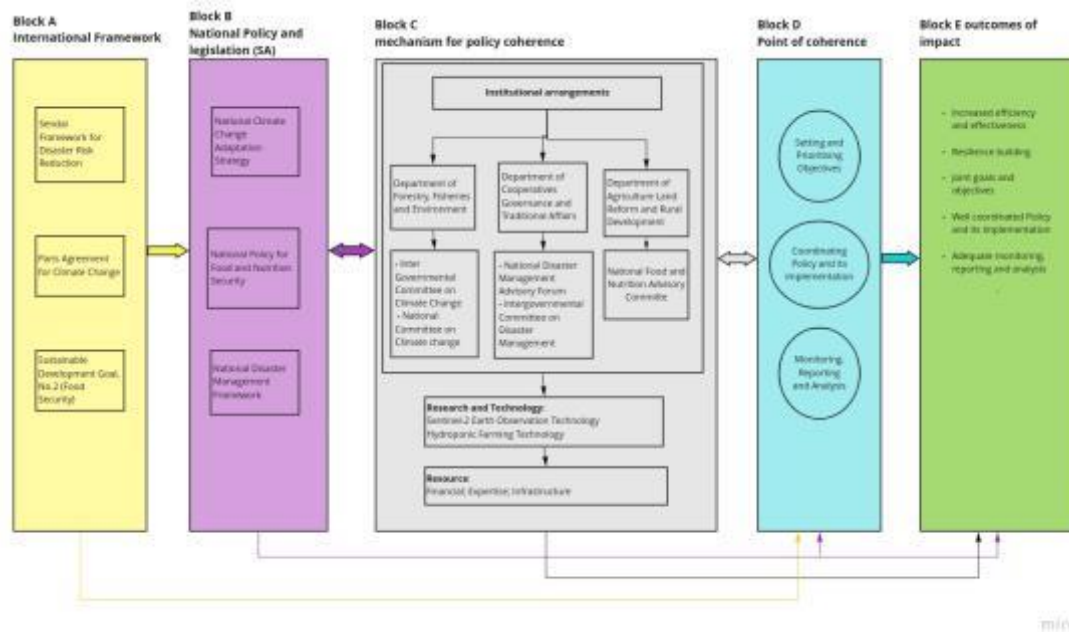


Figure 3: Framework for policy coherence between CCA, DRR and FS

The study's topics and respondents' conceptual understandings were taken into account as part of the construction of a framework for policy coherence across FS, CCA and in South Africa. The empirical evidence and the literature on policy coherence agree, indicating the need to establish and apply a framework that will improve coherence. Taking these into consideration, this paper proposes a framework for policy coherence (see Figure 3).

The framework comprises five constructs A-E, wherein A (yellow block) consists of the international frameworks for FS, CCA and DRR at the global level, i.e. Sendai Framework for Disaster Risk Reduction, Paris Agreement for Climate Change, and Sustainable Development Goal No. 2 (achieving food security). The short yellow arrow from the block indicates a link from which national policies must draw their guidelines, while the yellow arrow to D reflects a link to consider global norms to reduce conflicting objectives.

The purple block (B) constitutes national policies for FS, CCA and DRR in South Africa, which are the National Disaster Management Framework (NDMF), the National Climate Change Adaptation Strategy (NCCAS), and the National Policy on Food and Nutrition Security (NPFNS). The double purple arrow indicates the relationship with block C where mechanisms for coherence are drawn from the policies while departments govern the policies. The long purple arrows to D and E show the connection needed to align at point of coherence to achieve intended outcomes.

The grey block (C) constitutes mechanisms required to promote coherence between FS, CCA and DRR policies. These include institutional arrangements, i.e. Department of Agriculture, Land Reform and Rural Development, Department of Forestry, Fisheries and Environment (Directorate of Climate Change Adaptation), and Department of Cooperative Governance and Traditional Affairs (National Disaster Management Centre (NDMC), and Forums, councils or committees, including the National Disaster Management Forum (NDMAF), Inter-Ministerial Committee on Climate Change, Intergovernmental Committee

on Disaster Management (ICDM), the National Food and Nutrition Advisory Committee (NFNAC), Intergovernmental Committee on Climate Change (IGCCC), and the National Committee on Climate Change (NCCC). Research, innovation and technology and resources i.e. expertise, financial and infrastructure falls under block C as they are mechanisms used to promote coherence. The mechanisms for coherence are interlinked (as shown by down arrows) within the block in order to forge interactions and sharing of resources. The double grey arrow to D and E shows that all mechanisms should be attuned to objectives, aligned to implementation plans while using adequate MRA to lessen redundancy of interventions, thus optimal outcomes.

Block D represents the point of coherence where blocks A and B converge in aligning FS, CCA and DRR policy objectives, coordinating institutions, resources, research and technology for implementation, while ensuring flexible monitoring, reporting and analysis between relevant sectors. If policy coherence were to be pursued, block D would serve as the guiding scale for how policy coherence should be pursued from global to a national level, using Scobie's (2016) indicators (as described in sections 2.1 - 2.3). If the coherence option is chosen, it is expected that E (green block) will produce positive outcomes or impacts, such as increased efficiency and effectiveness, well-coordinated institutions, resources, expertise, and finance for proper implementation, while MRA will provide adequate processes through reviews and reports accessible to all relevant stakeholders

In line with the findings in section 4 above, the proposed policy coherence framework proposes six steps towards bringing FS, CCA and DRR policies together. In step 1, there is a need for the alignment of global frameworks and national policy objectives. This is because at the global level, the separation of the SFDRR, the Paris Agreement, and the SDGs No. 2 inhibits collaboration and is not designed to give integrated guidance across governmental levels on policy concerns, thus hindering policy coherence (Forino *et al.*, 2015). The proposed framework considers that the global frameworks should set shared objectives that would assist in aligning objectives of related policy areas at national level (Forino *et al.*, 2015) to promote coherence at all levels. Clarifying the frameworks' objectives, interconnection between FS, CCA and DRR and the need to address them in coherence at all levels could do this. In step 2, there is a need for alignment of FS, CCA and DRR national policy objectives (Figure 3 – Block B). To accomplish this, the framework proposes that setting and prioritising of objectives should be a multi-sector process, in which, notwithstanding turf conflicts and a lack of political will on the part of multiple institutions, FS, CCA and DRR policy objectives should be expressed in a way that promotes coherence.

Step 3 focuses on how the use of content should be considered when setting and prioritising FS, CCA and DRR objectives. The argument is that explicit content (language) should be used when setting policy objectives to produce visible synergies that can be easily discovered and used by practitioners from other sectors. In steps 4 and 5, the focus revolves around the coordination of mechanisms for policy coherence, as shown in Block C. As a result of existing structures that are uncoordinated, the framework proposes the development of a common coordinating structure and sharing of resources across the sectors. Moreover, government must invest in innovation and technologies that would promote coherence between the three policy areas. The last step addresses the importance of monitoring, reporting and analysis (MRA) when bringing coherence between FS, CCA and DRR policies. The step as suggested by Mercer (2010) puts more focus on the need for consistency

in policy reviews, the creation of communication links for reporting and visible avenues for analysis and participation by policy-makers and the public to allow external engagements.

It is envisaged that following these steps would assist in increased efficiency and effectiveness in addressing FS issues in South Africa. In the framework, efficiency refers to the recognition that, in the event of limited human, technical, and financial resources, a country can make better use of available capacities by taking a coordinated approach (GIZ, 2017). At the same time, effectiveness would mean understanding that achieving the goals of one policy effectively would result in significant progress towards the other two (ODI, 2016). The limitation of this framework is that it did not consider the entire body of international and national actors and arrangements potentially or to be involved in bringing coherence between FS, CCA and DRR policies. It also did not include provincial and municipal levels where this type of incoherencies is likely occurring. The proposed framework, on the other hand, is worth investigating because it benefits from the participatory character of its development and includes detailed processes that should be addressed at all levels, from global to national. As such, it fills in gaps in current understanding of the CCA-FS-DRR nexus, which has various sets of actors at the global, regional, and national levels that rarely meet on shared platforms and are unaware of the nexus' existence and relevance (Habiba *et al.*, 2016). It is expected that the proposed framework will give policy-makers and practitioners' insights and a systematic way of bringing coherence to FS, CCA and DRR policies in South Africa.

6. Conclusion

The findings from the study established that there are incoherencies between FS, CCA and DRR policy areas in terms of setting and prioritising of objectives, a lack of coordination during implementation and inadequate monitoring mechanisms that bring the policies together. Thus, in dealing with the lack of coherence between FS, CCA and DRR, this paper proposes a framework for bringing coherence between the policy areas in South Africa. The framework has the potential to accelerate policy coherence by aligning global and national objectives, coordinating implementation and monitoring mechanisms to have efficient or effective joint outcomes. The framework further brings coherence between FS, CCA and DRR in South Africa by linking national policies with international frameworks. The framework helps in understanding that well-coordinated mechanisms or tools, such as administrative, technological, resources and institutional bring collective use of resources, which in turn can increase efficiency, enhance sustainable approaches, and create one-stop-shop systems for knowledge sharing needed for coherence. In addition, the framework gives effect to the proper use of monitoring, reporting and analysis processes needed for effective policy reviews, multi-sector assessments and public engagements to get buy-in on the policy relevance.

However, this framework could face challenges. The study acknowledges that creating a framework that brings coherence between FS, CCA and DRR policies might pose a challenge because the institutions responsible for implementing these policies have separate mandates at international and national levels. As a result, it may cause divisions among sectors, limiting the effectiveness and frustrating the debating process. Thus, the framework's success is determined by how conflict is handled. To summarize, while the framework is not without flaws, it is an essential step in translating the theoretical CCA-DRR-FS nexus into a practical set of arrangements that practitioners may use to navigate the nexus's complicated and fluid landscape. This study argues that the setting up of this framework should not be a pseudo-indicator for success, but an enabler to bring policy

coherence to FS, CCA and DRR in South Africa. It is worth noting that the framework is not static. Therefore could be adjusted to fit the local context. As such, the study proposes testing the framework in practice so that it can be modified to meet the context of a particular locality.

References

Boecher, M. (2013) Regional governance and yardstick competition in forest nature conservation policy—the example ‘Idee. natur’. *Allgemeine Forst Und Jagdzeitung*, Vol.184 No. (3–4), pp. 58–69.

Campbell, B.M., Vermeulen, S.J., Aggarwal, P.K., Corner-Dolloff, C., Girvetz, E., Loboguerrero, A.M., Ramirez-Villegas, J., Rosenstock, T., Sebastian, L., Thornton, P.K., & Wollenberg, E. (2016) Reducing Risks to Food Security from Climate Change. *Global Food Security*, 11, pp. 34–43.

Council of the European Commission (CEC). (2011). A Resource-Efficient Europe – Flagship Initiative under the Europe 2020 Strategy, COM (2011) 571 final. European Commission: Brussels.

Chandra, A. and Idrisova, A. (2011) Convention on biological diversity: a review of national challenges and opportunities for implementation. *Biodiversity Conservation*, Vol. 20 No. 14, pp. 3295–3316. <http://dx.doi.org/10.1007/s10531-011-0141-x>

Clarvis, M.H., Fatichi, S., Allan, A., Fuhrer, J., Stoffel, M., Romerio, F, Gaudard, L., Burlando, P., Beniston, M., Xoplaki, E. & Toreti, A. (2014) Governing and managing water resources under changing hydro-climatic contexts: the case of the Upper Rhone Basin. *Environmental Science Policy*, 43, pp. 56–67.
<http://dx.doi.org/10.1016/j.envsci.2013.11.005> (mountain water governance: policy implications from the EU ACQWA Project)

Department of Agriculture, Land Reform and Rural Development (DALRRD) South Africa. (2014) National Policy on Food and Nutrition Security. Pretoria: Government Printers.

Department of Corporate Governance and Traditional Affairs (CoGTA), South Africa. (2005) National Disaster Management Framework, Pretoria: Government Printer.

Department of Forestry, Fisheries and Environment (DFFE), South Africa. (2019) National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printer.

Dunn W. (2003) Public Policy Analysis: An Introduction. Prentice Hall: Upper Saddle River, New Jersey.

Etikan, I., Musa, S.A. and Alkassim, R.S. (2016) Comparison of Convenience Sampling. *American Journal of Theoretical and Applied Statistics*, Vol. 5 No.1, pp.1–4

Food and Agriculture Organisation (FAO). (2012) Reducing Disaster Risks to Food Security in Southern Africa: Towards Integration and Co-operation. REOSA Policy Brief, 4. FAO Regional Disaster Risk Reduction and Management Office for Southern Africa (REOSA), Johannesburg, South Africa.

Fomunyan, K.G. (2019) Ending Hunger in Africa: The Fourth Industrial Revolution to the Rescue. *International Journal of Civil Engineering and Technology*, Vol.10 No. 7, pp. 228-234.

Forino, G., von Meding, J. and Brewer, G.J. (2015) A conceptual governance framework for climate change adaptation and disaster risk reduction integration. *International Journal of Disaster Risk Science*, Vol.6 No. 4, pp.372-384.

Forster, J. and Stokke, O.S. (2013) Policy coherence in development co-operation. Routledge, London.

Fowler, A. (1991) The role of NGOs in changing state-society relations: Perspectives from Eastern and Southern Africa. *Development Policy Review*, Vol. 9 No.1, pp.53-84.

Gero, A., Méheux, K. and Dominey-Howes, D. (2011) Integrating disaster risk reduction and climate change adaptation in the Pacific. *Climate and Development*, Vol. 3 No.4, pp.310-327. <https://doi.org/10.5194/nhess-11-101-2011> GIZ (2017) “Synergies in monitoring the implementation of the Paris Agreement, the SGDs and the Sendai Framework” <https://www.researchgate.net/publication/320858290>. Accessed 5 February 2018.

Global Initiative Disaster Risk Management (GIDRM)/Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). (2019) Guidance Note: Coherence Concepts and Practices. (DIDRM/GIZ).
2019file:///F:/Article%201/Guidance%20Note%20on%20Coherence.pdf

Habiba, U., Abedin, M.A. and Shaw, R. (2016) ‘Food security, climate change adaptation, and disaster risk’, in Uitto & Shaw (eds.), *Sustainable development and disaster risk reduction*, pp. 87–101. Springer, Tokyo.

Hall, D. M. and Steiner, R. (2020) Policy content analysis: Qualitative method for analysing sub-national insect pollinator legislation. *Methods X*, 7, 100787.

Hickey, G. and Kipping, C. (1996) Issues in research. A multi-stage approach to the coding of data from open-ended questions. *Nurse Researcher*, 4, pp. 81-91.

Hollnagel, E. (2018) *Safety-I and Safety-II: The Past and Future of Safety Management*. CRC Press.

