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MAFIKENG CAMPUS

EFFECTIVENESS OF THE STRATEGIC ENVIRONMENTAL ASSESSMENT PROCESS IN BOTSWANA

Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in Environmental Science

by

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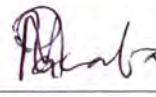
Promoter: PROF. C. MUNYATI

May 2014

SOLEMN DECLARATION

I, Lebogang Peggy Makaba, declare that this thesis which I hereby submit to the North West University as completion of the requirements set for the Doctor of Philosophy (PhD) degree in Environmental Science is my own work and has not already been submitted to any university. Further, I declare that I have duly acknowledged all my sources of information.

SIGNED: 

Lebogang Peggy Makaba

DATE: 19/09/2014

DEDICATION

I dedicate this work to my mother, Mrs Mavis Makaba, who is my pillar of strength.

ACKNOWLEDGEMENTS

I would like to express my appreciation to the Northwest University for the sponsorship that made this work possible. Sincere gratitude also goes to my promoter, Prof. C. Munyati, for his advice, encouragement and sustained commitment to this piece of work. I will always remember you for your understanding, patience and mentorship.

Special thanks also go to the Metsimotlhabe River community and the community leaders for their guidance and the assistance provided during field work. Special thanks to the village chief, the headmen, and the VDC. The Government of Botswana, through the Department of Environmental Affairs, is also duly acknowledged for giving permission for the researcher to conduct this research.

It would also have been impossible to complete this study without the support of my family. I thank especially my mother Mrs Mavis Makaba for her encouragement, and my children Warona and Angel, for their understanding.

Finally, I thank the Almighty God who strengthens and directs at all times and remains worthy of all the praise and glory.

ABSTRACT

There is a need for effective management of the natural resources and environment in developing countries because such countries have a high dependence on their natural resources and environment. Botswana is a developing country in southern Africa, with environmental problems arising from the pursuit for development. Strategic Environmental Assessment (SEA) is an emerging tool that can help towards the attainment of sustainable development. SEA has comparative advantages over its predecessor Environmental Impact Assessment (EIA). Although it is new and not well understood, SEA is well established in some developed countries.

In Botswana, the SEA process has been borrowed from neighbouring South Africa and has twelve procedural steps. This research assessed the effectiveness of SEA in Botswana by examining sources of ineffectiveness in the process. Sand mining on Metsimotlhabe River on the outskirts of Gaborone, Botswana, was used as case study. Sand mining on Metsimotlhabe River has been a long standing source of environmental problems that is known to the environmental authorities in the country. The activity was put through all the SEA stages as implemented in Botswana. Long-term hydrological data analysis, Remote Sensing and GIS analysis, and impact identification tools helped identify negative environmental impacts upon which sustainability proposals that were subsequently made were based. Public participation in the process was achieved through interviews with government officials, focus group discussions and questionnaire administration at Metsimotlhabe village. There were indications from analysis of data that the extraction of sand from the river exceeded the Maximum Sustainable Yield.

Major sources of ineffectiveness in the SEA process that were identified included limitations in the baseline environmental data stage upon which the rest of the SEA process relies. The result is errors that are passed on down the process. The assessments are also handled by consultants, with the possibility that the process would end up being result driven for financial gain instead of being objective about environmental considerations. Taking decisions on developmental activities in favour of socio-economic benefits at the expense of environmental well being was also identified as a source of ineffectiveness. The study determined that there is an adequate institutional framework for the SEA process in Botswana. However, a centralised agency to administer SEA and other environmental assessments is proposed, for purposes of streamlining and coordinating environmental assessment processes in the country given that the Department of Environmental Affairs (DEA) is overstretched. This agency would also remove the role of consultants in environmental assessments in the country, to make the SEA process more effective.

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LIST OF ACRONYMS

CIA	Cumulative Impact Assessment
CSO	Central Statistics Office
DEA	Department of Environmental Affairs
DFRR	Department of Forestry and Range Resources
DOM	Department of Mines
DOT	Department of Tourism
DWMPC	Department of Waste Management and Pollution Control
DWA	Department of Water Affairs
DWNP	Department of Wildlife and National Parks
EAD	Energy Affairs Department
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GDP	Gross Domestic Product
GIS	Geographic Information System
GNP	Gross National Product
IUCN	International Union for the Conservation of Nature
MEWT	Ministry of Environment, Wildlife and Tourism
NGO	Non-Government Organisation
PPP	Plan, Policy and Programme
SADC	Southern African Development Community
SIA	Social Impact Assessment
SEA	Strategic Environmental Assessment
SPOT	*Systemé Pour l'Observation de la Terre*
UN	United Nations
UNEP	United Nations Environment Programme
VDC	Village Development Committee

Chapter One

INTRODUCTION

1.0 Background

In the 1960's the widespread recognition that major environmental problems were created by government action led to legislation that considers environmental consequences, which led to Environmental Impact Assessment (EIA) legislation (Momtaz, 2002). Environmental assessment processes thereafter became vital components of the development process. Environmental assessment processes generally aim to ensure that developments are not detrimental to the environment. This is very crucial for all economies, especially developing countries whose livelihoods are dependent primarily on economic activities that directly exploit the environment (agriculture, tourism and mining). Botswana, which is a developing country, fits in this scenario. Figure 1.1 shows the country's location in southern Africa.

The livelihoods and well being of developing countries are, therefore, directly related to the way they manage their natural resources. Environmental management is, therefore, crucial for the sustenance and well being of the local communities and economies of developing countries (Retief *et al.*, 2008). This was pointed out by the UN Rio Declaration of 1992. In the case of Botswana, mining contributes the highest to the country's GDP, seconded by tourism (CSO, 2008). Mining is a sector with potentially the highest environmental impact, yet it contributes more to export earnings than any other sector (Rotting *et al.*, 2009). Diamond is the highest revenue earner in Botswana (Department of Mines, 2011). Other mining activities in Botswana include mining of base metals such as copper, nickel and matte production, gold, soda ash and salt. These mining activities are crucial to the economy and receive due attention and monitoring by authorities. The mining of crushed stone, gravel, clay, river sand and pit sand has, however, not attracted a lot of attention from the authorities and hence becomes a threat to the environment. This is worsened by the fact that the country is very vulnerable to degradation due to the semi arid nature. There is, therefore, a need to rigorously assess the effectiveness of existing environmental conservation processes and policies, and to develop new approaches to environmental management, to ensure that vital economic activities, small scale and large scale, can be carried out in a manner that does not permanently damage the fragile environment (Rotting *et al.*, 2009). This study contributes to this required assessment, with focus on Strategic Environmental Assessment.

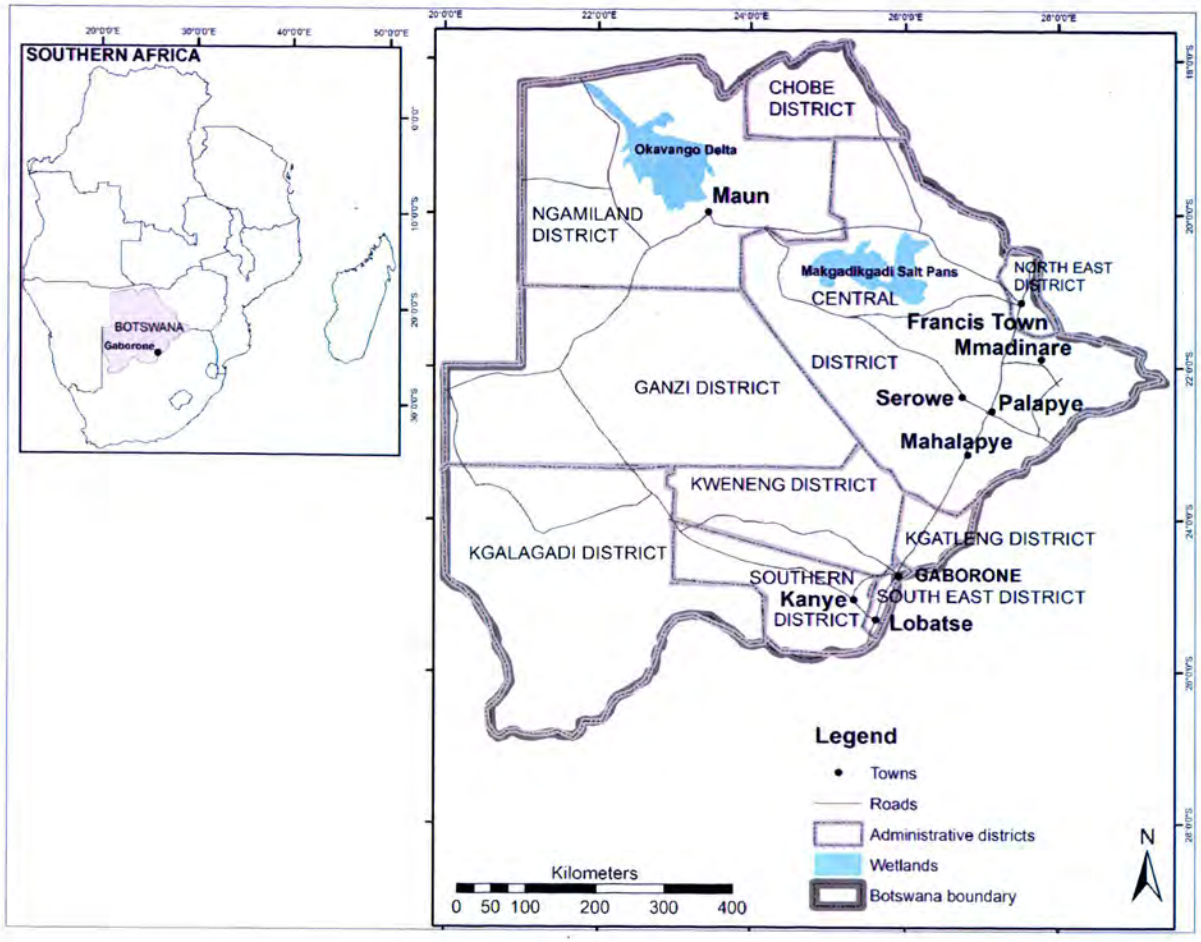


Figure 1.1 Location map and general features of Botswana.

1.1 Defining Strategic Environmental Assessment (SEA)

There are various definitions of SEA, all of which indicate that it is a diverse concept that presents a 'family of tools' and 'umbrella concepts' with multiple possible forms (Verheem and Tonk, 2000). The definitions, however, indicate that SEA is about consideration of the environment at the earliest stage of decision making.

Although no commonly accepted international definition has emerged (Retief *et al.*, 2008), SEA can be defined as 'a systematic process for evaluating the environmental consequences of proposed policy, plan or program initiatives in order to ensure they are fully included and appropriately addressed at the earliest appropriate stage of decision making on par with economic and social considerations' (Sadler and Verheem, 1996; Von Seht, 1999). SEA, therefore, entails the proactive assessment of alternatives to proposed or existing plans, policies and programmes. In the context of a broader vision, SEA consists of a set of goals or

objectives to assess the likely outcomes of various means to an end, to select the best alternatives to reach the desired ends (Noble, 2009).

SEA has become a current day approach to development and has been expanding internationally since the 1990's. Its consequent adoption has gained momentum in recent years (Chaker *et al.*, 2006). It is intended to complement other environment assessment tools such as Environmental Impact Assessment (EIA - which is firmly established in the planning process in many developing countries), Social Impact Analysis (SIA), Cumulative Impact Analysis (CIA), and Sustainability Assessments (SA).

1.2 The evolution of SEA

SEA evolved as an effort to 'front load' environmental assessment into policy formulation (Glasson, 1995) hence complementing EIA which is at project level. Despite the existence of good EIA guidelines and legislation, environmental degradation has continued to be a major concern in developing countries. When studying the limitations of project EIA, researchers called for something other than project level EIA. The researchers realised the need for environmental assessment of policy, plan and program as a way of encompassing environmental considerations (Alshuwaikhat, 2005). SEA, therefore, emerged as a supporting tool for development. It is not a substitute of EIA but rather an 'up-front supplement' that can ensure long term benefits to the environment as it allows sustainable principles to 'trickle down' from policies and plans to individual development projects within a particular programme (Therivel and Partidario, 1996). SEA is, therefore, currently perceived as 'a second generation paradigm moving EIA principles upstream in decision making process' (Chaker *et al.*, 2006). It is acknowledged to be an important decision support tool.