Hsieh, H.F. and Shannon, S.E. (2005) Three approaches to qualitative content analysis, *Qualitative Health Research*, Vol. 15 No. 9, pp.1277–1288.
<https://doi.org/10.1177/1049732305276687>

- Jordan, A. and Lenschow, A. (2010) Environmental policy integration: a state-of-the-art review. *Environmental Policy Governance*, Vol. 20 No.3, pp.147–158.
<http://dx.doi.org/10.1002/eet.539>
- Kalaba, F.K., Quinn, C.H. and Dougill, A.J. (2014) Policy coherence and interplay between Zambia's Forest, energy, agricultural and climate change policies, and multilateral environmental agreements. *International Environmental Agreements-Politics, Law, and Economics*, Vol.14 No. 2, pp.181–198. <http://dx.doi.org/10.1007/s10784-013-9236-z>.
- Koff, H., Challenger, A. and Portillo, I. (2020) Guidelines for operationalizing policy Coherence for Development (PCD) as a methodology for the design and implementation of sustainable development strategies. *Sustainability*, Vol. 12 No.10, p.4055
- Kondracki, N.L. and Wellman, N.S. (2002) Content analysis: Review of methods and their applications in nutrition education. *Journal of Nutrition Education and Behavior*, 34, pp. 224-230.
- Lee, H.J. (2017) The Fourth Industrial Revolution and the Future of Agriculture. Smart Farm and Shared Economy. Rep. of Korea: Science and Technology Policy Institute, 200 eds
- Makkonen, M., Huttunen, S., Primmer, E., Repo, A. and Hilden, M. (2015) Policy coherence in climate change mitigation: an ecosystem service approach to forests as carbon sinks and bioenergy sources. *Foreign Policy Economics*, Vol.50 No.1, pp.153–162.
<http://dx.doi.org/10.1016/j.forpol.2014.09.003>.
- Mercer, J. (2010) 'Disaster risk reduction or climate change adaptation: Are we reinventing the wheel?' *Journal of International Development: The Journal of the Development Studies Association*, Vol. 22 No. 2, pp.135–141.
<https://doi.org/10.1002/jid.1677>
- Morse, J.M. and Field, P.A. (1995) *Qualitative research methods for health professionals* (2nd ed.). Thousand Oaks, CA: Sage.
- Nemakonde, L.D. and Van Niekerk, D. (2017) A Normative Model for Integrating Organisations for Disaster Risk Reduction and Climate Change Adaptation within SADC Member States." *Disaster Prevention and Management: An International Journal*, 26: 361-76.
- Nilsson, M., Wiklund, H., Finnveden, G., Lundberg, K., Tyskeng, T., Jonsson, D. and Wallgren, O. (2009) Analytical Framework and tool kit for SEA Follow Up. *Environmental Impact Assessment Review*, Vol. 29 No.1, pp.186–199.
- Nilsson, M., Zamparutti, T., Petersen, J.E., Nykvist, B., Rudberg, P. and McGuinn, J. (2012) 'Understanding policy coherence: Analytical framework and examples of sector–environment policy interactions in the EU', *Environmental Policy and Governance*, Vol. 22 No.6, pp. 395–423. <https://doi.org/10.1002/eet.1589>

Organisation for Economic Cooperation and Development (OECD). (2002) Improving Policy Coherence and Integration for Sustainable Development: A Checklist. OECD: Paris.

Organisation for Economic Co-operation and Development (OECD). (2012) Policy Framework for Policy Coherence for Development. In Working Paper no 1, 2012: OECD. Paris

Overseas Development Institute (ODI). (2016) Resilience' Across the Post-2015 Frameworks: Towards Coherence? <https://www.odi.org/publications/10598-resilience-across-post-2015-frameworks-towards-coherence>. Accessed 5 February 2021.

Pintér, L., Hardi, P.M. and André, H.J. (2012) Bellagio STAMP: principles for sustainability assessment and measurement. Ecology Indicators, 17, pp.20–28. <http://dx.doi.org/10.1016/j.ecolind.2011.07.001> (indicators of environmental sustainability: from concept to applications).

Schipper, L. and Pelling, M. (2006) Disaster risk, climate change and international development: Scopes for, and challenges to integration. Disasters, Vol. 30 No.1, pp.19–38. Scobie, M. (2016). Policy coherence in climate governance in Caribbean Small Island developing states. Environmental Science & Policy, 58, pp.16-28.

Scott. J. (2000) Rational Choice Theory. Understanding Contemporary Society: Theories of the present, No.129. pp.671-685.

Terry, G., Hayfield, N., Clarke, V. and Braun, V. (2017) 'Chapter 2: Thematic analysis', in C. Willig and W.S. Rogers (eds.), The Sage handbook of qualitative research in psychology, pp.17–37, Sage, London.

Tesch, R. (1990). Qualitative research: Analysis types and software tools. Bristol: Falmer. Thow, A.M., Greenberg, S., Hara, M., Friel, S. and Sanders, D. (2018) Improving Policy Coherence for Food Security and Nutrition in South Africa: A Qualitative Policy Analysis. Food Security, Vol.10 No. 4, pp.1105-1130.

United Nations (UN). (2015) Sustainable Development Goals (SDGs) Goal No. 2. UN. <https://sdgs.un.org/goals/goal2>. Accessed 21 February 2021.

United Nations International Strategy for Disaster Reduction (UNISDR). (2015). Sendai framework for disaster risk reduction, <https://www.unisdr.org/we/coordinate/sendai-framework>. Accessed 07 February 2021.

United Nations Framework Convention on Climate Change (UNFCCC). (2015) Paris agreement on climate change, <http://unfccc.int/parisagreement/items/9485.php>. Accessed 07 February 2021.

Zembe, A., Nemakonde, L.D. and Chipangura, P. (2022) Policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa: A summative content analysis approach. Jambá: Journal of Disaster Risk Studies, Vol.14 No.1, pp.1-11

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This study, guided by the post-positivism research approach, sought to develop a framework of policy coherence between FS, CCA and DRR in South Africa. The approach of qualitative key informant interviews and content analysis employed in the study enabled the researcher to explore views and perspectives of government and research institution officials and policy and legislation in a deeper manner to build the framework. Four research articles were written to meet the study's objectives, and they form part of the thesis. The outcomes of these research articles are discussed in this chapter in relation to how the papers addressed research questions. Each research article's summary conclusion includes a brief description of the article's goal, main findings, design, and conclusions. The rest of the chapter draws from the conclusions to offer recommendations, emphasizing the study's major contributions and directing further research.

7.1.1 Article 1 - Policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa: A summative content analysis approach

The goal of this article was to simultaneously address Research Questions 1 and 2 of the thesis. The first research question was: What is CCA, DRR and policy coherence within the context of food security? and research Question 2 as: How does the content (text) within FS, CCA and DRR legislation and policy documents reflect coherence? Correspondingly, the article led to the accomplishment of two research objectives, namely, to conceptualise FS, CCA, DRR and policy coherence within the context of FS; and to explore how content (text) within FS, CCA and DRR policy and legislation documents is used to influence policy coherence. The point of departure in addressing these two research questions and objectives was to analyse if there is coherence in the policies that address FS, CCA and DRR in South Africa. This was attained by examining the use of text in FS, CCA and DRR CCA policy and legislative documents to better understand its context and meaning to enhance coherence. Through text analysis, valid and replicable inferences from data to context were established to provide fresh insights, knowledge, a representation of facts and practical guidance when pursuing coherence. The paper depended heavily on research of Habiba *et al.* (2016), who constructed a framework demonstrating the nexus between FS, CCA and DRR, which is discussed in Chapter 2. This nexus has demonstrated that countries cannot afford to undertake FS, CCA and DRR in isolation, because tackling the

challenge of food insecurity as a result of increased disasters, climatic variability, and extremes necessitates coordinated programmes, policies, and strategies.

A mixed-method study methodology was used to acquire empirical evidence, with data collected through a content analysis (CA) of policy and legislative documents relevant to FS, CCA and DRR in South Africa, key informant interviews (KIIs), as well as a thorough literature review. To understand the contextual use in relation to coherence, thematic analysis was used to analyse and present data gathered from 24 purposefully selected key informants from eight institutions (government -supported research institutions and government entities), while CA was used to identify and quantify content from 34 purposefully selected policy and legislative documents.

As a result of the findings presented in this research, providing coherence between FS, CCA and DRR policy domains is advocated as one of the methods for FS sustainability in South Africa. However, the interlinkages found between these three policy sectors revealed that many policies have yet to press the button that brings related policies together. As a result, tackling disaster risk and climate change on FS in a coherent manner continues to be a problem. Finally, despite some synergies in the contents of specific policy papers, the findings from both CA and KIIs found inconsistencies between the primary policies and regulations that address FS, CCA and DRR in South Africa.

This study argued that establishing coherence to the three policy areas demands explicit content in policy documents, as well as a review of policy documents and legislative changes, to recognise the links and relationships that exist between the policy domains. This is because policy documents and legislations play a critical role in encouraging disaster risk reduction and adaptation to climate change. In the end, this would aid in bridging the existing gaps between the institutions responsible for FS. KII's findings demonstrated that there was coordination, sharing of resources, clarity on mandates, duties and responsibilities, and joint use of methods, tools, and strategies in policy areas where the interlinkages between DRR-CCA, DRR-FS, and CCA-FS were visible, and the policy text was explicit. This aided in the reduction of duplication of work while increasing resource efficiency. According to the information presented in the article, providing consistency between the three policy domains requires officials with expertise and comprehension of the interconnections influencing policy processes during the review phase. Thus, the article was used as a policy coherence mechanism that contributed to the framing and use of content when setting and prioritising objectives in the study's novel framework. As the framework was built on a combination of mechanisms, this article recommended the need to explore institutional mechanisms for policy coherence that could feed into the implementation part of the framework, as discussed below.

7.1.2 Article 2 – Institutional mechanism for coherence between climate change adaptation, disaster risk reduction and food security in South Africa and beyond

The following third research question was answered in this article: What institutional mechanisms are used to coordinate FS, CCA and DRR institutions and functions for effective coherence in South Africa? Through this research question, the thesis addressed the research aim that sought to develop and explore institutional mechanisms to create consistency across FS, CCA and DRR functions and entities in South Africa. This research question was in response to some of the shortcomings mentioned in Article 1 regarding how South Africa's separate placement of institutions dealing with FS, CCA and DRR is preventing policy coherence.

Therefore, this paper aimed to address incoherencies in coordination between institutions that address FS, CCA and DRR in South Africa and beyond. Evidence from the literature study confirmed that in many countries, including South Africa, FS, CCA and DRR structures in governments have largely been developed in isolation, thus, they have been operating in parallel with little coordination, which is compromising the achievement of FS. This complexity prompted the study to develop a coordination support mechanism that promotes coherence of activities between FS, CCA and DRR policy areas. To reach that stage, firstly, a conventional CA was carried out to identify significant areas of overlap in the institutional roles and responsibilities towards FS in FS, CCA and DRR in South Africa. This helped to investigate how the three main policy documents enforce coordination of FS, CCA and DRR activities when addressing FS. Secondly, a thematic analysis of data gathered from 24 KIIs was used to understand how the identified institutions interact, challenges they encounter and recommendations they offer to change or transform the ways they coordinate for more coherent results. Finally, a coordination mechanism was developed using aspects from the FRAM, and findings from CA and KIIs to align various FS functions undertaken by FS, CCA and DRR institutions to produce a joint outcome.

The evidence in this article has established that there are numerous inconsistencies in how institutions (WRC, ARC, DCCA, NDMC, SAWS, Agri SA, DALRRD, and CSIR) carry out the food functions in South Africa. Although most institutions seem to understand their roles towards FS, these functions are coupled with challenges that emanate from a lack of clarity in the policy and legislative documents that address FS, CCA and DRR. On those roles that are articulated in such documents, there seems to be a lack of implementation plans that coordinate who should do what, when and where to avoid duplication of tasks and

conflicting goals. Therefore, the proposed coordination mechanism provided insights for policy-makers and practitioners to enable them to coordinate FS, CCA and DRR functions with fewer conflicts. This was done through characterisation of all aspects of a function before it is carried out to avoid duplication of tasks by institutions performing similar functions.

The mechanism was generic in the sense that it was not tailored to specific functions but could be applied to any simple or complex functions. The development of this mechanism has been described as a continuous process, as it is necessary to evaluate the mechanism's success and failures on a routine basis and adjust as needed. The study evidence acknowledged that despite creating a coordination mechanism that brings functions of FS, CCA and DRR together, it might still be a challenge because these institutions have different mandates, even at international and regional level; therefore, the setting up that mechanism was not a pseudo-indicator for success, but an enabler to coordinate FS, CCA and DRR functions. The evidence from this article has further demonstrated that coherence between FS, CCA and DRR does not revolve around the use of explicit content to the alignment of policy objectives and coordination of institutional mechanisms only but requires tools such as technologies that incorporate all policy coherence mechanisms in one platform for easy access by the relevant stakeholders, as presented below.

7.1.3 Article 3 – Using technology to bring coherence between climate change adaptation and disaster risk reduction for food security in South Africa

Research Question 4 of the thesis was answered through Article 3. The following was the research question: What practical examples, experiences, and tools are used to bring coherence between FS, CCA and DRR policies in South Africa? This research question was critical in attaining the research objective to explore practical examples, experiences, and tools used to bring coherence to FS, CCA and DRR in South Africa. In answering the research question, the article sought to investigate how FS projects are incorporating CCA and DRR using technology. The study began with an epiphany that disasters and climate change risks, such as veld fires and droughts, have and continue to affect FS in South Africa, therefore using technology that incorporates CCA and DRR measures would be viable to solve FS issues in the country. In doing this, the paper brought in the practical examples of FS projects that are incorporating CCA and DRR measures using technology. These included the Western Cape FS project using Sentinel-2 Earth Observation

technology and the Urban Agricultural Initiative (UAI) FS project using hydroponics technology.

To answer the research question, the paper utilised a qualitative research design, including a literature review relating to Sentinel-2 Earth Observation and hydroponics farming technology in general and in South Africa. It also used in-depth interviews with five respondents from the Western Cape FS project and five respondents from UAI FS project. Purposive sampling was used to select project managers, while the managers would then refer researchers to suitable project beneficiaries, i.e. making the referral snowball sampling (Creswell, 2015). In addition, KIIs were conducted with 10 purposively selected respondents from eight government and research institutions. The purpose of doing KIIs was a deliberate choice to get an external perspective of how the FS projects are performing in terms of incorporating CCA and DRR measures. Both in-depth interviews and KIIs were conducted through emails, face-to-face interviews; virtual/online platforms, and telephonic interviews giving participants liberty to choose a platform convenient to them. Finally, both responses were analysed using thematic analysis.

Qualitative findings from the Western Cape project established that the adoption of Sentinel-2 Earth Observation technology was to deal with a lack of information on the prevalence of climate change and variability and its impact on FS in the province. Thus, the evidence has shown that the technology has helped to make relevant data available that helps to monitor climate change hazards and extreme weather events that affect their cropping seasons. The same results also indicated that the technology has offered better monitoring capabilities to strengthen synergies in all food value chains, including food production information and market transparency to better decision-making during climate-related disasters. On incorporating DRR measures, the findings have shown that the technology can help in demarcating hazards, such as veld fires, and determine the extent to which drought could affect vegetation and crops in the province. However, the challenges revealed in the study included a lack of knowledge by the farmers about data and colour images that are shown by the satellite. Again, the cost of hiring programmers for data interpretation and training of project recipients was described as exorbitant considering the lack of funding from government.