1.3 Benefits of SEA

SEA intends to ensure that project proposals are set within a policy framework that has already been subject to environmental scrutiny, and assists the decision making process by influencing the design of more sustainable policies and strategies (Therivel and Partidario, 1996). Therefore, the incorporation of SEA would result in more sound and environmentally sensitive policies and plans that incorporate the necessary requirements for the subsequent

environmental project. The main task of SEA is to program and provide with prevention and mitigation measure (Zhu *et al.*, 2011). The Organization for Economic Cooperation and Development (OECD) states that when applied as part of development policy and plan making, SEA offers a systematic process to avoid or minimize adverse impacts on the environment (OECD, 2006). OECD lists additional benefits of SEA as follows (OECD, 2006):

i. It provides environmental evidence to support more informed decision making; hence SEA enables environmentally sensitive decisions.
ii. It identifies new opportunities by encouraging a systematic and thorough examination of development options.
iii. Preventing of costly mistakes, by alerting decision makers to potentially unsustainable development options at an early stage in the decision making process.
iv. Building public engagement in decision making for improved governance: SEA makes policy reforms more effective by reflecting the views, the values, options and knowledge of the public.
v. Facilitating trans-boundary co-operation: SEA provides an important arena for regional cooperation, e.g. addressing difficult issues concerning shared water resources.
vi. Safeguarding environmental assets for sustainable development and poverty reduction: SEA enhances the prospects of safeguarding the environment and natural systems that are critical foundations for human life and livelihood.

Retief *et al.* (2008) consider SEA as critically important within developing country contexts for two main reasons, firstly because developing countries rely primarily on economic activities such as agriculture, tourism and mining; secondly, sound environmental management is crucial in developing countries for both the global biodiversity conservation perspective and the wider well being of the biodiversity, because of the ecosystem service which makes them be labeled as 'biodiversity hotspots'. Further, the majority of the pristine environments are located within the developing countries (Retief *et al.*, 2008). However, there are only limited numbers of SEA systems in developing countries from which lessons of implementation can be learned (Alshuwaikhat, 2005). This study contributes to reducing this gap by enhancing the SEA system for Botswana.

It is worthwhile to note that in the SEA approach we need to deal with greater complexity and uncertainty. The need to incorporate the strategy at high level decision-making makes the strategy to be of medium or long term horizon (beyond 5 years). Furthermore, the practitioners need to assess the impacts at large spatial scales; and that the impacts relate to complex systems such as urban systems, energy systems and transport systems (Zhu *et al.*, 2011).

1.4 Problem statement

Water is a scarce resource in Botswana in general. The scarcity is evidently due to the semi arid climate which is characterized by low unreliable rainfall, recurrent drought and high rates of evapotranspiration (Masundire *et al.*, 1998). The environment is, therefore, very vulnerable to degradation due to the aridity. Mining river sand results in negative impacts on the country's meager water resources through impacts on sand bed aquifers.

The greater Gaborone area located along the eastern margin of Botswana (in the South East administrative district; Figure 1.1), is the most highly populated urban centre in the country and the fastest growing (Majelantle, 2011). The city threatens the already vulnerable semi arid environment with its dense population that has continued to expand rapidly over time. The Department of Mines (2011) indicates that Gaborone accounts for 30% of national domestic water use, and the report predicts that the consumption is expected to increase significantly due to rapid urbanization (up to 40% by 2020). The growth of the city definitely impacts negatively on the neighbouring rivers due to the resultant high demand for river sand to meet the escalating construction demands for the crucial and rapid infrastructural development of the city. Strategic Environmental Assessment procedures, therefore, should become a viable option for planning the development processes.

Though SEA is well established and standard globally as well as in the SADC region, it is unclear to what extent it can accommodate differences in institutional and environmental settings of a given economic activity. It is, therefore, worthwhile to investigate the extent to which SEA adequately addresses the low capacity for, and absence of, regulatory infrastructure for meaningful environmental mainstreaming which is recurrent in underdeveloped countries like Botswana.

There is a need to explore whether the established SEA processes do address all environmental components, especially in the arid and undeveloped context like Botswana. River sand mining around Gaborone area, which is crucial for the infrastructural development of the city, was utilized as case study. However, if not carefully managed, the sand mining may be a threat to the vulnerable semi arid environment.

1.5 Research aim

The aim of this study was to examine the effectiveness of the SEA process in Botswana, then identify gaps and weaknesses, and propose mitigating measures, using river sand mining as a case study.

1.6 Specific objectives

The specific objectives of the study were:

1. To evaluate the existing status of SEA as applicable to Botswana.
2. To examine the existing institutional framework for SEA in Botswana.
3. To formulate approaches that are required to make SEA more effective in Botswana, based on gaps and weaknesses identified in the process.

1.7 Research questions

The study addressed the following questions:

1. How is the development project implementation process in Botswana regulated in the existing legislation pertaining to SEA?
2. Is there an adequate and effective institutional framework for SEA in Botswana?
3. What methodological approaches are necessary to make SEA more effective?

1.8 Research hypothesis

The research hypothesis was that there are procedural gaps in the Strategic Environmental Assessment process as implemented in Botswana in terms of addressing the environment holistically, resulting in the process not adequately conserving the environment.

1.9 Justification for the study

Though SEA seems to be advanced and very relevant to modern day ideology of development, environmental degradation and loss of biodiversity are still on the increase. Environmental degradation due to economic activity continues to be a pertinent issue in Botswana. The research therefore, intended to identify the gaps and weaknesses in the SEA procedures, and then propose a much more holistic approach to make SEA more effective towards achieving sustainable development in Botswana. It was envisaged that the results from the research would make SEA more effective in biodiversity conservation in Botswana and similar underdeveloped countries. According to Sadler and Verheem (1996), there is consensus that SEA needs to be developed and refined within the particular context. This study, therefore, intends to provide such a framework for Botswana especially because little analytical and methodological guidance is given in the literature. The lack of methodological guidance for SEA is presently a barrier to the implementation (Nilsson *et al.*, 2003). This research will help to break this barrier for Botswana.

1.10 Sand mining in Botswana

Sand mining in Botswana is regulated by the Department of Mines under the Ministry of Minerals, Energy and Water Resources, which is responsible for granting permission to mine sand. In the eastern part of Botswana (of which Gaborone is part), construction sand is excavated from nearby rivers. Sand mining is a commercial activity (Department of Mines, 2011). In the western parts of the country (e.g. Kgalagadi and Ganzi Districts; Figure 1.1) is a sandveldt covered by Aeolian deposits where sand is abundant and, therefore, sand mining is not a commercial activity. The sand in the western parts is not actually mined, but rather just collected where it has been gathered by the wind.

Though the Department of Mines issues sand mining licenses, many people mine sand illegally probably because the penalties are too low to deter culprits from illegal sand mining (Department of Mines, 2011). The spread of illegal mining of sand has made it difficult for the Department of Mines to effectively control the mining of river sand. The poor control has led to changes in river flow patterns, dongas and pits that have led to deaths due to drowning. Conflicts between the riverside communities and the contractors have become a norm in the vicinity of Gaborone, therefore calling for attention.

1.11 Institutional Framework for environmental management in Botswana

The Department of Environmental Affairs (DEA) of the Government of Botswana is mandated with environmental coordination, conservation and protection (Department of Environmental Affairs, 2013). Therefore, DEA is the overarching institution for environmental management in Botswana. Located in the Ministry of Environment, Wildlife and Tourism (MEWT), the department is one of a number of government departments whose jurisdiction has a bearing on environmental management in Botswana (Figure 1.2). The environmental management related roles of these respective government departments are as follows (Botswana Government, 2014):

- *Department of Environmental Affairs (DEA)* – is mandated with overall environmental coordination, conservation and protection. Its mission is "to ensure protection of the environment and conservation of natural resources by formulating, coordinating and monitoring the implementation of national environmental policies, programmes and legislation". The department oversees a number of environmental legislations, for example the Environmental Impact Assessment Act No. 6 of 2005.
- *Department of Waste Management and Pollution Control (DWMPC)* – has the mission "to ensure a clean and safe environment through provision and enforcement of legislation and policy for the benefit of the nation".
- *Department of Wildlife and National Parks (DWNP)* – has the mission to "effectively conserve the fish and wildlife of Botswana in consultation with local, regional and international stakeholders for the benefit of present and future generations". The department issues Tour Guide and Hunters licenses subject to the terms and conditions of Section 43 of the Wildlife Conservation and National Parks Act, 1992.

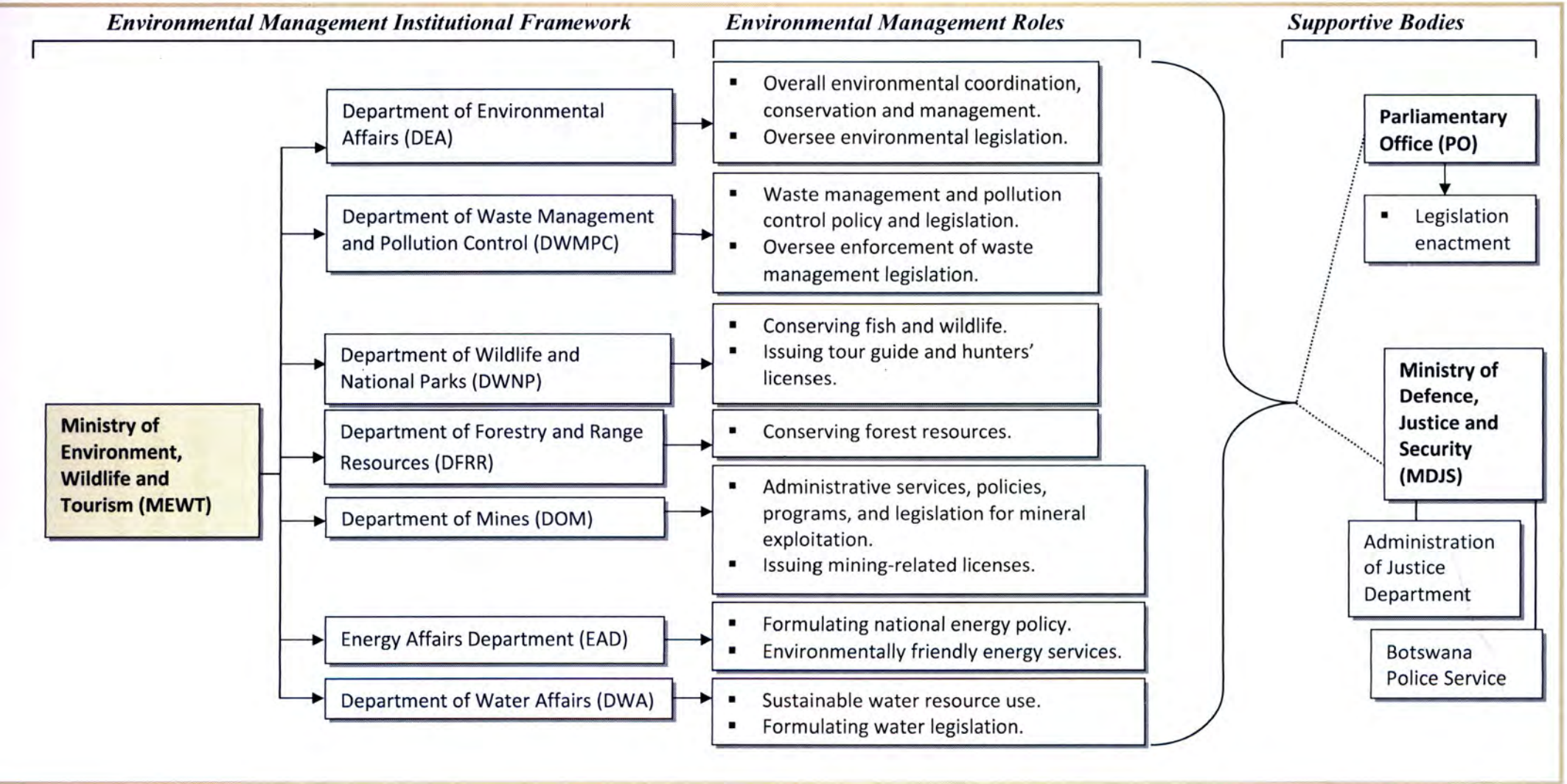


Figure 1.2 Schematic summary of the environmental management institutional framework in Botswana (SOURCE: summarised using material from Botswana Government, 2014).