The article provides further evidence that the incorporation of CCA measures into the UAI project was to introduce “green” i.e. crops, to the city of Johannesburg considering the level of pollution produced from industrial activities. Inclusively, the project brought agricultural production closer to consumers, thereby addressing food miles and food wastage, while increasing the availability of nutritious food fresh from the garden. Efforts to incorporate CCA measures were also seen using plastic tunnels that protect crops during disasters or

extreme events such as storms, drought, or cold temperatures in winter,, thus helping in maintaining full productive output amid disastrous events. The overall evidence from the study revealed that both projects incorporate CCA and DRR measures in most of their food value chains. Although the projects are different in nature, they still face similar challenges, such as the lack of expertise, resources, funding, and an inadequate regulatory environment to improve their farming practices. Again, although KIIs argued that more success of the projects could be achieved at small-scale farming, they applauded the innovation and its ability to bring coherence to FS, CCA and DRR. On this basis, the study proposed the use of technology as a mechanism that could be incorporated into the thesis' framework to bring coherence between FS, CCA and DRR, as shown in the following section.

7.1.4 Article 4 - A policy coherence framework for climate change adaptation, disaster risk reduction and food security in South Africa

The purpose of this article was to respond Research Question 5, which was as follows: What contribution can a framework make in guiding policy coherence between FS, CCA and DRR in South Africa? In answering this research question, the objective “to introduce a novel framework that could assist in bringing policy coherence between FS, CCA and DRR policies in South Africa”, was achieved. The research question was developed considering other aspects, which had reached various findings in Articles 1, 2 and 3, notably, Policy coherence between FS, DRR and CCA in South Africa: A summative content analysis approach, institutional mechanism for coherence between FS, CCA and DRR in South Africa and beyond, and using technology to bring coherence between CCA and DRR for FS in South Africa, respectively. The need for a novel framework for policy coherence was highlighted by preceding articles' multi-faceted study of policy coherence between FS, CCA and DRR, which was supplemented by existing research.

Subsequently, the proposed novel framework for policy coherence in this article followed a six-step process, including: (1) the alignment of objectives between global frameworks and national policy and legislations; (2) the alignment of FS, CCA and DRR objectives at national level; (3) the use of content (text) when setting and prioritising objectives; (4) the coordination of the implementation of policies between FS, CCA and DRR,;(5) the use of research and technology for policy coherence; and (6) flexible processes and systems for regular monitoring, reporting and analysis to guide the development of the framework. The arguments around Step 1 were that the separation of SFDRR, Paris Agreement and SDGs No. 2 at international level undermines collaboration and does not determine to give

integrated guidelines at all levels of government. Thus, the proposed framework considers that the global frameworks should clearly establish tools and mechanisms that align their objectives with those of national policies to promote coherence at all levels.

Step 2 discussed the need for alignment of FS, CCA and DRR national policy objectives. In doing this, it identified different geographical locations of departments, different budgets, silo mentality on framing objectives according to institutional frameworks and a lack of political will as challenges to effective policy coherence. Therefore, the framework proposes that the setting and prioritising of objectives should be a multi-sector process endorsed by political will to strengthen coherence.

Step 3 indicated the need to use explicit content when setting and prioritising objectives to establish observable synergies that practitioners can quickly recognise across FS, CCA and DRR sectors.

Under Steps 4 and 5, discussions revolved around how institutional arrangements are operating as independent entities, the lack of investment by government in technologies that incorporate FS, CCA and DRR measures in one platform, and inadequate sharing of resources across sectors as major hindrances to coherence.

Step 6 addressed the importance of monitoring, reporting and analysis (MRA) when bringing coherence to FS, CCA and DRR policies. The key components identified under this step were the need for consistency in policy reviews, specifically NPFNS, the creation of communication links for reporting and visible avenues for analysis and participation by policy-makers and the public to allow external engagements. The proposed framework shows that if the steps are followed properly, the results could be increased efficiency and effectiveness, which in the end could result in joint goals, well-coordinated implementation plans and adequate and flexible MRA. The framework helps in understanding that well-coordinated mechanisms or tools, such as technological, resources and institutional, bring collective use of resources, which in turn could increase efficiency, enhance sustainable approaches, and create one-stop-shop systems for knowledge sharing needed for coherence. The study acknowledges that creating a framework that brings coherence between FS, CCA and DRR policies might face some challenges because these policies have unique mandates at both international and regional spheres. Thus, it could create conflict among sectors, which may frustrate deliberation processes and limiting its effectiveness. In this light, the framework's achievement therefore depends on how conflict is managed.

In conclusion, while the framework is not without defects, it is an indispensable task in translating the conceptual CCA-DRR–FS nexus into a practical set of configurations that practitioners may use to navigate the nexus's dynamic and fluid landscape.

7.2 CONTRIBUTIONS OF THE THESIS

Through Article 1: *Policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa: A summative content analysis approach*, this study makes a significant contribution to the nexus between FS, CCA, and DRR, which is often overlooked in policies, resulting in fragmented application. As such, it addresses gaps in the current appreciation of the CCA-FS-DRR nexus, which has several actors at the national, regional, and global levels that rarely interact on common platforms and are oblivious of the significance and nature of this nexus. It further introduced the concept of use of explicit content (text) to understand meaning and context in which policy coherence is used. In doing this, it helped practitioners to be able to put meaning of data into contextual perspectives that serves as the representation of facts and a blueprint for practice.

The thesis, through Article 2: *institutional mechanism for coherence between climate change adaptation, disaster risk reduction and food security in South Africa*, contributes to the body of knowledge by bringing the concept of FRAM to bringing FS, CCA and DRR functions or mechanisms together. The proposed coordination mechanism in this thesis is a step forward towards bringing coherence to FS, CCA and DRR mechanisms. The coordination mechanism also contributes to literature on how different FS, CCA and DRR agents or organisations could simultaneously work on similar work without conflicting. This is done through characterisation of the pre-conditions, input, time, resources, control, and output of the functions, thus allowing practitioners to identify challenges, reduce conflicts and duplication of work, while targeting possible opportunities needed to achieve coherence systematically.

The thesis also adds to the current body of knowledge and debates on how technology brings coherence between FS, CCA and DRR policies. Through Article 3: *Using technology to bring coherence between climate change adaptation and disaster risk reduction for food security in South Africa*, it brings in the practical way of incorporating FS, CCA and DRR issues in one platform through two case studies: the Western Cape FS project using Sentinel-2 Earth Observation technology and the UAI FS project using hydroponics technology. The thesis demonstrates that pursuing policy coherence cannot be promoted in theory only, but also at practical level. This establishes the parameters within which

decision-making occur, defining the regulatory path and its preferred strategy in South Africa.

The policy coherence framework developed in Article 4: *A policy coherence framework for climate change adaptation, disaster risk reduction and food security in South Africa*, contributes to the growing body of knowledge of the post-positivism analysis of FS, CCA and DRR. The proposed framework in this thesis provides a vehicle that practitioners can use to bring policy coherence between FS, CCA and DRR. Furthermore, through Article 4, the thesis gives effect to the proper use of the monitoring, reporting and analysis process needed for effective policy reviews, multi-sector assessments and public engagements to get buy-in on the policy relevance. The proposal is a vital step in integrating the conceptual CCA-DRR-FS nexus into a set of operational structures that practitioners can use to manoeuvre the nexus's complex setting.

7.3 RECOMMENDATIONS

Despite their common goals and various synergies, FS, CCA and DRR are three distinct policy and practice domains, each with its own institutional and legal frameworks that varies among nations due to a variety of circumstances. The coherence between them can be enhanced using explicit content (text) that creates visible synergies across sectors, embraces the coordination mechanism that aligns FS, CCA and DRR institutions, strengthens investment in technology that incorporates FS, CCA and DRR, and strengthens mechanisms and the legislative/legal framework by embracing the proposed framework for policy coherence. The study summarised the key recommendations in more detail, as follows:

Recommendation 1: The use of explicit content that creates visible synergies across sectors

The thesis established that using explicit content may generate noticeable linkages that practitioners from other fields could easily identify and leverage to forge policy coherence between FS, CCA and DRR. Further, the use of explicit content could help practitioners to understand the meaning and context in which words or different terms are used when pursuing coherence. Therefore, it is recommended that policy-makers, practitioners, and scholars within the FS, CCA and DRR fraternity understand the significance of using explicit content as this could help in providing clear guidelines to follow in practice. Furthermore, the study suggested that outdated policy and legal frameworks from the 1990s be reviewed to address cross-cutting issues like FS, CCA and DRR. This would improve and deepen the three policy areas' synergies and interconnections.

Recommendation 2: Embrace the coordination mechanism that aligns FS, CCA and DRR institutions

The thesis identified that those institutional mechanisms established to bring coherence to FS, CCA and DRR have been working in parallel, compromising the achievement of FS in South Africa. Therefore, the study developed a coordination mechanism that could help in aligning FS, CCA and DRR institutions when addressing similar functions. The coordination mechanism was developed using aspects from the FRAM (input, time, pre-conditions, resources, control, and output). The coordination mechanism allows simultaneous participation of relevant stakeholders through a systematic characterisation of functions, agents or organisations. It also allows policy-makers and practitioners to identify variabilities, challenges and opportunities that should be considered before an activity is executed. This mechanism therefore opens up the possibility of greater coherence between FS, CCA and DRR in South Africa and beyond.

Recommendation 3: Strengthen investment in technology that incorporates FS, CCA and DRR

The thesis established that introducing the practical side of theorised policy coherence brings a new angle to how interlinkages between FS, CCA and DRR could be appreciated. However, a lack of investment by government in the industry in which these technologies lie is an obstacle to efforts of furthering the acknowledgements of the CCA-DRR-FS nexus in practice. Again, study findings have shown challenges, such as a lack of expertise, resources, funding, and inadequate regulatory environment, to operating the technologies. Therefore, the study recommends a review of policies that support innovation to fund training to people using the technologies, provide infrastructure sufficient to explore the technology and leverage all opportunities it brings to FS, CCA and DRR sectors.

Recommendation 4: Adopt the suggested framework for policy coherence to strengthen the legislative/legal framework and mechanisms.

The thesis established that in South Africa, policies that are addressing FS, CCA and DRR are working in parallel, thus hindering policy coherence. For the country to achieve the goal of bringing coherence to FS, CCA and DRR, greater efforts must be made in processes of monitoring, reporting and analysis, coordinating policy and its implementation, and setting and prioritising objectives. This allows identification of problems from global to national level using participatory avenues indicated in the steps in Article 4. This thesis recommends the proposed framework because it serves as a road map for practitioners from diverse sectors to employ in guiding policy coherence across FS, CCA, and DRR in South Africa.

7.4 LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

This section reflects on the limitations and suggests ways to address them in future research. External validity is limited by the study's context-specific nature. The study, however, employed an approach that might be replicated in a variety of similar developmental settings. In addition, the study could yield similar results if it is used in Southern Africa, where the countries have similar disaster and climate change risk profiles. For instance, studies (Crush et al., 2011) have shown that Botswana, Zimbabwe, South Africa, and Malawi are all dependent on agriculture. This is because the countries share similar climatic conditions such as unpredictable rainfall, frequent droughts, and floods, experience rapid urbanisation that leads to overpopulation in cities, and have rural farmers who depend on rain-fed agriculture that is susceptible to disaster risks. The study suggests more research that attempts to bring coherence to the FS, CCA, and DRR policy sectors at the regional level, particularly in Southern Africa, in an effort to improve the condition of food security in light of climate change and disasters. On this premise, this study proposes that, while the proposed framework was not tested in the study, additional research might be conducted to see if it is applicable in other developing regions, particularly Southern African countries. This is due to the fact that the framework provided fresh ideas, such as the use of technology and explicit content or text to bring about policy consistency amongst FS, CCA, and DRR. This could necessitate a review of policy wording and the purchase of technological tools to accomplish the purpose. Therefore, further study should concentrate on ways to lower the costs associated with such endeavours in order to persuade government authorities to prioritise their implementation. Again, the key is sensitive to site-specific context on issues of FS, CCA and DRR, thus context should be considered when addressing similar studies.

Although the study concentrated on national policy and legislative frameworks, it suggests more research on provincial and municipal levels because such policy inconsistencies are likely to be encountered.

The other key flaw in the study was that it only interviewed officials from government departments and research institutions that are funded by the government, leaving out cross-cutting organisations like businesses and industry, civil society, and the private sector. While the research was skewed toward qualitative findings, it was limited to a full description and juxtaposition of dominating discourses in FS, CCA and DRR. As a result, future study should include a larger number of community participants.

Future research should include longitudinal studies. Longitudinal studies aid in capturing changes in institutional systems impacting FS, CCA and DRRFS organisations, as well as social, political, and macro-economic variables that may vary over time and influence views.

7.5 CONCLUSION

This thesis has provided a detailed insight into how policy coherence can be brought about between FS, CCA and DRR in South Africa. Both literature review and empirical investigation were used in this study. Through Article 1, the study explored how the use of explicit of content (text) in setting and prioritising objectives can promote coherence between FS, CCA and DRR. This study demonstrated in Article 1 that using explicit content can aid in the creation of visible overlaps that can be easily confirmed and used by experts from other disciplines to better comprehend the meaning and context of policy coherence. It also aids in the creation of reproducible and valid interpretations of data to context, with the goal of delivering visual depiction of facts into practice.

Through Article 2, the study empirically established incoherencies in coordination between institutions that address FS, CCA and DRR in South Africa. These findings motivated the study to develop a coordination mechanism using FRAM's six aspects, including input, time, pre-conditions, resources, control, and output. The coordination mechanisms allow simultaneous participation of relevant stakeholders with no or minimum conflict through characterisation of similar functions before they are executed.

The study, through Article 3, thus clearly put in practice the issue of coherence between FS, CCA and DRR in South Africa. The study has shown that technology could help in incorporating FS, CCA and DRR on one platform that could be accessed by the relevant stakeholders. Finally, Articles 1, 2, and 3 displayed mechanisms that could be used to bring policy coherence to FS, CCA and DRR and these findings informed the development of a policy coherence framework in Chapter 6 through Article 4. The proposed framework is a six-step process of alignment of objectives between global frameworks and national policy and legislation; alignment of FS, CCA and DRR objectives at national level; the use of content (text) when setting and prioritising objectives; coordinating implementation of policies between FS, CCA and DRR; the use of research and technology for policy coherence; and flexible processes and systems for regular monitoring, reporting and analysis, which intends to assist practitioners to translate the conceptualisation of the CCA-DRR-FS nexus into a set of practical arrangements to navigate the complex and changing environment for bringing coherence to FS, CCA and DRR policies in South Africa.

In conclusion, the study has clearly shown how policy coherence could be pursued from the use of explicit content in setting and prioritising objectives, the development of a coordination mechanism to align FS, CCA and DRR institutions, the use technology to bring FS, CCA and DRR on one platform, and finally to develop a framework that combines all the recommendations in the articles into a practical policy coherence guide for South Africa and beyond.

BIBLIOGRAPHY

- Adger, W.N., Huq, S., Brown, K., Conway, D. and Hulme, M. 2003. Adaptation to Climate Change in the Developing World. *Progress in Development Studies*, 3(3):179-195.
- Ahrens, J. and Rudolph, P.M. 2006. The Importance of Governance in Risk Reduction and Disaster Management. *Journal of Contingencies and Crisis Management*, 14(4):207-220.
- Akinagbe, O.M. and Irohibe, I.J. 2015. Agricultural Adaptation Strategies to Climate Change Impacts in Africa: A review. *Bangladesh Journal of Agricultural Research*, 39(3):407–418. <https://doi.org/10.3329/bjar.v39i3.21984>
- Amankwah-Amoah, J. Osabutey, E.L.C. and Egbetokum, A. 2018. Contemporary Challenges and Opportunities of Doing Business in Africa: The Emerging Roles and Effects of Technologies. *Technological Forecasting and Social Change*, (131):171–174.
- Asfaw, S. and Lipper, L. 2016. Managing Climate Risk Using Climate-smart Agriculture. FAO, Rome Italy.
- Bandara, J.S. and Cai, Y. 2014. The Impact of Climate Change on Food Crop Productivity, Food Prices and Food Security in South Asia. *Economic Analysis and Policy*, 44(4):451–465. <https://doi.org/10.1016/j.eap.2014.09.005>
- Balagtas, J.V., Bhandari, H., Cabrera, E.R., Mohanty, S. and Hossain, M. 2014. Did the Commodity Price Spike Increase Rural Poverty? Evidence From a Long-run Panel in Bangladesh. *Agricultural Economics*, 45(3):303-312.
- Basera, T., Khamisa, N. and Mokgobi, M., 2020. Knowledge, Attitudes and Behaviours Towards People with HIV and AIDS Among Private Higher Education Students in Johannesburg, South Africa. *Southern African Journal of HIV Medicine*, 21(1):.1-7.
- Becker, P., Abrahamsson, M. and Hagelsteen, M. 2013. Parallel Structures for Disaster Risk Reduction and Climate Change Adaptation in Southern Africa. *Jàmbá: Journal of Disaster Risk Studies*, 5(2):1-5. <https://doi.org/http://doi.org/10.4102/jamba.v5i2.68>.

Begum, R.A., Sarkar, M.S.K., Jaafar, A.H and Pereira, J.J. 2014. Toward Conceptual Frameworks for Linking Disaster Risk Reduction and Climate Change Adaptation. *International Journal of Disaster Risk Reduction* 10:362–373.

Birkmann, J. and Mechler, R. 2015. Advancing Climate Adaptation and Risk Management. New Insights, Concepts and Approaches: What Have We Learned From the SREX and the AR5 Processes? *Climatic Change*, 133:1–6.
<https://doi.org/10.1007/s10584-015-1515-y>

Birkmann, J. and von Teichman, K. 2010. Integrating Disaster Risk Reduction and Climate Change Adaptation: Key Challenges—Scales, Knowledge, and Norms. *Sustainability Science* 5(2):171–184.

Blaikie, N. 2004. Designing Social Research: The Logic of Application. Cambridge: Polity Press.

Boatemma, S., Drimie, S. and Pereira, L. 2018. Addressing Food and Nutrition Security in South Africa: A review of Policy Responses since 2002. *African Journal of Agricultural and Resource Economics*, 13(311-2019-687):264-279.

Boecher, M. 2013. Regional Governance and Yardstick Competition in Forest Nature Conservation Policy—the Example ‘Idee. Nature’, *Allgemeine Forst Und Jagdzeitung*, 184 (3–4): 58–69.

Bontemps, S., Arias, M., Cara, C., Dedieu, G., Guzzonato, E., Hagolle, O., Inglada, J., Morin, D., Rabaute, T., Savinaud, M. and Sepulcre, G. 2015. Sentinel-2 for Agriculture”: Supporting Global Agriculture Monitoring. In 2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) (4185-4188). IEEE.

Boyatzis, R. E. 1998. Transforming Qualitative Information: Thematic Analysis and Code Development. Sage, London.

Braun, A., Colangelo, E. and Steckel, T. 2018. Farming in the Era of Industries 4.0. *Procedia CIRP*. (72):979-984.

Braun, V. and Clarke, V. 2006. Using Thematic Analysis in Psychology. *Qualitative Research in Psychology*, 3(2):77-101.

Braun, V. and Clarke, V. 2013. Successful Qualitative Research: A Practical Guide for Beginners. Sage. London

Brooks, N. and Adger, W.N. 2005. Assessing and Enhancing Adaptive Capacity. In Lim, B. and Spanger-Siegfried, E. (Eds.) Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies, and Measures. Cambridge: Cambridge University Press.
http://www.preventionweb.net/files/7995_APF.pdf

Browning, G., Halcli, A. and Webster, F. Eds. 1999. Understanding Contemporary Society: Theories of the Present. Sage.

Business Tech, 2017. Johannesburg Has a New Roof-top-farm with 100 More on the Way. 21 October 2017: 1.
<https://businesstech.co.za/news/business/204702/johannesburg-has-a-new-roof-top-farm-with-100-more-on-the-way/>. Date of access, 22 July 2022.

Campbell, B.M., Thornton, P., Zougmore, R., van Asten, P. and Lipper, L. 2014. Sustainable Intensification: What is its Role in Climate Smart Agriculture? *Current Opinion in Environmental Sustainability*. 8:39-43. <http://dx.doi.org/10.1016/j.cosust.2014.07.002>

Campbell, B.M., Vermeulen, S.J., Aggarwal, P.K., Corner-Dolloff, C., Girvetz, E., Loboguerrero, A.M., Ramirez-Villegas, J., Rosenstock, T., Sebastian, L., Thornton, P.K., & Wollenberg, E. 2016. Reducing Risks to Food Security from Climate Change. *Global Food Security*, 11, pp. 34-43.

Council of the European Commission (CEC). 2011a. A Resource-Efficient Europe – Flagship Initiative Under the Europe 2020 Strategy, COM (2011) 571 final. European Commission: Brussels.

Council of the European Commission (CEC). 2011b. White Paper: Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System, COM (2011) 144 final. European Commission: Brussels.

Chandra, A. and Idrisova, A. 2011. Convention on Biological Diversity: A Review of National Challenges and Opportunities for Implementation. *Biodiversity Conservation*. 20(14):3295–3316. <http://dx.doi.org/10.1007/s10531-011-0141-x>

- Chepkoech, W., Mungai, N.W., Stöber, S., Bett, H.K. and Lotze Campen, H. 2018. Farmers' Perspectives: Impact of Climate Change on African Indigenous Vegetable Production in Kenya. *International Journal of Climate Change Strategies and Management*, 10(4):551–579. <https://doi.org/10.1108/IJCCSM-07-2017-0160>
- Chipangura, P. 2019. Disaster “Problem” Framing: A Constructivist Framework for Disaster Risk Policy in Zimbabwe. PhD thesis. North-West University, Potchefstroom. South Africa.
- Clarvis, M.H., Fatichi, S., Allan, A., Fuhrer, J., Stoffel, M., Romerio, F, Gaudard, L, *et al.* 2014. Governing and Managing Water Resources Under Changing Hydro-climatic Contexts: The Case of the Upper Rhone Basin. *Environmental Science Policy* 43: 56–67. <http://dx.doi.org/10.1016/j.envsci.2013.11.005> (Mountain Water Governance: Policy Implications from the EU ACQWA Project).
- Conforti, P., Ahmed, S. and Markova, G. 2018. Impact of Disasters and Crises on Agriculture and Food Security, FAO, Rome.
- Cooley, H. 2006. *Floods and Droughts*. Island Press: Washington, DC.
- Corbin, J. and Strauss, A. 2008. Strategies for Qualitative Data Analysis. Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory 3. <https://dx.doi.org/10.4135/9781452230153.n4>.
- Cousins, P.D. 2002. A Conceptual Model for Managing Long-term Inter-organisational Relationships. *European Journal of Purchasing & Supply Management*, 8(2):71-82.
- Creswell, J.W. 2007. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, (2nd ed.). Sage Publications, Inc., Thousand Oaks.
- Creswell, J.W. 2014. Research design: Qualitative, Quantitative, and Mixed Method Approaches. Thousand Oaks, CA: SAGE.
- Creswell, J.W. 2015. A Concise Introduction to Mixed Methods Research, Thousand Oaks, CA: Sage Publications.

Cubie, D. and Natoli, T. 2022. Coherence, Alignment and Integration: Understanding the Legal Relationship Between Sustainable Development, Climate Change Adaptation and Disaster Risk Reduction. In Flood, S., Columbie, YJ., Le Tisser, M. and O'Dwyer, B. (eds), *Creating Resilient Futures* (45-64). Palgrave Macmillan, Cham.

Darlington, Y. and Scott, D. 2003. Qualitative Research in Practice: Stories from the Field. *Social Work Education: The International Journal*, 22(1):115-118.

De Anda, J. and Shear, H. 2017. Potential of Vertical Hydroponic Agriculture in Mexico. *Sustainability*, (9):140. doi: 10.3390/su9010140

De Vos, A.S. 2008. Research at Grass Roots for the Social Sciences and Human Services Professions. 3rd ed. Pretoria: Van Schaik.

Department of Agriculture, Land Reform and Rural Development (DALRRD), South Africa. 2019. Drought Update; Provinces' State of Readiness for 2019/20 Planting Season. Parliamentary Monitoring Group. <https://pmg.org.za/committee-meeting/29261/>. Accessed 25 August 2021.

Department of Agriculture, Land Reform and Rural Development (DALRRD), South Africa. 2013. Agricultural Policy Action Plan (APAP), Pretoria: Government Printers.

Department of Agriculture, Land Reform and Rural Development (DALRRD), South Africa. 2013. Fetsa Tlala- Integrative Food Production Initiative (FTIFPI). Pretoria: Government Printers.

Department of Agriculture, Land Reform and Rural Development (DALRRD), South Africa. 2002. The Integrated Food Security Strategy (IFSS). Pretoria: Government Printers.

Department of Agriculture, Land Reform and Rural Development (DALRRD) South Africa. 2014. National Policy on Food and Nutrition Security (NPFNS), Pretoria: Government Printers.

Department of Corporate Governance and Traditional Affairs (CoGTA), South Africa. 2015. Disaster Management Amendment Act (DMAA) No. 16. Pretoria: Government Printers.

Department of Corporate Governance and Traditional Affairs (CoGTA), South Africa. 2005. National Disaster Management Framework (NDMF). Pretoria: Government Printers.

Department of Corporate Governance and Traditional Affairs (CoGTA), South Africa. 2002. Disaster Management Act (DMA) No. 15. Pretoria: Government Printers.

Department of Environment, Forestry and Fisheries (DEFF) South Africa. 2019. National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printers.

Department of Environment, Forestry and Fisheries (DEFF) South Africa. 2019. National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printers.

Department of Environmental Affairs (DEA) (South Africa). 2017. National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printers.

Department of Environmental Affairs (DEA), South Africa. 2017. National Climate Change Adaptation Strategy. Pretoria: Government Printers.

Department of Environmental Affairs (DEA). 2017. National Climate Change Adaptation Strategy (NCCAS), South Africa. Pretoria: Government Printers.

Department of Forestry, Fisheries and Environment (DFFE), South Africa. 2019. National Climate Change Adaptation Strategy (NCCAS), Pretoria: Government Printers.

Department of Forestry, Fisheries and the Environment (DFFE), South Africa. 2011. National Climate Change Response White Paper. Pretoria: Government Printers.

Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. 2009. Determinants of Farmers' Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia. *Global Environmental Change* 19:248–255.

Dilley, M. and Boudreau, T.E. 2001. Coming to Terms with Vulnerability: A Critique of the Food Security Definition. *Food Policy*, 26(3):229-247.

Djalante, R. and Thomalla, F. 2012. Disaster Risk Reduction and Climate Change Adaptation in Indonesia. *International Journal of Disaster Resilience in the Built Environment*, 3(2):166–180.

Du Plooy, C.P., Maboko, M.M., Van den Heever, E. and Chiloane, S. 2012. Research and Technology Transfer by the Agricultural Research Council to sustain the South African Hydroponic Industry. *Acta Horticulture*. (947):147-152.

Dunn W. 2003. Public Policy Analysis: An Introduction. Prentice Hall: Upper Saddle River, New Jersey.

EM-DAT. 2021. The OFDA/CRED International Disaster Database UCL-Brussels Belgium, Accessed 22 November 2021 from <http://www.emdat.be/naturaldisasters-trends>

Escolà, A., Badia, N., Arnó, J. and Martínez-Casasnovas, J.A. 2017. Using Sentinel-2 Images to Implement Precision Agriculture techniques in Large Arable Fields: First Results of a Case Study. *Advances in Animal Biosciences*, 8(2):377-382.
<https://doi.org/10.1017/S2040470017000784>

Escorcia, C.M.R. 2016. Disaster Risk Management and Climate Change Adaptation in Urban Contexts. Cencip.lu.se

Etikan, I., Musa, S.A. and Alkassim, R.S. 2016. Comparison of Convenience Sampling. *American Journal of Theoretical and Applied Statistics*, 5(1): 1-4.

Fan, S. 2020. Preventing Global Food Security Crisis Under COVID-19 Emergency. International Food Policy Research Institute blog Recuperado de [https://www ifpri org/blog/preventing-global-food-security-crisis-under-covid-19-emergency](https://www.ifpri.org/blog/preventing-global-food-security-crisis-under-covid-19-emergency)

Flick, U. 2014. An Introduction to Qualitative Research. 5th ed. Los Angeles, CA: Sage.

Fomunyam, K.G. 2019. Ending Hunger in Africa: The Fourth Industrial Revolution to the Rescue. *International Journal of Civil Engineering and Technology*, 10(7):228-234.

Food Agricultural Organization, International Fund for Agricultural Development, United Nations International Children's Emergency Fund, World Food Programme, and Organisation, World Health Organization. 2017. *The State of Food Security and Nutrition in the World, Building Resilience for Peace and Food Security* Rome: FAO.

<http://www.fao.org/3/i7695e/i7695e.pdf>

Food and Agriculture Organization (FAO). 2008. *Climate Change and Food Security: A Framework Document*. FAO, Rome.

Food and Agriculture Organization (FAO). 2002. *The State of Food Insecurity in the World 2001*. FAO, Rome.

Food and Agriculture Organization (FAO). 2012. *Reducing Disaster Risks to Food Security in Southern Africa: Towards Integration and Co-operation*. REOSA Policy Brief, 4. FAO Regional Disaster Risk Reduction and Management Office for Southern Africa (REOSA), Johannesburg, South Africa.

Food and Agriculture Organization (FAO). 2013. *Resilient livelihoods: Disaster risk reduction for food and nutrition security*, Emergency and Rehabilitation Division, Food and Agriculture Organization of the United Nations, Rome.

Food and Agriculture Organization (FAO). 2021. *The State of Food Security and Nutrition in the World 2021: Transforming Food Systems for Food Security, Improved Nutrition, and Affordable Healthy Diets for all*. Rome, FAO.

<https://doi.org/10.4060/cb4474en>

Food and Agriculture Organization (FAO). 2006. *Food Security: Policy Brief: Division of Food Agriculture and Developmental Economics*. <http://www.fao.org/es/esa/>

Forino, G., von Meding, J. and Brewer, G.J. 2015. A Conceptual Governance Framework for Climate Change Adaptation and Disaster Risk Reduction Integration. *International Journal of Disaster Risk Science*, 6(4):372-384.