- *Department of Forestry and Range Resources (DFRR)* – has the mandate to "conserve, protect and sustainably manage the country's forest and rangeland resources". DFRR issues permits and licenses to individuals and groups who are interested in harvesting or dealing in veldt products and their derivatives as a regulatory measure.
- *Department of Mines (DOM)* – has the mission to "provide reliable, effective and efficient administrative services, policies, programs and legislation for mineral exploitation, prevent mining occupational diseases, injuries, and minimise degradation of the environment". The department issues a number of licenses, including mining licenses, blasting licenses, and semi-precious stones licenses.
- *Energy Affairs Department (EAD)* – is responsible for "the formulation, direction and coordination of the national energy policy; with the overall policy goal for the energy sector being to provide affordable, environmentally friendly and sustainable energy services in order to promote social and economic development."
- *Department of Water Affairs (DWA)* – has the mission "to plan, assess, develop and protect Botswana's water resources for sustainable contribution to socio-economic growth; the department administers the water law and other related legislations, and liaises with the riparian users of national and international rivers on the saving, conservation and protection of water resources."

The environmental management related activities of the government department in Figure 1.2 are supported by the Parliamentary Office (PO) through the passing of legislation, and two departments in the Ministry of Defence, Justice and Security, namely Administration of Justice (AOJ), which is mandated with the "administration of justice to ensure equal justice for all", and Botswana Police Service, whose mandate in accordance with The Botswana Police Act, Cap 21:01 section 6 (1) includes to "*...apprehend offenders, bring offenders to justice, duly enforce all written laws...*". Additional environmental management support is feasible through the Ministry of Local Government's local authorities that are divided into Town, City and District Councils as well as the District and Tribal Administrations.

1.12 Definitions of Terms

The following terms will be taken to have the following meanings throughout the thesis:

- The **Environment** can be defined as the sum total of air, water, plants and land, including the interrelationships among themselves and also with the human beings, other living organisms and property (Jain *et al.*, 2012). Implicit in this definition is that the built environment, being part of human property, is part of the environment.

- An **environmental impact** is the resultant change in environmental parameters in space and time, compared with what would have happened had the stimulus (e.g. a project) not occurred (Glasson *et al.*, 2013).

- **Sustainability**, from the economist point of view, can be defined as sustained economic development without compromising the existing resources for future generations (Gatto, 1995).

- **Monitoring** in the environmental assessment context is the recording of outcomes associated with a development project, policy or programme, after a decision to proceed (Glasson *et al.*, 2013). Therefore, it is the process of obtaining regular measurements about an environmental variable for purposes of detecting a change in its status.

- **Auditing** in the environmental assessment context is the process of comparing actual outcomes with predicted outcomes from a development project, policy or programme and can be used to assess the quality of the predictions or the effectiveness of mitigation (Glasson *et al.*, 2013). Therefore, auditing involves determining whether environmental parameters change in the way that was predicted prior to a stimulus such as a project, policy or programme.

- **Remote Sensing** is the science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object area or phenomenon (Lillesand *et al.*, 2008).

- A **Geographic Information System** (GIS) is a system of hardware, software, data, people, organizations and institutional arrangements, for collecting, storing, analysing and disseminating information about areas of the earth (Chrisman, 2002).

- **Flora** is the plant life occurring in a particular region or time, particularly the naturally occurring or indigenous native plant life, including microscopic plants like algae (Odum and Barrett, 2004). Some definitions of flora include the seed bank (Major and Pyott, 1966).

- **Fauna** are all of the animal life of any particular region or time, including microscopic animals (Odum and Barrett, 2004).

1.13 Structure of the thesis

The thesis consists of six chapters, whose contents are summarised as follows:

- Chapter one introduces the study in its broad context, then introduces SEA and outlines its evolution and importance. The research problem is then presented and the study justified. Then the objectives of the study are stated and the institutional framework for environmental management in Botswana is outlined.
- Chapter two summarises material from literature on SEA and its predecessor EIA. Example projects in Botswana that have undergone EIA and SEA are summarised as illustration.
- Chapters three and four detail the SEA that was undertaken by this study - sand mining on Metsimotlhabe River. Chapter three presents the scoping (i.e. 'scope') and methods of the SEA in the case study, and Chapter four gives the results.
- Chapter five proposes ways in which the SEA process in Botswana can be strengthened, based on the results from the SEA case study presented in Chapters three and four.
- Chapter six gives the conclusions emerging from the study, and suggested avenues of future research related to the topic tackled by this study.

Chapter Two

LITERATURE REVIEW

2.0 Introduction

This chapter summarises material from literature concerning SEA and EIA. The process of SEA and its importance are then presented. Implementation of SEA in different countries is discussed, grouped as developed and developing country context. A description of the implementation of SEA in Botswana concludes this chapter.

2.1 Environmental Impact Assessment: A precursor to SEA

Environmental Impact Assessment (EIA) is the process of assessing the consequences that are likely to flow from a proposed development (Momtaz, 2002). It is "a process and technique used to predict the environmental consequences of human development activities and to plan appropriate measures to eliminate or reduce adverse effects" (Department of Environmental Affairs, 2009). This planning and management tool intends to identify the type, magnitude and probability of environmental and social changes that may occur as direct or indirect results of a project or policy, and to design possible mitigation procedures. (Vanclay and Bronstein, 1995; Harvey, 1998). EIA, therefore, seeks to prevent environmental harm before it occurs (Coskun and Turker, 2011).

EIA appears to have originated in the United States of America. Momtaz (2002) states, "The legislative basis for EIA is the Environmental Policy Act of 1969, which resulted from a widespread recognition in the United States that some major environmental problems were created by government action. The legislation required that all federal agencies would consider the environmental consequences of their actions". EIA legislation was, therefore, developed as a management tool for environmental impacts resulting from development activities. Since its introduction and subsequent recommendation by the Rio Principle 17, EIA is widely practiced worldwide. It is currently very well established in many developing countries as part of legislation and is recognized as a main environmental protection tool.

Alshuwaikhat (2005) indicates that though EIA is firmly established and practiced in many developing countries, environmental degradation has continued to be a major concern in

these countries. The main limitations of project level EIA are due to the relatively late stage at which EIA is applied and they include (Alshuwaikhat, 2005):

i. EIA reacts to development proposal rather than anticipate them, hence cannot drive development away from sensitive areas.
ii. EIA does not adequately consider cumulative impacts.
iii. Small individual activities are often harmless, but their impact can be significant, EIA cannot address these.
iv. EIA is often carried out in short periods because of financial constraints and timing of planning application.
v. It is often difficult to evaluate indirect environmental impacts.

Alshuwaikhat (2005) further reveals that EIA has failed in developing countries due to insufficient staffing, experience and monitoring. Its failure is also due to evaluation inadequacies, lack of enough baseline data and lack of implementation capacity. Sometimes, adoption of environmental considerations is done as a political decision without public involvement and clear perceptions of environmental assessment by government agencies. Lack of implementation capacity and ability to conduct a proper EIA and to implement mitigation measures are identified as the biggest constraints of EIA. Project level EIA has not been able to provide 'environmental sustainability assurance' for these countries (Sadler and Verheem, 1996).The failure and inherent limitations of EIA led to the consideration of Strategic Environmental Assessment (Alshuwaikhat, 2005; Bond and Pope, 2012; Ness *et al.*, 2007).

2.2 SEA: Importance and process

Strategic Environmental Assessment (SEA) is a newer environmental assessment tool compared to EIA (Runhaar and Driessen, 2007). It is recognized as an important decision support tool for integrating environmental considerations along with social and economic considerations into proposed policies, plans and program (Chaker *et al.*, 2006). SEA emerged as a structural proactive process to strengthen the role of environmental issues at decision making level through assessment of environmental plans, policies and programs. It is intended to complement other environmental assessment tools. Unlike EIA, SEA considers environmental issues at very early stages of a project before irreversible decisions are made

(Chaker *et al.*, 2006). It focuses on improving decision making on the quality of the final plan, program or policy and strives towards decision making that will achieve sustainable development. This is one of the main arguments in favour of SEA over EIA, that by assessing the effects at an early stage of decision-making (at the level of policies, plans, and programmes), SEA can influence choices that have to be taken for granted in the case of traditional, project-based EIA (Runhaar and Driessen, 2007). In addition, SEA allows for assessing cumulative impacts of projects and is considered as a tool to improve the efficiency of environmental assessment (EA), as it could reduce the number and complexity of project EIAs (Runhaar and Driessen, 2007).

Being rather new, SEA appears to be misunderstood. According to Sanchez *et al.* (2008), SEA is an all encompassing idea that admits multiple interpretations. Partidario (2000) recognises the misunderstanding of SEA, describing it as 'enriching debate and critically confusing minds'. This confusion is confirmed by Noble (2009) whose review of SEA systems and practices in Canada reveals a diverse system that is 'founded on a range of principles and frameworks and not well understood', yet it has been going on in Canada for a number of years. In order to provide the basis for common understanding, international principles were proposed with the view that the principles will provide the basis for a common approach (Noble, 2009).

The importance of SEA has been emphasized in the international arena. The endorsement of international legal documents, being the European SEA Directive (2001/42/EC), and the United Nations Economic Commission for Europe (UNECE) 2003 SEA Protocol, played a vital role in re-emphasizing the importance of SEA (Chaker *et al.*, 2006; Retief *et al.*, 2008). Further, international financing institutions require beneficiary countries to adopt and potentially mainstream SEA into their planning and decision making process. These become main drivers for SEA (Chaker *et al.*, 2006; Retief *et al.*, 2008). Sometimes this results in the adoption of environmental considerations simply as a political decision without public participation or clear perception of environmental assessment (Alshuwaikhat, 2005). It is for this reason that SEA is often implemented in developing countries without adequate understanding, eventually leading to ineffectiveness as environmental consideration does not come in as priority, but rather a condition for acquiring funds (Alshuwaikhat, 2005). Nilsson *et al.* (2005) state that SEA presents a framework within which a range of different analytical tools and methods can be applied, resulting in great uncertainties regarding appropriate

methods for SEA. It is diverse and provides a family of tools and umbrella concepts with multiple forms (Verheem and Tonk, 2000). Since SEA is diverse, it suffers from the technical problems such as the formulation of predictive techniques and methods (Alshuwaikhat, 2005). This diversity also raises the need for each country to have an SEA approach suited to its own political, socio economic and environmental conditions. This places the current research into context in that it examines SEA as applicable to the context of Botswana.

The general template of the SEA process as suggested by Nilsson *et al.* (2005) is that SEA includes the following steps:

- *Step 1* - ***Scoping*:** deals with what to include in SEA. It considers the temporal and spatial boundaries, institutional context and decision scope.
- *Step 2* - ***Situation assessment*:** provides a baseline for determining environmental concerns, challenges and opportunities in the affected sectors or areas.
- *Step 3* - ***Alternatives***: at this stage decision alternatives are generated for analysis in close consultation with decision makers.
- *Step 4* - ***Environmental analysis***: this involves identification and analysis of environmental pressures and impacts of the various alternatives.
- *Step 5* - ***Valuation*:** makes a transparent and deliberate weighing of impact information through multicriteria analysis or economic valuation.
- *Step 6* - ***Decision*:** this is the structured presentation of the SEA process and results.

2.3 Implementation of SEA in different countries

2.3.1 Developed country context

Retief *et al.* (2008) noted that SEA has been successful within the context of developed countries and developing countries have been slower to embrace the concept. Partidario and Continho (2011) documented a decision making process and the role of SEA for the Lisbon New International Airport in Portugal.

The Lisbon airport study (Partidario and Continho, 2011) highlights the relevance of SEA in major project decision making. There was an initial location (Rio Frio) chosen for the airport,

the site chosen on the basis of its plain areas and accessibility. Then the airport was redirected to a second location (Ota) that was chosen basing on the fact that military installation was already in place, and that it had a large open area owned by government. This second site was also strategically located as it was between the two major cities in Portugal (Lisbon and Porto). Later, environmental issues were formally brought into picture and an EIA was carried out for both sites, and Ota was chosen again. The decision was based on the natural sensitivity of Rio Frio and Ota was favored due to its strategic location. However, the drainage and wind problem were a concern as they created topographical and hydrological complexities. Only two runways would be possible and the third would be expensive and difficult. Several years later SEA was carried out and an alternative third site (Camp de Tiro), a site that has never been considered, was identified which avoided all the problems that the second site presented. SEA, in this case, proved to be an effective decision making tool in a developed country context.

Runhaar and Driessen (2007) outline the role of SEA in Holland, in the North-Holland South Spatial Strategy Plan. The plan preceded the revision of provincial spatial planning and was a vision of how the region should develop until 2020. Its aim was a further economic plan development under conditions of viability, accessibility and water management. It involved 1500 new houses, 1000 hectares of industrial areas, improved water management and nature development. An open approach was used and stakeholders such as environmental NGO's were involved. There was also room for public consultation. Most of the stakeholders were of the view that new strategies were required to solve problems of deteriorating environmental quality and increasing congestion levels. An SEA had an impact on spatial planning and influenced attention paid to water management, the combination of water storage and accessibility. SEA also contributed to an increasing awareness on dilemmas relating to building on open areas (an environmental source of concern). The option was positive when the quality of living conditions was considered important, but negative when nature was considered. There was a growing awareness on spatial planning issues in general. SEA was considered useful except for the public consultation which took much time and yielded limited response.

These examples indicate successful use of SEA in developed countries. Though SEA has been successful in some developed countries, it is not the case with all developed countries. Kelly *et al.* (2012) present a comparison of approaches to SEA between New South Wales

(Australia) and Scotland. The authors indicate that SEA in Australia is fragmented and unfamiliar, while in Scotland it is well established. Any new public sector plan, policy and programme (PPP) in Scotland is subject to SEA, this extends to supplementary planning guidance and master plans. In Australia, SEA is viewed as a 'preventive mechanism designed to avoid or at least to ameliorate ecologically damaging development' (Kelly *et al.*, 2012) hence 'placing more emphasis on ecological concerns' (Harding, 1998). The Australian policy makers have not yet determined whether PPP's should seek to advance sustainable development or merely take the concept into account (Harding, 1998).

Chaker *et al.* (2006) have provided a comparative overview of SEA systems in 12 selected countries from their legal, institutional and procedural perspectives. The overview was in order to unveil potential implementation pitfalls, and lessons learned as well as uncertainties and lack of data for future research, replication and customization elsewhere or refining of existing systems. The countries studied were Canada, Czech Republic, Denmark, Hong Kong, Netherlands, New Zealand, Portugal, Slovenia, South Africa, Sweden, UK and USA all of which are developed countries with the exception of South Africa. The study indicates that there is no optimal way to implement SEA; the choice depends on the context including the legal and regulatory framework, history, means of legal enforcement and current government approach. Despite the variability, common milestones possessed by procedural arrangements include:

- *Screening and scoping*: it is common practice to submit plans and programmes to SEA where EIA procedures and approaches are readily applied. However, there is an argument that SEA at the policy level requires a different methodological approach than that necessary for lower tier plans and programmes.

- *Coverage of SEA*: the observed variability in the range of impacts considered reflect the national definition of "environment". In some cases it was perceived as biophysical and chemical surrounding, or as anything that affects the natural surroundings of humans as well as the quality and sustainability of their livelihoods.

- *Consideration of alternatives*: all studied countries (except for the Netherlands which uses the E-test) require consideration of alternatives. There is however little detail provided on the type of hierarchy of alternatives and the minimum requirement for scenario identification. The consideration of alternatives,

therefore, reflects the ongoing debate and priorities regarding sustainable development in the country.

- *Impact mitigation and monitoring*: only Denmark, the Netherlands and the UK have monitoring requirements.
- *Public participation*: it is an integral component of SEA. However, there is lack of information in the literature with respect to timing, means and methods.

2.3.2 Developing country context

The adoption of SEA is recommendable in the pursuit of sustainable development in developing countries (Lee and George, 2000). However, Alshuwaikhat (2005) indicates that SEA efforts are not equally effective and successful, further pointing out that there is only a limited number of fully operational SEA's, and that many developing countries with SEA provisions do not necessarily implement them. Alshuwaikhat (2005), further points out that in many developing countries there is a lack of appropriate discussion of alternatives and an absence of public participation procedures. SEA also suffers from technical problems, such as the formulation of predictive techniques and methods; the other factors that weaken SEA in developing countries including the lack of baseline information on the ecological and socio economic data (Alshuwaikhat, 2005; Momtaz and Kabir, 2013).

Ineffectiveness of SEA in a developing country context is illustrated by Retief *et al.* (2008) who present the results of research that evaluated the performance of SEA in South Africa. In the research, an analysis of 50 SEA's was carried out. The research indicates that SEA is widely embraced and promoted in South Africa, but not producing results. SEA was found to be voluntary in practice, diverse in nature and ineffective. Retief *et al.* (2008) state the following as the key factors that contributed to the ineffectiveness of SEA in South Africa:

i. An explicit legal framework providing backing for implementation of SEA is required in South Africa to make SEA effective as South Africa does not have formal SEA legislation and application remains voluntary.

ii. SEA is consultancy driven and divorced from decision making. However, the mandate for implementation of SEA outcomes lies with decision makers and not consultants; therefore, SEA becomes ineffective when consultancy driven.

iii. The lack of capacity and resources by the public sector make it doubtful that the public will take ownership of SEA outcomes and ensure implementation.

Though SEA tends to be unsuccessful in developing country context, Retief *et al.* (2008) explain that SEA is of critical importance in these states because their economies rely primarily on economic activities such as agriculture, tourism and mining. This agrees with OECD (2006) which states that 'the world's poor depend most directly on the natural resources both for subsistence and income opportunities'. The environment, therefore, is vulnerable to degradation. Secondly, SEA in developing countries is important from the global biodiversity conservation perspective and their wider wellbeing as they provide the majority of the world's pristine environments (OECD, 2006).

In order to be effective, SEA must be more adaptive to the context. Regarding this, Alshuwaikhat (2005) recommends: "There is need to develop simplified SEA procedures that would be consistent with the availability of resources and existing program and policy framework within the country". The recommendation is in line with the consensus that SEA needs to be developed and refined within the particular context (Sadler and Verheem, 1996).

Partidario (nd) presents background information on the evolution, concepts and principles and rationale of SEA, in a training module. The module goes on to discuss procedural models and approaches for SEA. The module does not identify any weakness that SEA procedures have. Most of Partidario's literature examines SEA strategy and its potential and significance without necessarily touching on weaknesses that could make the procedure less effective.

Von Seht (1999) outlines 15 requirements against which proposed SEA systems can be evaluated. These requirements relate to the legal basis and enforcement of SEA systems, coverage and screening, scoping, assessment and preparation of SEA report, review, monitoring, auditing and preparation of recommendations (Table 3.1). The requirements are emphasized as crucial to practitioners of SEA. The discussion presented, like in Chaker *et al.* (2006), intends to alter the existing frameworks under which SEA is implemented so that SEA can fit well and produce the expected results.

Table 2.1 Requirements against which SEA systems can be judged.*

Category	SEA Requirement
Legal basis and enforcement	1. Clear legal basis. 2. Provisions for litigation or an ombudsman agency/ SEA commission with enforcement powers.
Coverage and screening	3. Provisions for the screening of all PPP's (and proposed amendments to PPP's) with regard to their environmental significance; requirement to assess all those proposed PPPs which could cause a significant environmental effect. 4. Provisions for at least a limited form of participation in the screening process.
Scoping	5. Requirement to determine the terms of reference of the assessment in a process with participation by relevant agencies, environmental and other relevant groups or organisations, and where appropriate the general public. 6. Option of tiering to be provided.
Assessment and SEA report preparation	7. Requirement to assess the proposed PPPs and the main alternatives in line with the scoping results; early modification of the proposed PPP to be required where it appears to be desirable in the light of the assessment findings. 8. Provision for the preparation of an SEA report that should at least include a description of the proposed PPP and its main alternatives, a description of baseline environment, the significant environmental impacts of the proposed PPP and of its main alternatives, the main possible mitigation measures, comments on assessment problems and on the timescale and likelihood of predicted impacts. 9. Requirement to prepare (draft) non technical summary.
Participation and publication.	10. Provision for the publication of SEA documentation and of the proposed PPPs, requirement to provide opportunity to comment for the relevant groups, bodies, authorities and the general public following the preparation of the main (draft) SEA report.
Final review and decision making	11. Requirement to review and, if necessary, amend the (draft) SEA documentation and the proposed PPP after the main participation process (e.g. choice of an alternative or new mitigation measures). 12. Provision for the publication of the updated PPP and of the final SEA documentation; should include a statement of how findings of the SEA documentation and of the participation process have been taken into account in preparing the updated PPP proposal. 13. Requirement to make the final decision by taking the findings of prior SEA stages adequately into account; provisions for the publication of the decision and of the justification for it, including a statement on how the findings of the SEA process have been taken into account.
Monitoring and auditing	14. Provision for implementation monitoring and auditing. 15. Requirement to amend the PPP according to monitoring findings where appropriate.

*Source: summarised from Von Seht (1999).

The United Nations classifies China as a developing country (United Nations Statistics Division, 2013) and, therefore, the status of SEA in China is described in this section. Xiuzhen *et al.* (2002) indicate that SEA is not legally required in China. However, considerable work has developed in SEA since 1995 and SEAs are increasingly being carried out in practice. The SEA activities are taking place partly in response to inherent limitations of EIA and partly because government has recognized the significance of SEA as a useful decision making tool for effective sustainable development. Xiuzhen *et al.* (2002) further identify problems that SEA in China has, and they include:

I. Problems in incorporating environmental considerations into all stages and certain sectors of policy making.
II. Problems in promoting integrated decision making consistent with Agenda 21.
III. Clarification of environmental objectives.
IV. Identification of positive environmentally friendly options and opportunities.
V. Adoption of a range of impact mitigation measures.
VI. Modification of PPP proposals to take account of environmental considerations.

Identified deficiencies of SEA in China include procedural problems as China has no obligatory procedure for SEA, and technical and methodological problems due to lack of predictive techniques and methods (Xiuzhen *et al.*, 2002). Public participation is also a problem and very limited in practice. These problems with SEA in China have persisted (Wu *et al.* 2011).

2.4 EIA in Botswana

2.4.1 EIA status and procedures

In Botswana, EIA is undertaken when a decision to undertake a project has been made. EIA in Botswana is a legal requirement, as set by the Environmental Impact Assessment Act No. 6 of 2005.

According Department of Environmental Affairs (2009), EIA is important because it is a preventive measure and takes precaution on the environment before the project is implemented. It is costly to deal with harm and, therefore, prevention is cheaper. This agrees with Coskun and Turker (2011), who state that EIA is an important tool which aims to

prevent environmental harm before it occurs. Further, EIA involves community participation as people who live and work in areas affected by proposed projects have a right to a clean, healthy environment. The Botswana Department of Environmental Affairs explains that without environmental consideration, cultural, social, economic and ecological degradation can jeopardize project viability since ecosystems have a limited capacity to absorb and cope with stress resulting from various human development activities. EIA, therefore, serves to ensure that projects are made to fit well in a particular environment (Department of Environmental Affairs, 2009). According to the Environmental Impact Assessment Act No. 6 of 2005, only practitioners who are registered and certified by the Environmental Board as Environmental Assessment Practitioners can undertake an EIA. The EIA procedure involves the following (Department of Environmental Affairs, 2009):

I. ***Project description***: The project to be undertaken is fully defined.
II. ***Application***: The investor prepares an EIA application file and a commitment essay.
III. ***Public participation meetings***: Meetings are organized in order to inform the public sector about the planned project.
IV. ***Scoping***: The environmental effects of the project are considered, the subjects given in the general format of the regulation are detailed, and the scope is determined.
V. ***Monitoring and supervision***: The project is monitored throughout to ensure implementation of mitigation measures and environmental friendliness of the project.

2.4.1.1 Legal framework for EIA

2.4.1.1.1 The 1990 National Conservation Strategy Act as background

In the early 1980's, close cooperation between Government and UNEP resulted in the release of a report that reflected the importance of identifying measures that ensure sustainability of all future development (Government of Botswana, 1990). The government, therefore, became committed to sustainable development as one of the main planning objectives of the National Development Plans. This resulted in the preparation of a National Conservation Strategy (NCS) in 1983. The 1983 NCS defines sustainable development as development that 'ensures that present generation consume no more than the annual output of those natural resources

which are renewable, and that the future generations have access to capital stocks of natural resources at least similar to those presently available' (Government of Botswana, 1990). The 1983 NCS indicates that the Government attached great importance to the wide range of natural resources such as fresh air, clean waters, vegetation, livestock, wildlife, and soils; as well as human, cultural, visual, archaeological and other related features. Many of these resources were noted to be under pressure. According to the 1983 NCS, negative environmental impact in Botswana was manifested by the following:

a. Depletion of fuel wood resources, groundwater resources, wildlife species and indigenous veld products.
b. Land erosion.
c. Urban and rural pollution.
d. Rangeland degradation.