Forster, J. and Stokke, O.S. 2013. *Policy Coherence in Development Co-operation*. Routledge, London.

- Fourie, W. 2018. Aligning South Africa's National Development Plan with the 2030 Agenda's Sustainable Development Goals: Guidelines from the Policy Coherence for Development Movement. *Sustainable Development*, 26(6):765-771.
- Fowler, A. 1991. The Role of NGOs in Changing State-society Relations: Perspectives from Eastern and Southern Africa. *Development Policy Review*, 9(1):53-84.
- Fox, N.J. 1998. Trent Focus for Research in and Development in Primary Health Care: How to use observations in a research project. NHS Executive, Trent. Sheffield.
- Fox, N.J. 2008. Post-positivism. In: Given, L. M (ed.) The SAGE Encyclopedia of Qualitative Research Methods, (2):659-664. London, Sage.
- Freidberg, S. and Goldstein, L. 2010. Alternative Food in the Global South: Reflections on a Direct Marketing Initiative in Kenya. *Journal of Rural Studies*, 27(1):24-34.
- Fryer, D. 1991. Qualitative Methods in Occupational Psychology: Reflections Upon Why They Are so Useful but so Little Used. *The Occupational Psychologist*, 14 (Special issue on qualitative methods):3-6.
- Fukasaku, K. and Hirata, A. 1995. 'The OECD and ASEAN: Changing Economic Linkages and the Challenge of Policy Coherence'. The OECD and ASEAN Economies. The challenge of Policy Coherence, Development Centre Documents. Paris: OECD:19-40.
- Gandure, S., Walker, S. and Botha, J.J. 2013. Farmers' Perceptions of Adaptation to Climate Change and Water Stress in a South African Rural Community. *Environmental Development*, (5):39e53.
- Garschagen, M., Hagenlocher, M., Kloos, J., Pardoe, J., Lanzendörfer, M., Mucke, P., Radtke, K., Rhyner, J., Walter, B., Welle, T. and Birkmann, J. 2015. World Risk Report 2015. Bündnis Entwicklung Hilft and UNU-EHS: 74.
- Gbetibouo, G.A. 2009. Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin. International Food Policy Research Institute, South Africa.

Gero, A., Méheux, K. and D Dominey-Howes, D. 2011. Integrating Disaster Risk Reduction and Climate Change Adaptation in the Pacific. *Climate and Development*, 3 (4):310-327. <https://doi.org/https://doi.org/10.5194/nhess-11-101-2011>.

Gillham, B. 2004. Case Study Research Methods. London: Continuum.

GIZ. 2017. "Synergies in Monitoring the Implementation of the Paris Agreement, the SDGs and the Sendai Framework". Accessed 5 February 2018 from <https://www.researchgate.net/publication/320858290>.

Glantz, M. 2003. Climate Affairs: A Primer. Island Press, Washington DC.

Global Forest Watch. 2021. Fire Alerts in South Africa. Accessed 25 August 2021 from <https://www.globalforestwatch.org/dashboards/country/ZAF/?burnedAreaRanked>.

Global Initiative Disaster Risk Management (GIDRM)/Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). 2019. Guidance Note: Coherence Concepts and Practices. (GIDRM/GIZ).

Government of India/UNISDR. 2016. "Asia Regional Plan for Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030" in "Report: Asian Ministerial Conference on Disaster Risk Reduction". Accessed 6 February 2018 from <https://www.unisdr.org/we/inform/events/46721>

Government of Mongolia/UNISDR. 2018. "Action Plan 2018-2020 of the Asia Regional Plan for Implementation of the Sendai Framework for Disaster Risk. GIDRM/GIZ.

Grainger-Jones, E. 2011. Climate-smart Smallholder Agriculture: What's Different? In: IFAD Occasional Paper 3.

Habiba, U., Abedin, M. A., and Shaw, R. 2016. Food Security, Climate Change Adaptation, and Disaster Risk. In Uitto, J.I and Shaw, R (eds.), *Sustainable Development and Disaster Risk Reduction* (87-101). Springer, Tokyo.

Hall, D. M. and Steiner, R. 2020. Policy Content Analysis: Qualitative Method for Analysing Sub-national Insect Pollinator Legislation. *Methods X*, 7:100787.

Hammersley, M. 2000. The Relevance of Qualitative Research. *Oxford Review of Education*, 26(3-4):393-405.

Hampwaye, G., Nel, E. and Rogerson, C.M. 2007. Urban Agriculture as Local Initiative in Lusaka, Zambia. *Environment and Planning C: Government and Policy*, 25(4):553-572.

Hart, C. 1998. *Doing A Literature Review: Releasing the Social Science Research Imagination*. Sage, London.

Hart, C. 2009. *Doing A Literature Review: Releasing the Research Imagination*. 2nd edition. Sage Publications, Thousand Oaks, CA.

Heath, A. 1976. Rational Choice and Social Exchange: A Critique of Exchange Theory. CUP Archive.

Hensengerth, O. 2018. South-South Technology Transfer: Who Benefits? A Case Study of the Chinese-built Bui Dam in Ghana. *Energy Policy* 114 (C):499–507.

Hetz, K. 2016. Contesting Adaptation Synergies: Political Realities in Reconciling Climate Change Adaptation with Urban Development in Johannesburg, South Africa. *Regional Environmental Change*, 16(4): 1171-1182.

Hickey, G. and Kipping, C. 1996. Issues in Research. A multi-stage Approach to the Coding of Data from Open-ended Questions. *Nurse Researcher*, 4: 81-91.

Hoebink, P. 2004. Evaluating Maastricht's triple C: The C of Coherence. *In The Treaty of Maastricht and Europe's Development Co-Operation*, Hoebink, P. (ed.). Aksant Academic Publishers: Amsterdam:183–218.

Hollnagel, E. 2013. An Application of the Functional Resonance Analysis Method (FRAM) to Risk Assessment of Organisational Change. Strålskyddsnämnden (SSN), Stockholm.

Hollnagel, E. 2018. *Safety-I and Safety-II: The Past and Future of Safety Management*. CRC Press.

Hollnagel, E. 2018. The Functional Resonance Analysis Method: A Brief Guide on how to use the FRAM. Accessed 08 November 2021 from, <https://functionalresonance.com/onewebmedia/Manual%20ds%201.docx.pdf>

Holloway, A., Fortune, G. and Chasi, V. 2010. Risk and Development Annual Review for the Western Cape, Disaster Mitigation for Sustainable Livelihoods Programme. South Africa, Peri Peri Publications, University of Cape Town.

Holsti, O.R. 1969. Content Analysis for the Social Sciences and Humanities, Addison-Wesley, Reading, MA.

Hoogstad, W. and Kruger, C. 2008. The Link Between Development Planning and Disaster Risk Management in Selected Municipalities. South African National Disaster Management Centre, Pretoria.

Howes, M. 2014. Disaster Risk Management and Climate Change Adaptation Revisited. *In Applied Studies in Climate Adaptation*, 1st ed.; Palutikof, J.P., Boulter, S.L., Barnett, J. and Rissik, D., (Eds). Wiley Blackwell: West Sussex, UK: 26.

Howes, M., Grant-Smith, D., Reis, K., Tangney, P., Bosomworth, K., Heazle, M., McEvoy, D. and Burton, P. 2012. The Challenge of Integrating Climate Change Adaptation and Disaster Risk Management: Lessons from Bushfire and Flood Inquiries in an Australian Context. Urban Research Program, Griffith University, Brisbane, QLD. [Working Paper].

Hsieh, H.F. and Shannon, S.E. 2005. Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, 15(9):1277–1288.
<https://doi.org/10.1177/1049732305276687>

Hussain, S.S. and Mudasser, M. 2007. Prospects for Wheat Production Under Changing Climate in Mountain Areas of Pakistan—an Econometric Analysis. *Agricultural Systems* 94:494–501.

ICSU. 2017. “Coherence Between the Sendai Framework, the SDGs, the Climate Agreement, New Urban Agenda and World Humanitarian Summit, and the role of science in their implementation”. Accessed 5 February 2018 from <https://www.icsu.org/publications/disaster-risk-reduction-policy-briefs-2017>

Immitzer, M., Vuolo, F. and Atzberger, C. 2016. First Experience with Sentinel-2 Data for Crop and Tree Species Classifications in Central Europe. *Remote Sensing*, 8(3):166.

Intergovernmental Panel for Climate Change (IPCC). 2007. Climate Change: Impacts, Adaptation and Vulnerability Summary for Policymakers. (IPCC).
https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg2_full_report.pdf

Intergovernmental Panel for Climate Change (IPCC). 2018. Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty [Masson-Delmotte, V., Zhai, P., Pörtner, H.-O. Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Ignor, M. and Waterfield, T. (eds.)]. In Press.

Intergovernmental Panel on Climate Change (IPCC). (2007). Intergovernmental Panel on Climate Change Fourth Assessment Report, Cambridge University Press, Cambridge, UK.

IPCC. 2012. Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change. [Field, C.B. *et al.*, eds.]. Cambridge, UK & New York, USA, Cambridge University Press: 582.

Ireland, P. 2010. Climate Change Adaptation and Disaster Risk Reduction: Contested Spaces and Emerging Opportunities in Development Theory and Practice. *Climate and Development* 2(4):332–345.

Israel, D.C. and Briones, R.M. 2012. Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines (No. 2012-36). PIDS Discussion Paper Series.

Jordan, A. and Lenschow, A. 2010. Environmental Policy Integration: A State of the Art Review. *Environmental Policy Governance*. 20(3):147–158.
<http://dx.doi.org/10.1002/eet.539>

- Kahsay, G.A. and Hansen, L.G. 2016. The Effect of Climate Change and Adaptation Policy on Agricultural Production in Eastern Africa. *Ecological Economics*, (121):54–64. <https://doi.org/10.1016/j.ecolecon.2015.11.016>
- Kalaba, F.K., , Quinn, C.H. and Dougill, A.J. 2014. Policy Coherence and Interplay Between Zambia's Forest, Energy, Agricultural and Climate Change Policies, and Multilateral Environmental Agreements. *International Environmental-Agreements, Politics, Law, and Economics*. 14(2):181–198. <http://dx.doi.org/10.1007/s10784-013-9236-z>.
- Kallis, G. 2008. Droughts. *Annual Review of Environment and Resources*, 33.
- Kelman, I., Mercer, J. and Gaillard, J.C. 2017. The Routledge Handbook of Disaster Risk Reduction Including Climate Change Adaptation, Routledge, New York.
- Khoza, S., Van Niekerk, D. and Nemaconde, L. 2020. Rethinking Climate-smart Agriculture Adoption for Resilience-building Among Smallholder Farmers: Gender-sensitive Adoption Framework. *African Handbook of Climate Change Adaptation*: 1-22., Springer, Potchefstroom
- Khoza, S., Van Niekerk, D. and Nemaconde, L.D. 2019. Understanding Gender Dimensions of Climate-smart Agriculture Adoption in Disaster-prone Smallholder Farming Communities in Malawi and Zambia. *Disaster Prevention Management: International Journal*, 28(5): 530–547.
- Koff, H., Challenger, A. and Portillo, I. 2020. Guidelines for Operationalizing Policy Coherence for Development (PCD) as a Methodology for the Design and Implementation of Sustainable Development Strategies. *Sustainability*, 12(10):4055.
- Kondracki, N.L. and Wellman, N.S. 2002. Content analysis: Review of Methods and their Applications in Nutrition Education. *Journal of Nutrition Education and Behavior*, 34:224-230.
- Kroll, F., Rudolph, M., Ruysenaar, S. and Dlamini, T. 2012. The State of Food Insecurity in Johannesburg. *AFSUN Food Security Series*, (12).

Kumar Panday, P. 2006. Central-local Relations, Inter-organisational Coordination and Policy Implementation in Urban Bangladesh. *Asia Pacific Journal of Public Administration*, 28(1):41-58.

Kurukulasuriya, P. and Rosenthal, S. 2003. Climate Change and Agriculture: A Review of Impacts and Adaptations, June 2003. Environment Department. World Bank, Washington, DC, USA.

Lakkireddy, K.K.R., Kasturi, K. and Sambasiva Rao, K.R.S. 2012. Role of Hydroponics and Aeroponics in Soilless Culture in Commercial Food Production. *Res. Rev. J. Agriculture. Science. Technology*. (1):26–35.

Le Blanc, D. 2015. Towards Integration at Last? The Sustainable Development Goals as a Network of Targets. *Sustainable Development*, 23(3):176–187.
<https://doi.org/10.1002/sd.1582>

Lee, H.J. 2017. The Fourth Industrial Revolution and the Future of Agriculture. Smart Farm and Shared Economy. Representatives of Korea: Science and Technology Policy Institute; 2017; 200 ed.

Leedy, P. 1993. *Practical research: Planning and design*. New York, NY: MacMillan.

Lei, Y. 2014. 'A Preliminary Discussion on the Opportunities and Challenges of Linking Climate Change Adaptation with Disaster Risk Reduction'. *Natural Hazards* 71(3):1587–1597. <https://doi.org/10.1007/s11069-013-0966-6>

Lewis, R.B. 2004. 'NVivo 2.0 and ATLAS. ti 5.0: A Comparative Review of Two Popular Qualitative Data-analysis Programs'. *Field Methods* 16(4):439–464.

Liliana, H. 2005. The Food Gaps: The Impacts of Climate Change on Food Production: A 2020 Perspective, Universal Ecological Fund, Alexandria, VA, USA.

Lipper, L., McCarthy, N., and Zilberman, D. 2018. Climate Smart Agriculture: Building Resilience to Climate Change. Springer, Berlin.

Lipper, L., Thornton, P., Campbell, B.M., Baedeker, T., Braimoh, A., Bwalya, M.P. *et al.* 2014. 'Climate-smart Agriculture for Food Security'. *Nature Climate Change* 4(12):1068–1072. <https://doi.org/10.1038/nclimate2437>

Maboko, M.M., Du Plooy, C.P. and Bertling, I. 2009. Comparative Performance of Tomato on Soilless vs. In-soil Production Systems. *Acta Horticulture*, (843):319-326.

Machi, L.A. and McEvoy, B.T. 2012. The Literature Review: Six Steps to Success. Second Edition. Thousand Oaks, CA: Corwing, A Sage Publications Company.

Madurapperuma, S.J.K., Amaratunga, D. and Haigh, R. 2021. Disasters, Climate Change and Development Nexus: Food Security Sector in Asia. In Amaratunga, D., Haigh, R. and Dias, N. (eds.), *Multi-Hazard Early Warning and Disaster Risks*. Springer, Cham: 111-126.

Makkonen, M., Huttunen, S., Primmer, E., Repo, A. and Hilden, M. 2015. Policy Coherence in Climate Change Mitigation: An Ecosystem Service Approach to Forests as Carbon Sinks and Bioenergy Sources. *Foreign Policy Economics*, 50:153–162. <http://dx.doi.org/10.1016/j.forpol.2014.09.003>.

Makridakis, S. 2017. The Forthcoming Artificial Intelligence (AI) Revolution: Its Impact on Society and Firms. *Futures*, 90:46–60.