The primary goals of the 1983 NCS were to pursue policies and measures which were to increase the effective management of the natural resources and reduce environmental harm. Strategy goals focused on balancing development and conservation. The Government, therefore, submitted to the national assembly the National Conservation Strategy Act (NCS Act) which was passed in 1990 and proposed the following measures:

I. The requirement that all ministries, departments, local authorities parastatals shall, in the course of their work, show regard for conservation and enhancement of the environment in the interest of achieving sustainable development.
II. The need for government ministries to work closely with the NCS coordination agency in discharging their environmental responsibilities.
III. The necessity for new development projects (both public and private) to be accompanied by professionally prepared and approved Environmental Impact Assessment (EIA's).
IV. The obligation for the NCS Agency to prepare annual state of the environmental reviews.
V. The provision of necessary powers, whereby planning and other authorities can be required to prepare resource conservation strategies at local level and review these regularly.
VI. The encouragement which government intended to give to NGO's in sharing responsibility for conservation and enhancement of the environment.

It was envisaged that both the NCS advisory Board and Coordination Agency will play major roles in helping to implement the EIA provision under the NCS act. The government was committed to ensuring the success of the NCS strategy, specifically the achievement of its twin goals, being sustainable development and conservation of natural resources.

2.4.1.1.2 The Environmental Impact Assessment Act of 2005

The Environmental Impact Assessment Act of 2005 was passed by the national assembly on the 29th of March 2005, about 22 years after the 1983 NCS Act. The Environmental Assessment Act stipulated that Environmental Impact Assessment shall be used to assess the potential effects of planned activities:

> *"to determine and to provide mitigation measures for effects of such activities as may have a significant adverse impact on the environment; to put in place a monitoring process and evaluation of the environmental impacts of implemented activities; and to provide for matters incidental to the foregoing".*

i. Application of the Act

The Act applies to activities in respect of which are likely to cause significant adverse effects on the environment, or the locations that may be environmentally sensitive.

ii. Requirement to undertake Environmental assessment

The Act emphasises that no person shall undertake any activity prescribed under the Act unless the environmental impact of the proposed activity is fully taken into account in accordance with the provisions of the Act. Any person who undertakes an activity in contraventions of the Act commits an offence and is liable to a fine not exceeding P100 000 (or US$11 390 at 1 US$ = P8.78, April 2014).

iii. Requirements for authorisation

Every application made to obtain authorisation for a proposed activity shall, according to the Act, contain or be accompanied by preliminary EIA which shall include a description of the activity.

The applicants are required to seek views of the communities likely to be affected through publicising the intended activity in the media, then after 21 days of publicity, hold meetings with the affected people.

The Act stipulates the EIA process and procedures. It further requires that consultants be engaged at the cost of the applicant, and the consultant must be registered in accordance with the provisions of the Act.

iv. The 2009 general environmental impact guidelines

In 2009, general guidelines for conducting EIA studies under the EIA Act of 2005 were published (Department of Environmental Affairs, 2009).

The overall objective was to prepare guidelines for the conduct of EIA studies under the EIA Act and to facilitate orderly and effective administration of the EIA process. The general guidelines outline the administrative procedures of the EIA process and explain the key terminologies as used in the EIA Act. The guidelines describe each component and the key steps and requirements which should be followed in undertaking such components of the EIA process. Brief mention is made of SEA at the end of the guidelines.

2.4.1.1.3 The Environmental Assessment Act, 2011

The 2005 Environmental Impact Assessment Act was reviewed in 2010 and the revised Act enacted by parliament on the 17th June 2011. In addition to the contents of the 2005 Act, a Board called the Environmental Assessment Practitioners Board was introduced by the Environmental Impact Assessment Act 2011, to register and to certify practitioners as per the terms of the Act:

> *"The board is to regulate environmental assessment by established criteria for registration of practitioners, uphold a defined code of conduct and acting in the best interest of the environment, establish disciplinary procedures and sanctions. The board is also to promote awareness of the purpose and practice of practitioners, define type of work to be performed by practitioners, advise minister on environmental assessment issues, liaise with relevant government departments on matters of public importance, and also do all that is deemed necessary or expedient."*

Unlike the definitions given in Section 1.12 of this thesis, The Environmental Impact Assessment Act, 2011 defines the environment as "...the physical, ecological, archaeological, aesthetic, cultural, economic, institutional, human health and social aspects of the surroundings of a person" and an environmental impact as "any positive or negative effects caused by an activity on the environment" (The Environmental Impact Assessment Act 2011, Section 2).

2.4.1.1.4 Environmental Assessment Regulations, 2012

The regulations provide a guideline of the necessary procedures in carrying out Environmental Assessment. A list of locations and thresholds for which assessment statement is required is indicated. Guidelines are provided on how a project brief should be written, and the necessary details of the contents of the environmental management plan explained. The procedures for the scoping exercise are also explained and the guidelines provide a detailed description of the contents of the Environmental Impact Statement. Fees for reviewing both the EIA and SEA reports are indicated in the report. The guidelines also stipulate qualification criteria for certification of Environmental Assessment Practitioner and conclude by stipulating the code of conduct.

2.4.2 Illustrative projects that have undergone EIA in Botswana

A number of projects have undergone EIA in Botswana since the legislation requiring EIA was passed. Illustrative examples are summarized here.

(a) *Project 1: Environmental and Archaeological Impact Assessment for the proposed Mmamantswe Power project (MMP) Kgatleng District, Botswana by Earthtec Consultancy (August 2012).*

The project intended to construct a multi-facet power project called Mmamantswe Power Project, in Kgatleng District (Figure 1.1), in order to increase the supply of electricity in the country and possibly export coal. The project was to comprise of a coal mine, a power station, transmission lines, beneficiary plant, railway line, water storage pond, ash stock pile,

and mine infrastructure which would include an export market infrastructure (Earthtec Consultancy, 2012). The Mmamantswe Power Project was motivated by the presence of 1.3 billion tonnes of coal deposits in Kgatleng District. The coal was found to be easily exploitable through open cast mining. There was a possibility of exporting the coal to the international market.

The proposed Mmamantswe Power Project project was to comprise of:

(i) A mine area – an open cast coal mine covering 8 x 6 km, with a depth of 40-100 meters. Strip mining was to be adopted. The mine was expected to produce 10MT run of mine (ROM) per annum for a period of 28 years.

(ii) A power station – a power station producing 100-2000 MW, to be air-cooled.

(iii) Transmission lines – two transmission lines: one of 400kv (45km) and one of 400kv (80 km).

(iv) Mine infrastructure – the proposed mine infrastructure was to comprise of internal roads, workshops, administrative building, well fields for supply of water for housing construction, fuel points, ash stock pile area, waste rock dump, discard dump, water storage pond area, conveyor belts, and power supply which would depend on diesel generator during the initial stages.

(v) Coal beneficiary plant area – would utilise clean coal technology to remove the sulphur and ash content of coal.

(vi) Access roads – a 41 km access road through a cut line from the Gaborone Francistown road.

(vii) Railways spur – a railway spur was proposed to run about 40 km from the Gaborone Francistown railway line.

(viii) Housing facility – about 230 employees were to be employed and housing would be sourced from private house owners, failing which a plot would be obtained for construction of housing.

According to Earthtec Consultancy (2012), the project was going to have the following negative environmental impacts:

- The project was expected to affect the water quality and quantity.
- A lot of noise pollution was also expected from the blasting.
- Air pollution was also expected to result.

- A lot of waste would be generated from the mine.
- Traffic congestion would also result.
- The fauna and the flora would be affected (although the exact flora and fauna impacts are not stated)

The final decision following the EIA was that the project was permitted. A number of post-implementation monitoring and auditing measures were recommended. Daily monitoring was planned to ensure work occurred within the specified period so as to control the noise pollution. The contractor would ensure re-seeding and fertilising of the soil where vegetation cover has been removed. Re-vegetated areas would be visually inspected on a weekly basis to ensure growth and adequate cover. The contractor would also ensure reduced or no accidental spillage of oil and tar. Compliance with the environmental code would be regularly monitored through audits and reviews. The Project Engineer would conduct these audits at intervals of not more than two months. The contractor would make available all necessary documentation for effective review and auditing of the environmental compliance programme.

Perhaps what can be of concern from these monitoring and auditing tasks is that it was left to the contractor to perform them and then report. It is quite feasible that a contractor can report what the Department of Environmental Affairs would like to hear, i.e. a positive report that makes it seem like all is well and environmental harm is low. This is perhaps one of the sources of procedural weakness in the EIA procedures in Botswana.

(b) Project 2: Environmental Impact Assessment for the Proposed Mupane Gold Mine, by Geoflux (PTY) Ltd, 2002.

Mupane is located in the vicinity of Francistown city (Figure 1.1). The city of Francis Town developed in the early 1960's after the discovery of gold by the geologist Karl Monarch, and later discoveries by Daniel Francis after whom the city is named (Geoflux Ltd, 2002). The potential for discovering an economically viable gold deposit has, therefore, always been high in the area given the geological structure and mineralisation potential due to the archaen greenstone belt known as Tati greenstone Schist belt, which underlies the city.

The potential for gold mining has always been high in the region, hence a decision by Gallery Gold Botswana (GGB) to undertake an extensive exploration programme throughout much of the Tati greenstone. It was through the application of advanced geochemical exploration technique that GGB were able to detect the Mupane mineralisation in the area (Geoflux Ltd, 2002), which led to proposals for the new mine.

The identified potential negative environmental impacts of the new mine, according to the consultant Geoflux, were:

- Removal of vegetation would affect the flora and fauna (exact impacts not specified).
- There was also potential to change the hydrological regime of the sub catchment area and the flow regime of the subsequent rivers of Tsokwane and Tati.
- Further, previous mining left permanent scars in the area such that cumulative impacts can transform the physiography of the area.
- The greatest environmental risk identified was ground water pollution.

The decision following the EIA was that the project was given permission to proceed. Post implementation monitoring and auditing would include dust suppression through water spraying using water carts along haul roads and other dust sources. A permanent sprinkler would also be installed to suppress dust during tipping, and nozzles were to be checked regularly.The contractor would develop a drainage system that would channel runoff into natural drainage pattern. Storm water harvesting would be adopted and the water would be used in the mine. The top soil would be stock piled for the rehabilitation process. As regards waste dumps, continuous rehabilitation and re-establishment of indigenous vegetation would be conducted so as to increase aesthetic appeal. Cleared vegetation would be laid as mulches on bare areas to establish and hold soil together to decrease flow and erosion. Livestock areas would be fenced to allow co-existence with the mine. GGB also considered buying a game farm in the area to ensure use was in sync with uses in the adjacent farms and that vegetation was less impacted on upon use.

Of concern from this project in terms of sources of EIA ineffectiveness in Botswana is the fact that some environmental impacts were completely ignored in the monitoring and auditing measures, and faunal and floral impacts are completely vague (as was the case with project

1). As identified from the EIA, ground water impacts were the most serious, but no mention of ground water monitoring is made in the monitoring and auditing plan.

(c) Project 3: Kanye Water Supply Emergency Works (Water Augmentation Project), by Geo Science Consultancy Services, May 2009.

The aim of the project was to augment the current water supply network for Kanye (Figure 1.1) and the nearby Moshupa village. Kanye and Moshupa had experienced rapid growth and development in terms of commercial, industrial and general public services (Geo Science Consultancy Services, 2009). More yard connections had been necessitated. Further, there had been a tremendous decline in borehole yields under the existing water supply network. An environmental impact assessment was, therefore, undertaken.

With the water shortages that were being experienced in Kanye and Moshupa, it was realised that the drainage network coupled with the low rainfall pattern were not favourable for construction of dams of sufficient sizes to harvest adequate water to meet the needs for Kanye and Moshupa. A decision was, therefore, made to adopt the Kanye Water Supply Emergency Works, later named the Water Augmentation Project, so as to increase the current supply by an additional well field (Geo Science Consultancy Services, 2009). This included routing the pipeline directly through 18.25 km bush from the northern booster to Kgwakgwe booster.

The negative environmental impacts identified by the consultant were:

- Disturbance of existing land uses.
- Possible disruption of water supply during works.
- Waste generation from construction activities was also expected.

The decision following the EIA was that the project was given permission to proceed. A number of post-implementation monitoring and auditing tasks were set. The contractor would monitor soil and water contamination from leakages of machinery used throughout the construction period. The contractor would also dispose of waste at designated dumping sites, and ensure minimal accidental risks of fire. The Clerk of Works would ensure avoidance of, or minimise damage to, existing pipelines. The contractor would also ensure all trenches or

pits were backfilled after construction. The Supervising Contractor and Project Engineer would ensure minimal water supply interruptions during works. The contractor, together with Environmental Clerk of Works, (Department of Water and Sanitation, Southern District) would ensure proper sanitation facilities and acceptable worker conduct to ensure sanitation, hygiene and proper worker's conduct. The Southern District Council Health Team, together with the contractor, would ensure minimal hazard to workers safety and health, prevent or minimise the spread of HIV and other diseases (Geo Science Consultancy Services, 2009).

Similar to the case with Project 1, there is a possible source of concern in this project in that it was left to the contractor to monitor environmental impacts (on soil and water), with the likelihood that some impacts would be concealed from the Department of Environmental Affairs.

(d) Project 4: Bonwapitse Proposed Well Field Area, by ERM, 2008.

The aim of the project was to construct two boreholes to meet the water demands of the Mmamabule Energy Project, which needed a sustainable source of water to meet its operational demand (ERM, 2008). The Bonwapitse Well Field area was identified as the preferred option to meet the need for a high yielding aquifer in order to supply the Mmamabula Enegy Project (MEP). The MEP incorporates a number of activities including construction of up to 2700MW (gross) power plant, underground and surface strip coal mining activities as well as development of a network of power transmission lines.

Bonwapitse Proposed Wellfield area (BPW) contains groundwater of brackish quality, averaging about 2400 mg/l total dissolved solids (TDS). Reverse osmosis was to be used for desalination of the brackish ground water to meet the low salinity demand of the power plant.

The use of brackish water from Bonwapitse in combination with the desalination process aimed at the efficient use of water in eastern Botswana. The use of brackish ground water instead of better quality surface water from the North South Carrier (NSC) was in line with the National Water Management Plan of Botswana.

Construction of Bonwapitse was to begin in 2008, water supply for the construction phase would be derived initially from two construction boreholes, demand was expected to be $0.02Mm^3$/year in 2008 rising to a pick of $6Mm^3$/year in 2013. From 2011 onwards, supply

would be complemented from 16 proposed production boreholes within the Bonwapitse PWA to reach the peak supply. The planned life of MEP was 40 years.

The negative environmental impacts of the project that were identified were:

- Noise pollution during the construction phase.
- Disruption of existing land uses.
- Removal of vegetation to create an access road.

The decision following the EIA was that the project was given permission to be implemented. A number of monitoring and auditing tasks were set. All monitoring data were to be collected into an access data base on a monthly basis. The data collected were to be analysed and forwarded to Department of Water Affairs.

The monitoring and auditing regime for this project has both positive and negative aspects. On the positive side, depositing the monitoring and auditing data into a database permits transparency in that all concerned parties, including environmental groups and expert scientists, can access them and check for quality and accuracy. On the negative side, impacts on vegetation are vaguely stated, and the side effects of that removal of vegetation (e.g. synergistic impacts, future impacts) are not specified. In somewhat a grey area is the fact that this project reported to the Department of Water Affairs and not the Department of Environmental Affairs. This raises a question of possible duplication of duties or coordination lags in the Government departments that have environmental management duties as in Figure 1.2.

(e) Project 5: The Southern Okavango Integrated Water Development Project (SOIWDP), by SMEC Consultants, 1990.

The SOIWDP was a considerably controversial project, and also one with potentially the highest environmental sensitivity (Scudder *et al.*, 1993). The project aimed at improving the flow of water from the Okavango Delta southwards, thereby improving the supply of water for example to the town of Maun (Figure 1.1) and diamond mines run by the company Debswana. This was to be achieved by dredging the main channels that funnel water from the Okavango Delta, for example the Boro and Boteti Rivers. The Okavango Delta is a

wetland that is recognized by conservation organizations like the IUCN and WWF, with a spectacularly aesthetic mixture of wetland and dry land vegetation, water channels, along with wildlife (Scudder *et al.*, 1993). These organizations and sections of local society opposed the SOIWDP, while the government was in favour citing benefits like improved water supply and increased agricultural production. An Australian company, Snowy Mountains Engineering Company (SMEC) was contracted.

A large number of negative environmental impacts were identified, including the following summarized impacts (Scudder *et al.*, 1993):

- The effect of channel dredging and the resultant increased flow of water out of the Okavango Delta would be to reduce the area flooded in the Okavango Delta on a seasonal basis.
- Reduced habitat for wildlife due to reduced flooded area (contraction of the wetland).
- Reduced carrying capacity of the wetland for wildlife, resulting in reduced wildlife populations.
- Reduced evapotranspiration from the Okavango Delta due to the reduced flooding area with possible micro-climatic impacts.

A programme of re-seeding and transplanting of indigenous species vegetation with the intention of re-vegetating the areas impacted by channel dredging works and reducing environmental impacts was proposed (Scudder *et al.*, 1993). Written and verbal comments were sought from the public and Government departments. Comments from at least 15 Government officials based in Ngamiland District (Figure 1.1) and Boteti Sub-District, and those of Bebswana, were unanimously in favour of the project, but some in central Government ministries (e.g. departments in the Ministry of Mineral Resources and Water Affairs) were critical (Scudder *et al.*, 1993). IUCN proposed an alternative to meet the water supply needs intended by the SOIWDP in May 1992, and on the same day the Government of Botswana cancelled the plans for the SOIWDP.

The experience from the SOIWDP raises a number of positives in terms of EIA in Botswana. First and perhaps of paramount importance is that the main way to mitigate negative environmental impacts is to stop a development project. The second point is that transparency in detailing the design parameters of a development project enables the

identification of its impacts. Thirdly, that public participation in the EIA process does lead to identification of detailed environmental impacts, as was the case in this project since an NGO (IUCN) was able to assemble a team of experts to identify detailed impacts from a scientific viewpoint. According to the IUCN, this was the first time that a national government had asked for an independent review from an international conservation agency on a major water development project (Scudder *et al.*, 1993).

2.5 SEA in Botswana

The EIA Act of 2005 makes mention of SEA as having an important role in environmental management in Botswana. The Department of Environmental Affairs (DEA) characterises SEA as "a system of incorporating environmental considerations into policies, plans, and programmes" (Department of Environmental Affairs, 2009). DEA does acknowledge that SEA overcomes inherent limitations of project level EIA, and that SEA provides better opportunities for analyzing existing policies, plans and programmes and further supports environmentally sound investment strategies (Department of Environmental Affairs, 2009). The merits of the SEA as stipulated by DEA are (Department of Environmental Affairs, 2009):

a) SEA can prevent serious environmental impacts through analysis of sector policies and investment strategies upstream in the planning process.

b) Through SEA, opportunities and constraints which the environment places on development are identified.

c) SEA provides opportunities for consideration of alternative policies, plans and programmes taking into account their cost and benefits.

d) SEA assists in selecting appropriate sites for projects to be subsequently subjected to EIA.

e) SEA highlights and anticipates potential environmental problems, hence facilitates environmental planning.

f) SEA facilitates a more effective assessment of cumulative, indirect synergistic, delayed, regional, transboundary and global impacts.

g) SEA reduces the time and effort required for project EIA by identifying issues, initiating baseline studies and assembling data at an early stage.

h) SEA provides a basis for collaboration and coordination across sectors.

i) SEA provides guidelines to ensure the formulation of environmentally sustainable development.

j) SEA improves the way in which cumulative effects of development are dealt with.

2.5.1 SEA procedures as implemented in Botswana

According to Department of Environmental Affairs (2009), SEA is not undertaken routinely in Botswana. The SEA guidelines currently used are adopted from South Africa. The characteristics proposed for adoption in Botswana are those that underpin the SEA process in South Africa. These main characteristics are context specific, integrative and sustainability led SEA.

Regarding SEA principles for Botswana, Department of Environmental Affairs (2009) admits that the evolutionary approach has not been suitable due to the limited practice. Instead, principles developed in other countries are adopted for initial use in Botswana. The key steps in the SEA process in Botswana (Figure 2.1) are as in South Africa, as follows (Department of Environmental Affairs, 2009):

i. ***Step 1: Identify broad plan and programme alternatives*** – here broad plan alternatives are identified. These indicate physical and administrative boundaries, level of planning and type of plan or programme.

ii. ***Step 2: Screening*** – involves identifying the purpose of the plan or the programme and deciding if an SEA is required. The decision could be determined by local requirements or an identified need.

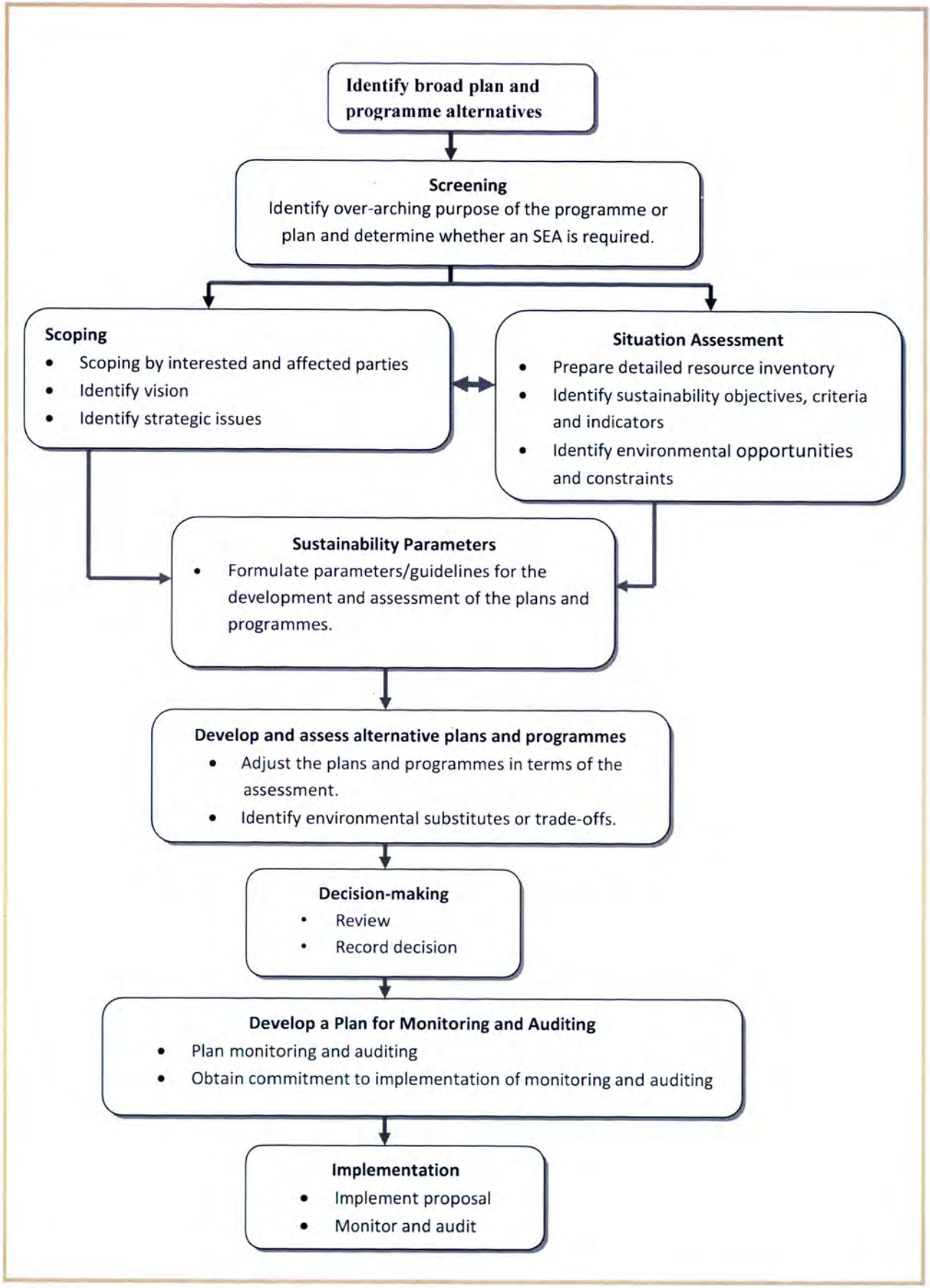


Figure 2.1 The SEA process in Botswana (Source – Department of Environmental Affairs, 2009).