Marshall, M.N. 1996. The Key Informant Technique. *Family Practice*, 13:92-97.

Martinez, J.I. and Jarillo, J.C. 1989. The Evolution of Research on Coordination Mechanisms in Multinational Corporations. *Journal of International Business Studies*, 20 (3):489-514.

Masipa, T.S. 2017. The Impact of Climate Change on Food Security in South Africa: Current Realities and Challenges Ahead. *Jàmbá: Journal of Disaster Risk Studies* 9(1):a411. <https://doi.org/10.4102/jamba.v9i1.411>

McCain, N. 2020. Free State Farmers Suffer 'Devastating Losses' in Runaway Fire. News24. 21 October 2020. Accessed 25 August 2021 from <https://www.news24.com/news24/southafrica/news/free-state-farmers-suffer-devastating-losses-in-runaway-fire-20201021>.

Mendelsohn, R. 2001. Global Warming and the American Economy: A Regional Assessment of Climate Change Impacts. In: Wallace, E. Oates, H. F. (Eds.), Global Warming and the American economy. New Horizons in Environmental Economics, Edward Elgar Publishing.

Mercer, J. 2010. 'Disaster Risk Reduction or Climate Change Adaptation: Are we Reinventing the Wheel?' *Journal of International Development: The Journal of the Development Studies Association* 22(2):135–141. <https://doi.org/10.1002/jid.1677>

Midgley, G.F., Chapman, R.A., Hewitson, B., Johnston, P., De Wit, M., Ziervogel, G., Mukheibir, P., Van Niekerk, L., Tadross, M., Van Wilgen, B.W. and Kgope, B. 2005. A Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-economic Effects of Climate Change in the Western Cape. CSIR Environmentek, Stellenbosch.

Moni, R.W., Hryciw, D.H., Poronnik, P. and Moni, K.B. 2007. 'Using Explicit Teaching to Improve How Bioscience Students Write to the Lay Public'. *Advances in Physiology Education* 31(2):167–175. <https://doi.org/10.1152/advan.00111.2006> Morifi, R.R., Maponya, P.I. and Van Niekerk, J.A. 2017. The Sustainability in Training Hydroponic Production to Smallholder Farmers in the Tshwane Area of Gauteng Province in South Africa. *Unpublished Manuscript*. University of the Free State, South Africa.

Morse, J.M. and Field, P.A. 1995. Qualitative Research Methods for Health Professionals. Second edition ed. Thousand Oaks, CA: Sage.

Mottaleb, K.A., Mainuddin, M. and Sonobe, T. 2020. COVID-19 Induced Economic Loss and Ensuring Food Security for Vulnerable Groups: Policy Implications from Bangladesh. *PloS one*, 15(10): e0240709.

Mpandeli, S., Nesamvuni, E. and Maponya, P. 2015. Adapting to the Impacts of Drought by Smallholder Farmers in Sekhukhune District in Limpopo Province, South Africa. *Journal of Agricultural Science*, 7(2):115.

Mukheibir, P. and Ziervogel, G. 2007. Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town. *Environment and Urbanization*, 19(1):143-158. doi:10.1177/0956247807076912

NAP Global Network. 2018. "Alignment to Advance Climate-Resilient Development. Overview Brief 1: Introduction to Alignment." (DIDRM/GIZ).

National Development Plan (2015-2030), South Africa. 2012. Pretoria, Government Printer.

National Disaster Management Centre (NDMC). 2011. Annual Report 2010-2011. NDMC, Pretoria, Government Printer.

Naudé, W. 2017. Entrepreneurship, Education, and the Fourth Industrial Revolution in Africa. *IZA Discussion Papers*, No.10855.

NDMC (National Disaster Management Centre). 2015. Annual Report 2014-2015. NDMC, Pretoria, Government Printer

NDMC (National Disaster Management Centre). 2016. Annual Report 2015-2016. NDMC, Pretoria, Government Printer

NDMC (National Disaster Management Centre). 2017. Annual Report 2016-2017. NDMC, Pretoria, Government Printer

Nemakonde, L.D., Van Niekerk, D., Becker, P. and Khoza, S. 2021. "Perceived Adverse Effects of Separating Government Institutions for Disaster Risk Reduction and Climate Change Adaptation within the Southern African Development Community Member States." *International Journal of Disaster Risk Science* 12(1):1-12.

Nemakonde, Livhuwani David and Van Niekerk, Dewald. 2017. 'A Normative Model for Integrating Organisations for Disaster Risk Reduction and Climate Change Adaptation within SADC Member States', *Disaster Prevention and Management: An International Journal*, 26: 361-76.

Nilsson, M., Wiklund, H., Finnveden, G., Lundberg, K., Tyskeng, T., Jonsson, D. and Wallgren, O. 2009. Analytical Framework and Tool Kit for SEA Follow Up. *Environmental Impact Assessment Review* 29(1):186–199.

Nilsson, M., Zamparutti, T., Petersen, J.E., Nykvist, B., Rudberg, P. and McGuinn, J. 2012. Understanding Policy Coherence: Analytical Framework and Examples of Sector–Environment Policy Interactions in the EU. *Environmental Policy and Governance*, 22(6):395-423. <https://doi.org/10.1002/eet.1589>

Nuttall, D. 2005. Coherence and Consistency. In *International Relations and the European Union*, Hill C. and Smith, M. (Eds.). Oxford University Press: Oxford.

Oberthür, S. and Gehring T. 2006. Institutional Interaction in Global Environmental Governance: Synergy and Conflict among International and EU Policies. MIT Press: Cambridge.

O'Brien, G., O'keefe, P., Rose, J. and Wisner, B. 2006. Climate Change and Disaster Management. *Disasters*, 30(1):64-80.

ODI. 2016. “Resilience’ Across the post-2015 Frameworks: Towards Coherence?” Accessed 5 February 2018 from <https://www.odi.org/publications/10598-resilience-across-post-2015-frameworks-towards-coherence>.

Olawuyi, D.S. 2018. From Technology Transfer to Technology Absorption: Addressing Climate Technology Gaps in Africa. *Journal of Energy & Natural Resources Law*, 36(1):61–84.

Olsen, G.R. 2008. Coherence, Consistency and Political Will in Foreign Policy: The European Union's Policy Towards Africa. *Perspectives on European Politics and Society*, 9(2):157–171. <https://doi.org/10.1080/15705850801999644>

Organisation for Economic Co-operation and Development (OECD). 2002. Improving Policy Coherence and Integration for Sustainable Development: A Checklist. OECD: Paris.

Organisation for Economic Cooperation and Development (OECD). 2012. Policy Framework for Policy Coherence for Development. In Working Paper no 1, 2012: OECD. Paris.

Organisation for Economic Co-operation and Development (OECD). 2015. Better Policies for Development 2015: Policy Coherence and Green Growth. OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264236813-en>

Organisation for Economic Co-operation and Development (OECD). 2016. Better Policies for Sustainable Development: A New Framework for Policy Coherence. Paris, France: OECD.

Organisation for Economic Co-operation and Development (OECD). 2018. Policy Coherence for Sustainable Development: Towards Sustainable and Resilient Societies. Paris: OECD.

Organisation for Economic Co-operation and Development (OECD). 2019. OECD Recommendation on Policy Coherence for Sustainable Development; OECD: Paris.

Orsini, F., Kahane, R., Nono-Womdim, R., and Gianquinto, G. 2013. Urban Agriculture in the Developing World: A Review. *Agron. Sustainable Development*, (33):695–720.

Overseas Development Institute (ODI). 2016. Resilience Across the Post-2015 Frameworks: Towards Coherence? Accessed 5 February 2021 from <https://www.odi.org/publications/10598-resilience-across-post-2015-frameworks-towards-coherence>

Pasquini, L., Cowling, R.M. and Ziervogel, G. 2013. Facing the Heat: Barriers to Mainstreaming Climate Change Adaptation in Local Government in the Western Cape Province, South Africa. *Habitat International*, (40): 225-232.

Patriarca, R. and Bergström, J. 2017. Modelling Complexity in Everyday Operations: Functional Resonance in Maritime Mooring at Quay. *Cognition, Technology & Work*, 19(4):711-729.

Pelling, M. and Holloway, A. 2006. Legislation for Mainstreaming Disaster Risk Reduction. Tearfund, Middlesex.

Pereira, L. and Drimie, S. 2016. Governance Arrangements for the Future Food System: Addressing Complexity in South Africa. *Environment: Science and Policy for Sustainable Development*, 58(4):18–31.

Peters, K., Bahadur, A., Tanner, T. and Langston, L. 2016. 'Resilience' Across the Post-2015 Frameworks: Towards Coherence? Overseas Development Institute.

Pintér, L., Hardi, P.M. and André, H.J. 2012. Bellagio STAMP: Principles for Sustainability Assessment and Measurement. *Ecology Indicators*, 17: 20–28.
<http://dx.doi.org/10.1016/j.ecolind.2011.07.001> (indicators of environmental sustainability: from concept to applications)

Pradhan, A., Chan, C., Roul, P.K., Halbrendt, J. and Sipes, B. 2018. Potential of Conservation Agriculture (CA) for Climate Change Adaptation and Food Security Under Rain Fed Uplands of India: A Transdisciplinary Approach. *Agricultural Systems*, 163:27-35.

Randolph, J.J. 2009. A Guide to Writing the Dissertation Literature Review. *Practical Assessment, Research & Evaluation*, 14(13).

Rani, W.N.M.W.M., Kamarudin, K.H., Razak, K.A. and Asmawi, Z.M. 2020. 'Climate Change Adaptation and Disaster Risk Reduction in Urban Development Plans for Resilient Cities', in IOP Conference Series: *Earth and Environmental Science*, 409(1):012024.

Richie, S.M. and Rigano, D.C. 2001. Evaluation Positivism against Interpretivism: Post Positivist Approaches to Research.

Ringler, C. 2007. The Impact of Climate Variability and Climate Change on Water and Food Outcomes: A framework for Analysis, in C. van Bers, D. Petry and C. Pahl-Wostl, eds., *Global assessments: Bridging Scales and Linking to Policy*, GWSP Issues in Global Water System Research No. 2, http://www.gwsp.org/downloads/gwsp_issues_no2.pdf.

Rivera, C. and Wamsler, C. 2014. Integrating Climate Change Adaptation, Disaster Risk Reduction and Urban Planning: A Review of Nicaraguan Policies and Regulations. *International Journal of Disaster Risk Reduction*, 7:78-90.

Rosa-Rodriguez, R.D.L., Lara-Herrera, A., Trejo-Tellez, L.I., Padilla-Bernal, L.E., Solis-Sanchez, L.O. and Ortiz-Rodriguez, J.M. 2020. Water and Fertilisers Use Efficiency in Two Hydroponic Systems for Tomato Production. *Horticultura Brasileira*, (38):47-52.

Roteta Otaegui, E., Bastarrika Iriarte, A., Padilla, M., Storm, T. and Chuvieco, E. 2019. Development of a Sentinel-2 Burned Area Algorithm: Generation of a Small Fire Database for Sub-Saharan Africa. *Remote Sensing of Environment*, 222:1-17.

Roudier, P., Sultan, B., Quirion, P. and Berg, A. 2011. The Impact of Future Climate Change on West African Crop Yields: What Does the Recent Literature Say? *Global Environmental Change*, 21(3):1073–1083.
<https://doi.org/10.1016/j.gloenvcha.2011.04.007>

Ruel, M. 2013. 'Food Security and Nutrition: Linkages and Complementarities', in M. Eggersdorfer, K. Kraemer, M. van Ameringen, H.K. Biesalski, M. Bloem, J. Chen, *et al.* (eds.), *The Road to Good Nutrition*: 24–38, Karger Publishers.

Ruyter, K. and Scholl, N. 1998. Positioning Qualitative Market Research: Reflections from Theory and Practice. *International Journal of Qualitative Market Research*, 1:7-14.

Ryan, A.B. 2006. Post-Positivist Approaches to Research. *In: Researching and Writing your Thesis: A Guide for Postgraduate Students. MACE: Maynooth Adult and Community Education*:12-26.

Saunders, M., Lewis, P. and Thornhill, A. 2009. *Research Methods for Business Students (9th ed)*. London: Prentice Hall.

Schipper, L. and Pelling, M. 2006. Disaster Risk, Climate Change and International Development: Scopes for, and Challenges to, Integration. *Disasters* 30(1):19–38.

Schratz, M. and Walker, R. 1995. *Research as Social Change*, London: Routledge.

Schwab, K. 2015. The Fourth Industrial Revolution: What it Means and How to Respond. Accessed from <http://www.foreignaffairs.com/articles/2015-12-12/fourth-industrialrevolution>

Scobie, M. 2016. Policy Coherence in Climate Governance in Caribbean Small Island Developing States. *Environmental Science & Policy*, 58:16-28.

Scott, J. 2000. Rational Choice Theory. *Understanding Contemporary Society: Theories of the Present*, 129:671-685.

Seidler, R., Dietrich, K., Schweizer, S., Bawa, K.S., Chopde, S., Zaman, F., Sharma, A., Bhattacharya, S., Devkota, L.P, and Khaling, S. 2018. Progress on Integrating Climate Change Adaptation and Disaster Risk Reduction for Sustainable Development Pathways in South Asia: Evidence from Six Research Projects. *International Journal of Disaster Risk Reduction*, 31:92-101.

Senyolo, M.P., Long, T.B., Blok, V. and Omta, O. 2018. How the Characteristics of Innovations Impact their Adoption: An Exploration of Climate-smart Agricultural Innovations in South Africa. *Journal of Cleaner Production*, (172):3825-3840.

Sianes, A. 2017. Shedding Light on Policy Coherence for Development: A Conceptual Framework. *Journal of International Development*, 29(1):134–146.
<https://doi.org/10.1002/jid.2977>

Singh, N. 2020. Fire's Trail of Destruction. *The Witness*. 15 September 2020. Accessed 25 August 2021 from <https://www.news24.com/witness/news/fires-trail-of-destruction-20200914>.

Smit, B. 2002. Atlas. ti for Qualitative Data Analysis. *South African Journal of Psychology*, 20(3):65-76.

Smit, B. and Skinner, M.W. 2002. Adaptation Options in Agriculture to Climate Change: A Typology. *Mitigation, Adaptation, Strategies Global Change* 7:85–114.

Smith, J.B. and Lenhart, S.S. 1996. Climate Change Adaptation Policy Options. *Climate Resilience*, 6:193–201.

Strydom, H. and Delport, C.S.L. 2011. Sampling and Pilot Study in Qualitative Research. *Research at Grass Roots: for the Social Sciences and Human Service Professions*, 4:390-396.

Terry, G., Hayfield, N., Clarke, V. and Braun, V. 2017. 'Chapter 2: Thematic Analysis', in C. Willig and W.S. Rogers (eds.), *The Sage Handbook of Qualitative Research in Psychology*: 17–37, Sage, London.

Tesch, R. 1990. *Qualitative Research: Analysis Types and Software Tools*. Bristol: Falmer.

Thamaga-Chitja, J.M. and Morojele, P. 2014. The Context of Smallholder Farming in South Africa: Towards a Livelihood Asset Building Framework, *Journal of Human Ecology*, 45(2):147-155. DOI: 10.1080/09709274.2014.11906688

The Africa Competitiveness Report. 2017. Addressing Africa's Demographic Dividend. The World Economic Forum with the Support of the International Bank for Reconstruction and Development/ the World Bank and the African Development Bank.
www.weforum.org/acr.