iii. ***Step 3*: *Situation assessment (Scoping)*** – determines the nature and extent of SEA and involves vision formulation and identification of significant strategic issues to be addressed. This stage should be informed by effective participatory procedures particular to the context hence involve a wide range of affected parties.

iv. ***Step 4: Identify sustainability objectives, criteria and indicators*** – this stage involves formulating sustainability objectives, then translating them into context specific criteria. The objectives, criteria and indicators reflect the social, economic and biophysical context of the plan or programme. Measurable sustainability indicators may be identified to determine if the criteria are being met. Sustainability criteria and indicators may be used to compare alternatives and monitor the implementation of the plan or programme.

v. ***Step 5*: *Identify environmental opportunities and constraints*** – opportunities and constraints that the biophysical environment places on the plan are identified in this stage.

vi. ***Step 6*: *Formulate sustainability parameters for the development of the plan or programme*** – sustainability parameters are then formulated to guide the outcomes of the plan or programme towards achieving sustainability. These are written in the form of principles or guidelines and include recommendations on how the plan or programme may be addressed, this includes addressing constraints and enhancing opportunities.

vii. ***Step 7*: *Develop and assess alternative plans and programmes*** – the developed sustainability parameters, objectives, criteria and indicators provide a framework that can be used either to guide the formulation of a new plan, or to provide a measure against which existing plans and programmes can be measured.

viii. ***Step 8: Decision-making*** – this stage involves three main components: review, record the decision, and prepare an implementation strategy.

ix. ***Step 9*: *Develop a plan for implementation, monitoring and auditing*** – a strategy for implementation of the plan or programme is clearly described and may be integrated with the implementation strategy required in terms of other legislation.

x. ***Step 10*: *Plan monitoring and auditing*** – measures to restore sustainability are implemented and resources are monitored and audited to identify any threats of non sustainable use.

xi. ***Step 11*: *Implementation*** – the plan will then be implemented. The environmental committee can be established to guide the monitoring and auditing process.

xii. ***Step 12*: *Audit*** – auditing is undertaken according to the programme prepared in the planning and assessment stage.

Therefore, the stages in the SEA process adopted in Botswana as outlined in Figure 2.1 is more elaborate than the one outlined by Nilsson *et al.* (2005) as in Section 2.2.

2.5.2 Legal framework for SEA

SEA in Botswana dates back to the 2005 Environmental Impact Assessment Act (Section 2.4.1.2.2). The Act states that formulation of a policy or programme shall contain or be accompanied by an approved Strategic Environmental Assessment which contains a full description of the proposed policy or programme.

The Environmental Assessment Act 2011, which resulted from a review of the 2005 Environmental Impact Assessment Act, also stipulates that 'formulation of a policy programme, legislation, physical plan, shall contain or be accompanied by an approved Strategic Environmental Assessment, which shall contain a description of the policy, programme, legislation, physical plan, as the case may be." The dimensions added here are legislation and physical plan. The Act, however, does not specify the penalty for non-compliance with the SEA requirement.

The applicants, like in the EIA procedure, are required to seek views of the communities likely to be affected through publicising the intended activity in the media, then after 21 days of publicity, hold meetings with the affected people.

2.5.3 Illustrative projects that have undergone SEA

Compared to EIA, SEA is relatively new in Botswana. Therefore, not many projects have undergone SEA. Two projects whose reports were available at the Department of Environmental Affairs will be used as illustration in this thesis.

(a) Project 1: Strategic Environmental Assessment (incorporating EIA of existing development) for the Gaborone Dam catchment area, by EHES (PTY) Ltd Consulting Engineers and Hydrologists (2004).

The study aimed at formulating a strategic plan for controlling land use in the Gaborone Dam Catchment area, to ensure that future development is taken in an environmentally sustainable manner that conserves the environmental heritage of the Gaborone Dam catchment area (EHES Ltd, 2004). The SEA that was undertaken provided development guidelines that explicitly set out appropriate policies, objectives, and management controls to guide and shape the future growth in the catchment area in order to protect the Gaborone dam from pollution.

The catchment area of Gaborone Dam is 3 741km^2, out of which 559 km^2 falls within South Africa, and the rest is in Botswana. Activities in the Gaborone area of the catchment were considered a major driving factor in the land use problems encountered in the area. There was an increasing trend of freehold land to be subdivided into residential plots, particularly in the Gaborone and Lobatse areas (Figure 1.1). These were undertaken without approval of local planning authorities due to a loophole in the planning division.

The total population impacting on the dam was estimated to be 458 370 in 2001, 19% (90 945) estimated to live within the catchment area, hence a population density of 24 people per km^2 (EHES Ltd, 2004). It was projected that by the year 2024, some 835 625 people would impact on the dam and 183 838 would be staying within the catchment area (EHES Ltd, 2004).

Increase in population was accompanied by the need for increased provision of social facilities such as housing. About 1 305 economic activities were registered in the dam catchment area (a lot more continued unregistered), and 38 activities were listed as commercial agriculture, most of which were poultry and vegetable gardens. A number of

developments such as hospitals, hotels, leisure and tourism had been proposed within the catchment area, of the dam.

The environmental concerns identified for the catchment were (EHES Ltd, 2004):

- Increasing land degradation due to overgrazing and continued deforestation.
- Current land use conflicts (agricultural land being compromised for urban expansion).
- Surface and ground water pollution risks from domestic sewage disposal, particularly the freehold land around the dam area.
- Immense pressure resulting from growth of Gaborone city.
- Land and water pollution threats from agricultural activities.
- Depletion of groundwater reserves from the drilling of boreholes for water supply in the freehold areas.

A number of monitoring and auditing measures were proposed. All developments were to be critically subjected to the zoning requirements recommended in the report. Development guidelines and recommendations pertaining to impacts on all possible economic sectors were made, examples of which included:

i. Poultry farming - Environmental Impact Assessment was required for issuing a permit by the planning authorities in the catchment area. The Department of Sanitation was to monitor waste management. Further, holding ponds were to be constructed by sealing the bottom and sides with concrete or polyethylene lining to prevent seepage of effluent into the ground water.
ii. Horticulture - use of environmentally friendly agrochemicals was enforced.
iii. Animal husbandry - effluent from the cleaning process in dairy farms should be first treated before disposal on to land or surface water. If disposed of in surface water, the water should be used for irrigation of pastures or fodder crops to avoid discharge into the rivers.
iv. Sanitation facilities - rigorous campaigns for residents of Ramotswa to connect to sewer lines as pit latrines and septic tanks (on site sanitation facilities) had resulted in high nitrate levels in the Ramotswa aquifer and its use was stopped. Development of Ramotswa and surrounding areas needed to be streamlined with the development of Gaborone.
v. Domestic waste - all surface waste disposal facilities to be provided and the public made aware of implications of improper waste disposal.

vi. Manufacturing industries - renewal of licences for existing development should be upon approval of an Environmental Management Plan (EMP) to facilitate environmental monitoring and environmental audits.

vii. Quarrying - all quarries to be rehabilitated after closure in line with the Mines and Minerals Act.

viii. Freehold land - legal obligations should apply to these areas to ensure uniformity in development and to enable local authorities to control their development.

b) Project 2: Okavango Delta Management Plan, by the Department of Environmental Affairs, 2008.

The overall aim of the SEA was to integrate resource management for the Okavango Delta Figure 1.1) and ensure long term conservation that will provide benefits for both the present and future generations, through sustainable use of its natural resources. The specific aims were (Department of Environmental Affairs, 2008):

- To establish viable management institutions to support integrated resource management in the Okavango Delta.
- To ensure long term conservation of the Okavango Delta and the provision of the existing ecosystem services.
- To sustainably use the natural resources of the Okavango Delta in an equitable way and support the livelihoods of all stakeholders.

The Okavango Delta was selected as a wetland of international importance in accordance with the Ramsar Convention. The delta is an inland drainage system which is important for approximately 1300 plant species, 71 fish species, 33 amphibian species, 44 reptile species, 444 bird species and 122 mammal species (Department of Environmental Affairs, 2008).

The delta also contains high densities of large mammals species particularly elephants. It is a habitat to one of the largest remaining populations of the African wild dog (*Lycan pictus*) and is a strong hold for the Sitatunga antelope (*Tragelaphus spekii*) and the Nile crocodile (*Crocodilus niloticus*), one endermic reptile species - the Tsodilo Gecko *(Pachydactylus tsodiloensis*) - has been identified. Two resident bird species the wattled

crane (*Burgeranus carunculatus*) and the slaty egret *(egretta vinaceiqula*) are globally threatened ((Department of Environmental Affairs, 2008).

The current known flora of the Okavango Delta comprises about 1 300 species that belong to 530 genera and 134 families. One near endemic species has been identified, the ground orchi (*Harbenaria pasmithii*). The delta is, therefore, important in terms of its ecology, botany, zoology and hydrology.

2.6 Summary

From a review of literature, the following can be deduced in the context of the work in this thesis:

1. SEA and EIA are practiced both in developed and in developing countries. SEA in particular appears more established in developed countries although, being newer than EIA, it is still subject to misunderstanding. In developing countries, including Botswana and South Africa, SEA is still in its infancy and quite ineffective.

2. SEA has comparative advantages over EIA. Yet in Botswana, project EIA is more common that SEA.

3. EIA legislation in Botswana sets the basis for SEA. The EIA legislation dates back to the 1980's and has been reviewed at least twice since then, culminating in the Environmental Impact Assessment Act of 2011. The newer EIA legislation does make mention of obligatory SEA for development projects, failure of which constitutes an offence that can be prosecuted for legal penalties that include a fine.

4. The definition of 'environment' as recognized by the Government of Botswana in its environmental legislation goes beyond the biotic and abiotic natural environment as defined from the ecological viewpoint to include economic activity, institutional aspects, human welfare and archaeology. Environmental impacts are similarly recognized by the Government to be positive and negative, the positive impacts including economic development and improvements in human welfare.

5. From the projects that have undergone EIA in Botswana, a number of procedural weaknesses in the EIA process in Botswana can be identified. Firstly, EIA is undertaken

mainly by consultants, who are registered Environmental Assessment Practitioners approved by the Government of Botswana. These practitioners appear to be mainly engineering firms whose environmental training credentials are unclear. As an apparent consequence, the identification of negative environmental impacts appears to be vague and superficial, with only the parameters of the environment at risk being mentioned as impacts (e.g. "impacts on flora, fauna, groundwater, noise pollution") without identifying the secondary or synergistic impacts or forecasting into the future. A second weakness is that the contractor on the project appears to be the one with the obligation to monitor and audit environmental impacts after the implementation of the project, with the likely consequence that the contractor can ignore the actual monitoring and simply state that 'all is well'. Such weaknesses are likely to permeate to the SEA process, given that the same legislation applicable to EIA extends to SEA.

6. Very few actual development projects have undergone the SEA process in Botswana. The process is so new that the procedures are borrowed from neighbouring South Africa.

SEA CASE STUDY CONTEXT AND METHODS

3.0 Introduction

In this chapter an illustrative Strategic Environmental Assessment case study is introduced, and the methods of conducting the actual SEA are detailed. The case study that is used is the problem of sand mining on Metsimotlhabe River, located on the northern outskirts of Gaborone in Botswana. The issue of sand mining on Metsimotlhabe River is a problematic environmental issue, and some studies have been undertaken on it as a result (e.g. Department of Mines, 2004; Olesitse, 2009). These previous studies have mainly focused on identifying the environmental impacts of sand mining and as such, they have been in the context of Environmental Impact Assessment. In this study sand mining on Metsimotlhabe River is assessed in the context of SEA. The assessment follows the steps in the SEA process as implemented in Botswana (Figure 2.1; Section 2.5.1). The SEA case study is, therefore, presented so as to follow the outlined steps in the SEA process in Botswana so as to identify ways in which the process can be strengthened, which was the aim of the study (see Section 1.5).

3.1 Sand mining on Metsimotlhabe River

Metsimotlhabe River drains the northern outskirts of Gaborone (Figure 3.1a), with its source in the hills near Moshupa village and mouth at its confluence with the Notwane (at approximately 26°6'E, 24°26'38"S). Gaborone, being the capital city of Botswana, has the largest and fastest growing population in the country (CSO, 2012). The city's growing population and economy have fuelled a demand for building sand due to the need for residential and business building accommodation. The nearby Metsimotlhabe River has served as source of the sand.