The Fourth Industrial Revolution and Agriculture. 2016. Rep. of Korea: Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry; 2016.

Thomalla, F., Downing, T., Spanger-Springfield, E., Han, G. and Rockstrom J. 2006. Reducing Hazard Vulnerability: Towards a Common Approach Between Disaster Risk Reduction and Climate Adaptation. *Disasters* 30(1):39–48.

Thomas, G, Botha, R.A. and Van Greunen, D. 2015. Understanding the Problem of Coordination in a Large Scale Distributed Environment from a Service Lens View—Towards the South African Public Sector e-Administration Criteria for Coordination Support. *Government Information Quarterly*, 32(4):526-538.

Thow, A.M., Greenberg, S., Hara, M., Friel, S. and Sanders, D. 2018. Improving Policy Coherence for Food Security and Nutrition in South Africa: A Qualitative Policy Analysis. *Food Security*, 10(4):1105-1130.

Tirivangasi, H.M. 2018. 'Regional Disaster Risk Management Strategies for Food Security: Probing Southern African Development Community Channels for Influencing National Policy'. *Jàmbá: Journal of Disaster Risk Studies* 10(1):1–7.

Turnbull, M., Sterrett, C. and Hilleboe, A. 2013. Toward Resilience: A Guide to Disaster Risk Reduction and Climate Change Adaptation, Practical Action Publishing, Warwickshire.

Ueltzhoffer, J. and Ascheberg, C. 1999. Transnational Consumer Cultures and Social Milieus. *Journal of the Marketing Research Society*, 41(1):47-59.

UN Climate Change Secretariat. 2017. "Opportunities and options for integrating climate change adaptation with the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction 2015–2030." Accessed 5 February 2018 from <http://tep-a.org/technical-paper/>.

UN General Assembly. 2008. International Cooperation on Humanitarian Assistance in the Field of Natural Disasters, from Relief to Development (Report of the Secretary-General. No. A/62/323. New York, 2007); United Nations Economic and Social Council, 2008. (ECOSOC/6345, Background Release, 27 June 2008).

UNDP. 2017. "Resilient: Zero-Carbon, Risk-Informed, Sustainable. UNDP's Work in Climate Change, Disaster Risk Reduction, and Energy, 2015-2017". Reduction 2015-2030". Accessed 10 November 2018 from <https://www.unisdr.org/conference/2018/amcdrr>.

United Nations (UN). 2015. Sustainable Development Goals (SDGs) Goal No.2. UN. Accessed: 21 February 2021. <https://sdgs.un.org/goals/goal2>.

United Nations Framework Convention on Climate Change (UNFCCC). 2017. *Human Health and Adaptation: Understanding Climate Impacts on Health and Opportunities for Action*. UNFCCC Secretariat (Bonn: UNFCCC).

United Nations Framework Convention on Climate Change (UNFCCC). 2015. Paris Agreement on Climate Change. Accessed 7 February 2021 from http://unfccc.int/paris_agreement/items/9485.php.

United Nations International Strategy for Disaster Reduction (UNISDR). 2009. "Adaptation to Climate Change by Reducing Disaster Risk: Country Practices and Lessons", Briefing Note 2, United Nations, Geneva.

United Nations International Strategy for Disaster Reduction (UNISDR). 2009. UNISDR Terminology on Disaster Risk Reduction. UNISDR. Accessed: 21 February 2021 from https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf.

United Nations International Strategy for Disaster Reduction (UNISDR). 2017. "Coherence Between the Sendai Framework, the 2030 Agenda for Sustainable Development and Climate Change." Global Platform for Disaster Risk Reduction, 22-26 May 2017, Cancun. Accessed 5 February 2018 from <https://www.unisdr.org/conferences/2017/globalplatform/en/programme/plenaries/view/582>.

United Nations International Strategy for Disaster Reduction (UNISDR). 2015. Sendai Framework for Disaster Risk Reduction. Accessed 7 February 2021 from <https://www.unisdr.org/we/coordinate/sendai-framework>

United Nations (UN). 2016. Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology Relating to Disaster Risk Reduction". Seventy-first Session, Agenda item 19 ©. UN: Geneva

Van Niekerk, D. 2005. A Comprehensive Framework for Multi-sphere Disaster Risk Reduction in South Africa. PhD-Thesis, North West University. Potchefstroom.

Van Niekerk, D. 2006. Disaster Risk Management in South Africa: The Function and the Activity Towards an Integrated Approach. *Politeia*, 25(2): 96-116.

Van Zyl, K. 2013. *Disaster Management, Mitigation and Adaptation to the Right to Food and Food Security: food Security and Disasters in South Africa for Centuries*. Agri SA (South Africa).

Venton, P. and La Trobe, S. 2008. Linking Climate Change Adaptation and Disaster Risk Reduction, Tearfund: 19. United Kingdom

Visser, R. and Van Niekerk, D. 2009. A Funding Model for Disaster Risk Management Functions of Municipalities. NDMC (National Disaster Management Centre/African Centre for Disaster Studies). Accessed 3 August 2017 from <http://www.ndmc.gov.za/Documents/CapacityBuildingandResearch/tabid/263/ctl/ViewDocument/mid/630/ItemID/65/Default.aspx>.

Vogels, M.F., De Jong, S.M., Sterk, G., Douma, H. and Addink, E.A. 2019. Spatio-temporal Patterns of Smallholder Irrigated Agriculture in the Horn of Africa Using GEOBIA and Sentinel-2 imagery. *Remote Sensing*, 11(2):143.

- Vollgraaff, R. 2020. South Africa Extends Drought State of Disaster by a Month. *Bloomberg Green: Climate Adaptation*(Issue). [bloomberg.com/news/articles/2020-June](https://www.bloomberg.com/news/articles/2020-June).
- Vuolo, F., Neuwirth, M., Immitzer, M., Atzberger, C. and Ng, W.T. 2018. How Much Does Multi-temporal Sentinel-2 Data Improve Crop Type Classification? *International Journal of Applied Earth Observation and Geoinformation*, (72):122-130.
- Winter, K. 2018. Crisis Proofing South Africa's Water Security. *The Conversation*.
- White, W., Lunnan, A., Nybakk, E. and Kulisic, B. 2013. The Role of Governments in Renewable Energy: The Importance of Policy Consistency. *Biomass and Bioenergy*, (57):97-105.
- Wolcott, H.F. 1990. Making a Study "More Ethnographic". *Journal of Contemporary Ethnography*, 19(1):44-72.
- World Bank Group. 2016. World Development Report: Digital Dividend. Washington, DC. The World Bank.2016. Accessed 25 January 2020.
- World Economic Forum. 2017. The Future of Jobs and Skills in Africa Preparing the Region for the Fourth Industrial Revolution. Doha: World Economic Forum. www3.weforum.org/doc/WEF_EGW_FOJ_Africa.pdf.
- Zembe, A., Nema-konde, L.D. and Chipangura, P. 2022. Policy Coherence Between Food Security, Disaster Risk Reduction and Climate Change Adaptation in South Africa: A Summative Content Analysis Approach. *Jàmbá: Journal of Disaster Risk Studies*, 14(1): 1-11
- Zwane, E.M. 2019. Impact of Climate Change on Primary Agriculture, Water Sources and Food Security in Western Cape, South Africa. *Jàmbá: Journal of Disaster Risk Studies*, 11(1):1-7.

APPENDIX A: LETTERS OF PERMISSION FROM ALL THE CO-AUTHORS INVOLVED
IN THE RESEARCH TO USE THE ARTICLES IN THE THESIS



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22 March 2022

TO WHOM IT MAY CONCERN

This letter serves to grant permission for Ms, **Annegrace Zembe** as the first author to use the articles listed hereunder in her thesis titled. I would like to stress that all these articles have been compiled by Ms. Zembe under my supervision and that her contribution has been more than 60% on each article. The articles that should be included are:

1. **Annegrace Zembe, Livhuwani David NemaKonde, Paul Chipangura, 2022.** Policy coherence between food security, disaster risk reduction, and climate change adaptation in South Africa: A summative content analysis approach. *Jamba: Journal for Disaster Risk Studies*, 14 (1), a1173. <https://doi.org/10.4102/jamba.v14i1.1173> (Published)
2. **Annegrace Zembe, Livhuwani David NemaKonde, Paul Chipangura, 2021.** Institutional mechanism for policy coherence between climate change adaptation, disaster risk reduction and food security in South Africa and beyond. *Submitted to the International Journal of Agricultural Governance and Ecology. (Under Review).*
3. **Annegrace Zembe, Livhuwani David NemaKonde, Paul Chipangura, 2022.** Using technology to bring coherence between climate change adaptation and disaster risk reduction for food security in South Africa. *To be submitted to the International Journal of Agricultural Sustainability*
4. **Annegrace Zembe, Livhuwani David NemaKonde, Paul Chipangura, 2022.** A policy coherence framework for food security, climate change adaptation and disaster risk reduction in South Africa. *To be submitted to Disaster Management and Prevention International*

Kind regards

LIVHUWANI NEMAKONDE
Prof NemaKonde LD



**National University of
Science and Technology**

Think in Other Terms



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TO WHOM IT MAY CONCERN

This letter serves to grant permission for Ms, Annegrace Zembe as the first author to use the articles listed hereunder in her thesis titled. I would like to stress that all these articles have been compiled by Ms. Zembe under my supervision and that her contribution has been more than 60% on each article. The articles that should be included are:

1. Annegrace Zembe, Livhuwani David NemaKonde, Paul Chipangura, 2022. Policy coherence between food security, disaster risk reduction, and climate change adaptation in South Africa: A summative content analysis approach. *Jamba' Journal for Disaster Risk Studies*, 14 (1), a1173. <https://doi.org/10.4102/jamba.v14i1.1173> (Published)
2. Annegrace Zembe, Livhuwani David NemaKonde, Paul Chipangura, 2021. Institutional mechanism for policy coherence between climate change adaptation, disaster risk reduction and food security in South Africa and beyond. *Submitted to the International Journal of Agricultural Governance and Ecology. (Under Review)*.
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4. Annegrace Zembe, Livhuwani David NemaKonde, Paul Chipangura, 2022. A policy coherence framework for food security, climate change adaptation and disaster risk reduction in South Africa. *To be submitted to Disaster Management and Prevention International*

Kind regards

Dr. Paul Chipangura

APPENDIX B: LANGUAGE EDITOR'S LETTER



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TO WHOM IT MAY CONCERN

This serves to confirm that I have edited and proofread the document entitled

**A framework for policy coherence between food security, climate change
adaptation and disaster risk reduction in South Africa**

prepared by Ms A Zembe in accordance with the requirements for the degree of Doctor of Philosophy in Science with Disaster Risk Science at the North-West University, according to the specifications of the University, where available, and the latest standards for language editing and technical (computer-based) layout.

Editing was restricted to language usage and spelling, consistency, formatting and the style of referencing. No structural writing of any content was undertaken. The editing excluded Chapter 3 – Article 1, which has already been published.

As an editor I am not responsible for detecting any content that may constitute plagiarism.

To the best of my knowledge all references have been provided in the prescribed format.

I am not accountable for any changes made to this thesis by the author or any other party after the date of my edit.

(Electronically signed – actual signature withheld for security reasons)

MONICA BOTHA

22 March 2022

Sole Proprietor: Monica Botha

*Business Planning Corporate Systems Engineering Corporate Document Standards
Business and Academic Document Technical and Language Editing*

APPENDIX C: RESEARCH ETHICS CLEARANCE



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ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Faculty of Natural and Agricultural Sciences Ethics Committee (FNAS-REC)**, the Faculty of Natural and Agricultural Sciences Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCRE) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: A framework for policy coherence between food security, climate change adaptation and disaster risk reduction in South Africa			
Study Leader/Supervisor: Prof LD Nemaikonde			
Student: A Zembe			
Ethics number:	N	W	U
	-	0	1
	3	8	6
	-	2	0
	-	A	9
	Institution	Study Number	Year
	Status		
Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation			
Application type: Single	Risk Category: Minimal		
Commencement date: 01/02/2020			
Expiry date: 07/10/2022			
Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.			

Special in process conditions of the research for approval (if applicable):

- The following documentation are archived by FNASREC and should be complete and kept up to date:
 - Research proposal
 - Signed approval from the scientific committee indicating the proposed risk category
- All researchers involved in the study should submit signed NWU code of conduct statements annually.
- All researchers of low risk studies should submit proof of relevant ethics training every two years.
- All researchers that take part in activities that pose a safety and security threat to the researchers or the environment should submit a risk assessment form annually.
- All research involving human interaction should follow best ethical practise and keep documents as proof. This includes informed consent, questionnaires, incorporation of risk-benefit, and responsible data management.
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the FNASREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The study leader/supervisor (principle investigator)/researcher must report in the prescribed format to the FNASREC:*
 - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
 - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the FNASREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility, the NWU-SCRE and FNASREC reserves the right to:*
 - *request access to any information or data at any time during the course or after completion of the study;*
 - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
 - *withdraw or postpone approval if:*
 - * *any unethical principles or practices of the study are revealed or suspected;*
 - * *it becomes apparent that any relevant information was withheld from the FNASREC or that information has been false or misrepresented;*
 - * *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
 - * *new institutional rules, national legislation or international conventions deem it.*
- *FNAS-REC can be contacted for further information or any report templates via Roelof.Burger@nwu.ac.za 018 299 4269*

The FNASREC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the FNASREC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely,



Prof Roelof Burger
Chairperson Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC)

APPENDIX D: CONSENT FORM

A FRAMEWORK FOR POLICY COHERENCE BETWEEN FOOD SECURITY, DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION IN SOUTH AFRICA

INFORMATION SHEET AND CONSENT FORM

Who I am?

Hello, my name is Annegrace Zembe. I am a PhD student from North West University (Potchestroom Campus) in the Unit of Environmental Sciences and Management, faculty of Natural and Agricultural sciences.

What am I doing?

I am conducting a research study titled: **A framework for policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa**. South Africa is exposed to multiple and compound repeating disasters and climate risks which is preventing communities from fully recovering and achieving food security. Policy coherence between climate change adaptation (CCA) and disaster risk reduction (DRR) would constitute a crucial step in reducing the impacts of natural and climate disasters on food security and reducing disasters and climate change risks by improving food security. Prominent policies that addresses food security, DRR and CCA in South Africa will be assessed to see if a legal and policy foundation exist that promotes policy coherence among them. Semi-structured interviews will be used to assess the current levels of coherence with relevant policy makers, academia and research institutes in South Africa.

Your participation

I have contacted you because you are an environmental science and management expert involved in decision making and policy making at national level. I am asking you whether you will allow me to have a discussion with you about your knowledge and opinions on current practices in addressing coherence between food security, disaster risk reduction and climate change adaptation in South Africa. If you agree, I will ask you to participate in one interview for approximately one and half hours.

I am also asking you to give me permission to audio record the interview. I audio record interviews so that I can accurately record what is said. Please understand that only me the researcher will have access to the audio recordings. You do not have to agree to be recorded in order to participate in the study. The audio recordings will be used for research purposes only. The audio recordings will not include your name or any other information that could link you to them. The recordings will be stored in a password-protected computer

linked with a code and not your name. The audio tapes will be destroyed 10 years after publication of study result.

Please understand that **your participation is voluntary**, and you are not being forced to take part in this study. The choice of whether to participate or not, is yours alone. If you choose not to take part, you will not be affected or penalised in any way whatsoever. If you agree to participate, you may stop participating in the research at any time and tell me that you do not want to continue. Your participation is very important because the more people participate the more useful the findings will be.

Confidentiality

Any study records that identify you will be kept confidential to the extent possible by law. The records from your participation may be reviewed by people responsible for making sure that research is done properly, including members of the ethics committee at the North West University. At present time, I do not see any risks in your participation. When it comes to answering the question, there is no right or wrong answers. If I ask you a question which makes you sad or upset, we can stop and talk about it a little.

Benefits

There are no immediate benefits to you from participating in this study. However, this study will be helpful to you in implementing the climate change adaptation strategy that you are currently working on. If you would like to receive feedback on my study, you may request a copy of the final copy of my final report when it gets released.

Your contribution to this study is highly valuable and I thank you for your time.

CONSENT

I hereby agree to participate in a discussion related to the project A framework for policy coherence between food security, disaster risk reduction and climate change adaptation. I understand that my interview will be audio-taped. I understand that only the researcher will have access to this tape. I also understand that I can stop participating at any point should I not want to continue, and that this decision will not in any way affect me negatively.

I understand that this is a project whose purpose is not necessarily to benefit me personally in the immediate or short term.

I understand that my participation will remain confidential.

.....

Date

Signature of participant

APPENDIX E: JOURNAL REQUIREMENTS AND AUTHOR GUIDELINES

Chapter 3: Article 1

A Summative Content Analysis for Policy Coherence between FS, CCA and DRR

(Published in JÀMBÁ – Journal of Disaster Risk Studies)

Original Research Article full structure

Title: The article's full title should contain a maximum of 95 characters (including spaces).

Abstract: The abstract, written in English, should be no longer than 250 words and must be written in the past tense. The abstract should give a succinct account of the objectives, methods, results and significance of the matter. The unstructured abstract for an Original Research article should consist of five paragraphs unlabelled Background, Objectives, Method, Results and Conclusion.

Background: Why do we care about the problem? State the context and purpose of the study. (What practical, scientific or theoretical gap is your research filling?)

Objectives: What problem are you trying to solve? What is the scope of your work (e.g. is it a generalised approach or for a specific situation)? Be careful not to use too much jargon.

Method: How did you go about solving or making progress on the problem? State how the study was performed and which statistical tests were used. (What did you actually do to get the results?) Clearly express the basic design of the study; name or briefly describe the basic methodology used without going into excessive detail. Be sure to indicate the key techniques used.

Results: What is the answer? Present the main findings (that is, as a result of completing the procedure or study, state what you have learnt, invented or created). Identify trends, relative change or differences on answers to questions.

Conclusion: What are the implications of your answer? Briefly summarise any potential implications. (What are the larger implications of your findings, especially for the problem or gap identified in your motivation?)

Do not cite references and do not use abbreviations excessively in the abstract.

Introduction: The introduction must contain your argument for the social and scientific value of the study, as well as the aim and objectives:

Social value: The first part of the introduction should make a clear and logical argument for the importance or relevance of the study. Your argument should be supported by use of evidence from the literature.

Scientific value: The second part of the introduction should make a clear and logical argument for the originality of the study. This should include a summary of what is already known about the

research question or specific topic, and should clarify the knowledge gap that this study will address. Your argument should be supported by use of evidence from the literature.

Conceptual framework: In some research articles it will also be important to describe the underlying theoretical basis for the research and how these theories are linked together in a conceptual framework. The theoretical evidence used to construct the conceptual framework should be referenced from the literature.

Aim and objectives: The introduction should conclude with a clear summary of the aim and objectives of this study.

Research methods and design: This must address the following:

Study design: An outline of the type of study design.

Setting: A description of the setting for the study; for example, the type of community from which the participants came or the nature of the health system and services in which the study is conducted.

Study population and sampling strategy: Describe the study population and any inclusion or exclusion criteria. Describe the intended sample size and your sample size calculation or justification. Describe the sampling strategy used. Describe in practical terms how this was implemented.

Intervention (if appropriate): If there were intervention and comparison groups, describe the intervention in detail and what happened to the comparison groups.

Data collection: Define the data collection tools that were used and their validity. Describe in practical terms how data were collected and any key issues involved, e.g. language barriers.

Data analysis: Describe how data were captured, checked and cleaned. Describe the analysis process, for example, the statistical tests used or steps followed in qualitative data analysis.

Ethical considerations: Approval must have been obtained for all studies from the author's institution or other relevant ethics committee and the institution's name and permit numbers should be stated here.

Results: Present the results of your study in a logical sequence that addresses the aim and objectives of your study. Use tables and figures as required to present your findings. Use quotations as required to establish your interpretation of qualitative data. All units should conform to the SI convention and be abbreviated accordingly. Metric units and their international symbols are used throughout, as is the decimal point (not the decimal comma).

Discussion: The discussion section should address the following four elements:

Key findings: Summarise the key findings without reiterating details of the results.

Discussion of key findings: Explain how the key findings relate to previous research or to existing knowledge, practice or policy.

Strengths and limitations: Describe the strengths and limitations of your methods and what the reader should take into account when interpreting your results.

Implications or recommendations: State the implications of your study or recommendations for future research (questions that remain unanswered), policy or practice. Make sure that the recommendations flow directly from your findings.

Conclusion: Provide a brief conclusion that summarises the results and their meaning or significance in relation to each objective of the study.

Acknowledgements: Those who contributed to the work but do not meet our authorship criteria should be listed in the Acknowledgments with a description of the contribution. Authors are responsible for ensuring that anyone named in the Acknowledgments agrees to be named. Refer to the acknowledgement structure guide on our Formatting Requirements page.

Also provide the following, each under their own heading:

Competing interests: This section should list specific competing interests associated with any of the authors. If authors declare that no competing interests exist, the article will include a statement to this effect: The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article. Read our policy on competing interests.

Author contributions: All authors must meet the criteria for authorship as outlined in the authorship policy and author contribution statement policies.

Funding: Provide information on funding if relevant

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Chapter 4: Article 2

Institutional Mechanisms for Coherence

(Accepted to be published in International Journal of Agricultural Resources, Governance and Ecology)

From Inderscience, publishers of the International Journal of Agricultural Resources, Governance and Ecology

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[Conference papers](#)

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[Figures](#)

[Units of measurement](#)

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references and notes

tables, figure captions and figures

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- Use any relevant keywords to improve the findability of your paper in online search engines and indexes.
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Full reference should include all authors' names and initials, date of publication, title of article, title of publication (*italics*), volume and issue number (of a journal), publisher and form (books, conference proceedings) and page numbers.

Find [examples of how to reference materials here \(PDF\)](#).

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The names of mathematical functions may change in translation - check against an English or American mathematical reference text.

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Chapter 5: Article 3

Practical Examples, Experiences and Tools Used to bring Coherence to FS, CCA and DRR Policies in South Africa

To be submitted to International Journal of Agricultural Sustainability

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Chapter 6: Article 4

Coherence Framework for Food Security, Climate Change Adaptation and Disaster Risk Reduction

– *Submitted to International Journal of Environment and Sustainable Development.*

From Inderscience, publishers of the International Journal of Agricultural Resources, Governance and Ecology

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Article preparation

Conference papers

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References and notes

Figures

Units of measurement

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Additional guidance

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APPENDIX F: INTERVIEW GUIDE

SEMI-STRUCTURED INTERVIEW GUIDE: PHD STUDY

Study title: A framework for policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa

Introduction

The researcher is a student at the University of Northwest (Potchefstroom campus) and currently pursuing studies for PhD in Environmental Sciences and Management with Disaster Risk Sciences. I am developing a framework for policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa. South Africa is exposed to multiple and compound frequently repeating disasters and climate risks which is preventing communities from fully recovering and achieving food security. Due to previous experiences with droughts, floods, poverty and livelihood insecurity and other extreme events, the South African government established institutional mechanisms at national, regional, and local level to respond to such events. These include disaster risk reduction (DRR), climate change adaptation (CCA) and food security institutions. These institutions had to operate within the existing international and regional frameworks which encourage for coherence among the three policies for best practices. This paper argues that policy coherence between CCA and DRR would constitute a crucial step in reducing the impacts of natural and climate disasters on food security and reducing disasters and climate change risks by improving food security. To assess the policy coherence status between these policy areas, a systems approach will be conducted using the qualitative research design. Prominent policies that address food security, DRR and CCA in South Africa will be assessed to see if a legal and policy foundation exist that promotes policy coherence among them. Semi-structured interviews would be used to assess the current levels of coherence with relevant policy makers. Kindly take note that the information obtained will be used only for research purposes and no names or any identifying data regarding the participant will be revealed. Participation is voluntary. Your co-operation and assistance are greatly appreciated.

Section A: Personal and Institutional Details

Name of organisation			
Name of respondent, gender, and age			
Designation of respondent			
Years of experience			
Contact details			

Section B: Interview questions

a) A policy coherence framework for food security, climate change adaptation and disaster risk reduction in South Africa.

1. What are your views on the importance of DRR and CCA to make sure that there is food security in South Africa?

2. What do you understand by these terms in the South African context?

a) Policy coherence,

b) Climate change adaptation,

c) Disaster risk reduction, and

d) Food security

3. What mechanisms are in place to ensure policy coherence between food security, CCA & DRR in South Africa? How are policy objectives understood?

4. What are the benefits/challenges of policy coherence from policy formulation to implementation between CCA & DRR to achieve and maintain food security in South Africa?

5. Is there coherence between these international policies (Paris Agreement, Sendai Framework, SDGs specifically goal no 2 for food security)? Are they promoting coherence between food security, CCA, DRR at national level or they are causing disintegration?

6. What kind of institutional arrangements do you have at national level that ensure and govern coherence between CCA/DRR and food security? Is there a policy or legislative framework that guides these arrangements? Who/which institutional arrangement/policy area do you think should be the driver for coherence between these policy areas (CCA, DRR, and food security)?

7. Which strategies or principles do you follow to make sure there is coherence in policies, specifically for DRR, CCA and food security? Are they effective, evidence-based to produce better policies?

8. To what extent do you ensure the following during policy formulation?

- a) Transparency
- b) Accountability
- c) Advocacy
- d) Inclusiveness

9. How do you make sure that your policies/ policy objectives/strategies and plans are not conflicting with other related policies- to minimise incoherencies between (FS, CCA, and DRR).

10. How do you ensure political commitment when making policies or giving directions for implementation strategy?

11. Which stakeholders are involved when developing or reviewing your policies to ensure coherence? How do you make sure everyone is consulted?

12. How do you resolve potential conflicts and address inconsistencies between policies and politics behind policy decisions?

13. What systems are available for monitoring and evaluation for policy coherence between food security, CCA, and DRR for reporting back to parliament/ congress and the public?

14. In your view, how can these three policies (FS, DRR/CCA) be integrated? What should be the characteristics or key priority areas of a coherent framework in South Africa?

b) Policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa: A summative content analysis approach

1. How does the content (text) in FS, CCA and DRR policies and legislations interlink? Explain clarifying the following nexus:

i) FS – DRR

ii) FS – CCA

iii) DRR – CCA

2. To what extent does FS, CCA and DRR policies and legislations content promote policy coherence? Answer using the following nexus.

i) FS – DRR

ii) FS – CCA

iii) DRR – CCA

3. What are the possible challenges and opportunities for not/ or using explicit content to promote coherence between FS, CCA and DRR. Clarify the answer using the following:

i) FS – DRR

ii) FS – CCA

iii) DRR – CCA

c) Institutional mechanism for policy coherence between climate change adaptation, disaster risk reduction and food security in South Africa.

- 1) What are the food security disaster response management systems that you use during disasters?
- 2) Do you have established institutional arrangements that you use to coordinate FS, CCA, and DRR institutions when responding to disasters?
- 3) Does your institution have disaster management plans and contingency plans in place that collaborate with FS, CCA and DRR institutions for effective disaster response?
- 4) What challenges or opportunities do you face when detecting, mapping, and interpreting early warning systems (EWS) within your organisation?
- 5) What challenges or opportunities do you face during dissemination and management of EWS?
- 6) How does your institution invest in research and capacity building with reference to bringing FS, CCA and DRR information together?
- 7) What are CCA, DRR and FS measures within your organisation that you use to enhance food security resilience in South Africa?

d) Coherence of climate change adaptation and disaster risk reduction for food security: Practical examples, approaches, experiences, and tools

1. What measures/ or projects are being put in place by the government, private sectors, or research entities to reduce, respond or prevent the risk of climate related hazards on food security in South Africa?

2. Department of Agriculture-Western Cape, Fourth Industrial Revolution: Sentinel-2 Earth observation technology to enhance sustainable farming

- a) What is Sentinel-2 Earth observation technology? Discuss the history behind it?
- b) How does it work in the South African context?
- c) How does it address food security in the face of climate change and disasters?
- d) To what extent has the project been successful/ failure in improving food security in the Western Cape Province? Would you recommend it to be used by the rest of South Africa?

- e) Describe the challenges the Sentinel-2 is facing in the South African context including the aspect of affordability?
- f) How accessible is the information stored by the technology to the public, farmers, research entities and interested parties?
- g) What mechanisms in terms of policies, are in place to support this technology? How effective are they in improving food security?
- h) Tell us about your experience with this technology in relation to food security in your province?
- i) What is your opinion concerning the following projects?
The Johannesburg Inner City Partnership: The Urban Agriculture Initiative (UAI)
- j) Final recommendations or any additional suggestions you may have related to the development of a framework that fosters policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa

3. The Johannesburg Inner City Partnership: The Urban Agriculture Initiative (UAI)

- a) What measures/ or projects are being put in place by the government, private sectors, or research entities to reduce, respond or prevent the risk of climate related hazards on food security in South Africa?
- b) Can you give a brief background of your project and its relation to food security in South Africa?
- c) How eco-friendly is your project as it is close to people's workplace and residential places?
- d) How does your project address food security in the face of natural and climate hazards?
- e) To what extent has the UIA successful/failure in improving food security Johannesburg? Would you recommend it for the whole of South Africa?
- f) Would you recommend it in rural areas where there is much food insecurity? How would they go about it?
- g) How are you managing your waste products to ensure a safe environment?
- h) What challenges are you facing to achieve the food security goal? Include the costs.

- i) Describe your overall experience in this project and give some lessons learnt.
- j) What is your opinion concerning the following projects: Department of Agriculture- Western Cape, Fourth Industrial Revolution: Sentinel-2 Earth observation technology to enhance sustainable farming)?
- k) Final recommendations or any additional suggestions you may have related to the development of a framework that fosters policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa

Final recommendations or any additional suggestions you may have related to the development of a framework that fosters policy coherence between food security, disaster risk reduction and climate change adaptation in South Africa

Thank you all for your support and cooperation!!!