Until 2010, sand mining was legally permitted in the Metsimotlhabe River. Due to concerns about possible deterioration in the quality of the river, the Department of Mines of the Government of Botswana stopped issuing sand mining permits for extracting sand from the river in June 2010. However, illegal sand mining has continued on Metsimotlhabe River,

particularly in the section of the river in the vicinity of Metsimotlhabe village and upstream towards Thamaga village (Figure 3.1a). In this section the river has a gentle gradient of approximately 1 in 621 (Figure 3.1b).

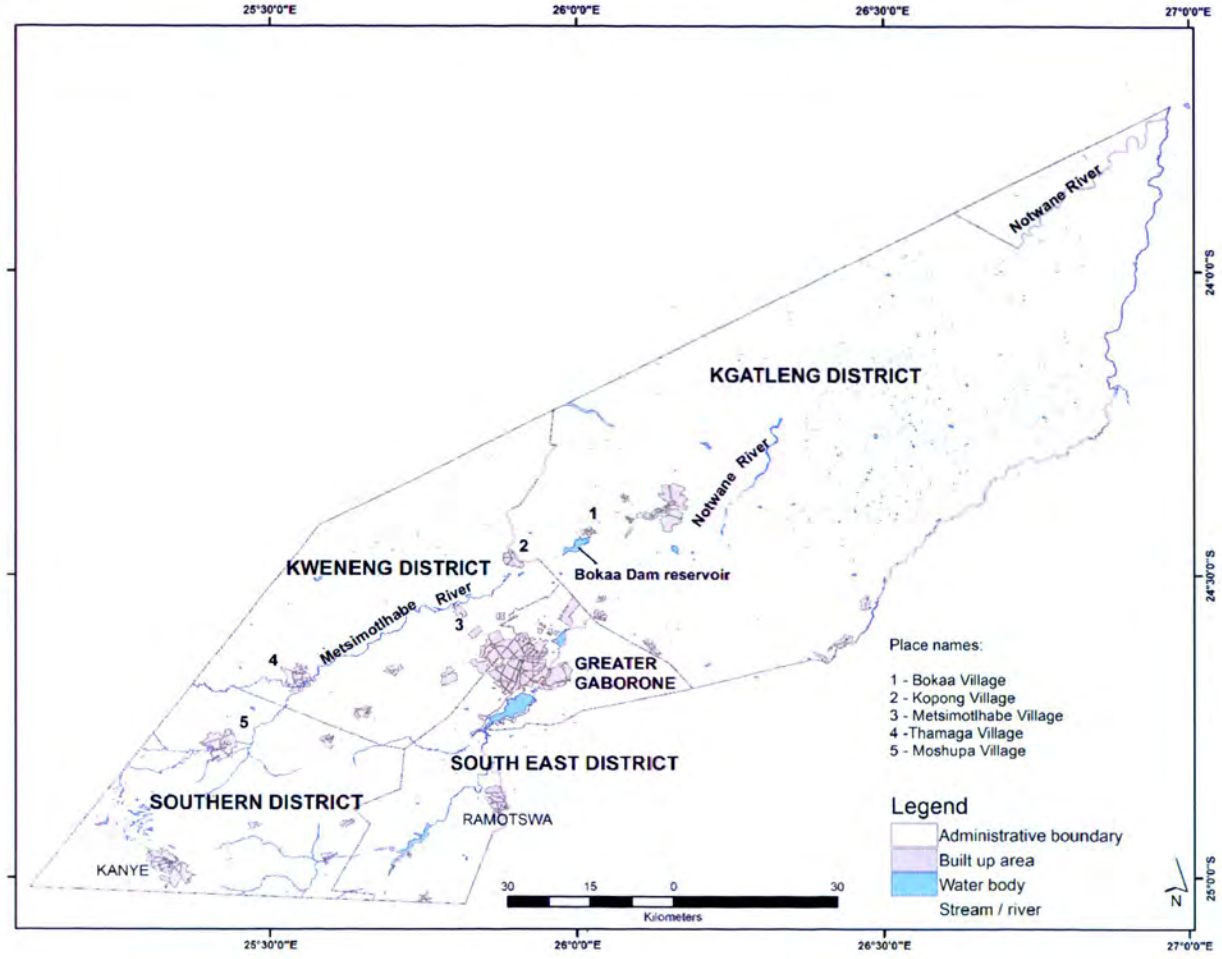
The illegal sand extraction in the river is surprising given that Botswana has vast quantities of sand on the Kalahari Desert that covers much of the country's western half, but proximity of the river to the sand demand areas in the city probably explains it. The illegal extraction is perpetrated by small scale sand traders who use hand shovels to fill truck loads (approximately $11m^3$) that they transport to customers, mainly private home builders and other constructers (Figure 3.2). These small scale traders want to limit their transport costs by sourcing the sand from as close as possible to their customers in and near the city.

3.2 Project screening for sand mining on Metsimotlhabe River

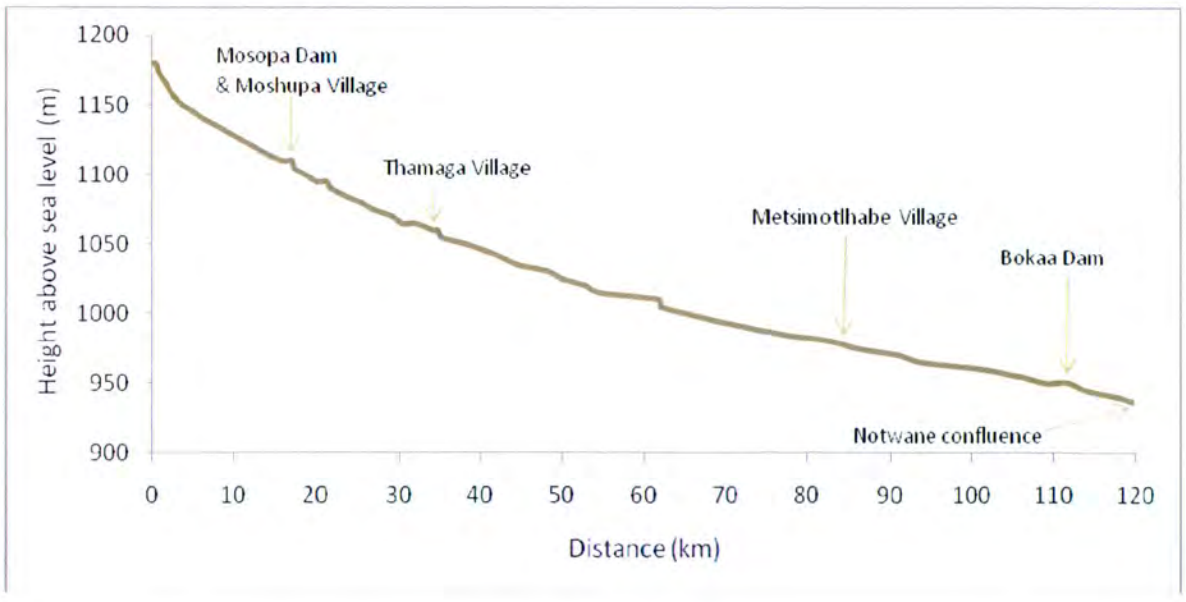
Sand mining on Metsimotlhabe River has been the subject of long-running controversy, given the attention it has received in the media in Botswana, as well as the attention it has received in environmental studies (e.g. Department of Mines, 2004; Olesitse, 2009). There is a genuine need for sand for building, for example building homes (see Figure 3.2b) for the relatively poor communities in the villages along the river (Moshupa, Thamaga, Metsimotlhabe, Kopong, Bokaa; Figure 3.1a). With this acute demand to source sand from the river comes the risk of environmental deterioration since the river is the only major water course in the northern and western outskirts of the city of Gaborone.

Due to the scarcity of water in the area the river was dammed at Bokaa in 1990, resulting in the Bokaa Dam reservoir (Figure 3.1a), and also upstream at Moshupa village resulting in the smaller Mosopa Dam (CSO, 2009; Birdlife Botswana, 2013). The 18 500 000m^3 Bokaa Dam reservoir meets some of the water requirements of Gaborone (CSO, 2009).

Surface water sources for flora and fauna in the area as well as the city of Gaborone are, therefore, threatened by any disturbance to the flow of the river. In addition, the recharge of the ground water table is also threatened. Given this environment versus development conflict scenario, an SEA is required for sand mining on Metsimotlhabe River for purposes of achieving sustainable development.

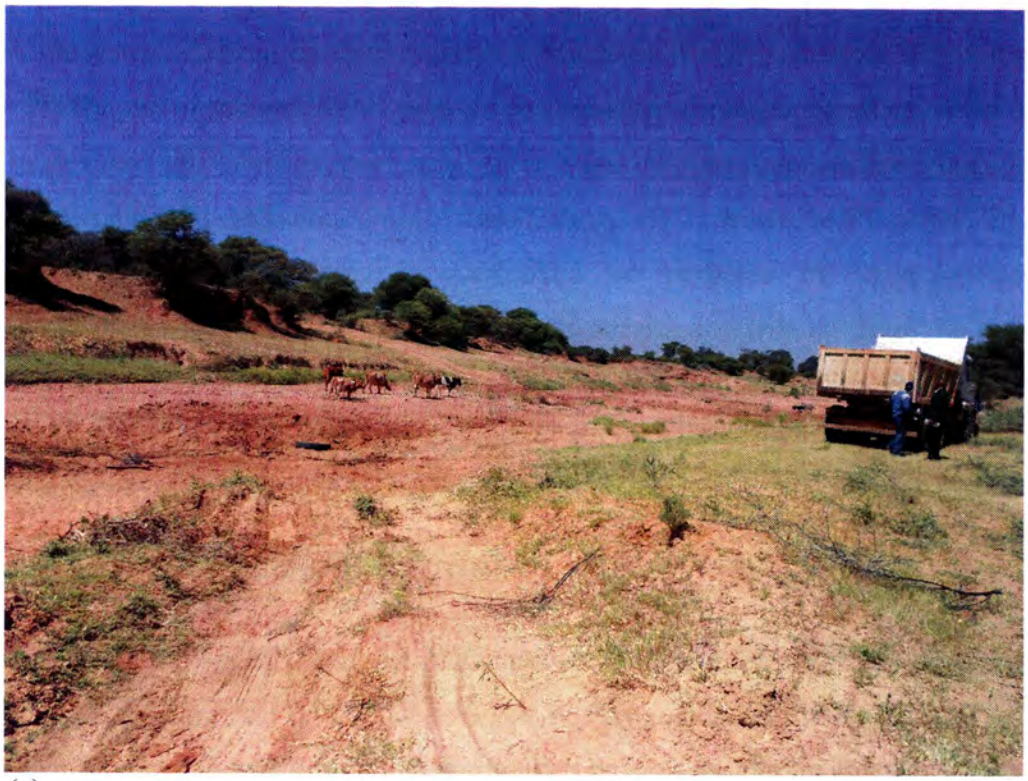


(a)



(b)

Figure 3.1 Location and hydrological context of the sand mining SEA case study area on Metsimotlhabe River. The longitudinal profile of the river in (b) was constructed using height contour GIS data obtained from the Department of Surveys and Mapping, Gaborone, Botswana.



(a)

(b)

ure 3.2 Pictorial illustration of sand mining on Metsimotlhabe River. In (a) a standard truck used for ferrying sand is pictured next to the river's sand-scoured dry bed, with a member of the Botswana Police Service in attendance, and in (b) a truck load of sand (foreground) is shown outside a house in Metsimotlhabe Village, for use in building the unfinished house in the background (photos by author, taken in March 2013).

SEA in Botswana is driven by the concept of sustainability (Department of Environmental Affairs, 2009), and sustainability is required for the sand mining activity on Metsimotlhabe River. In developing countries in general, the pursuit of economic development inevitably leads to environmental degradation (de Araujo Castro, 1972; Walter and Ugelow, 1979), but usually environmental well-being is overlooked for purposes of achieving economic development. Botswana as a developing country is striving towards uplifting the livelihoods of its citizens and economic development in general, and sustainability is a key requirement.

3.3 Scoping for sand mining SEA

The aim of scoping is to determine the nature and extent of the SEA (Department of Environmental Affairs, 2009). The Department of Environmental Affairs (2009) guidelines suggest that Scoping should initially be undertaken by a group of key interested and affected parties that play a coordinating role, for example through a steering committee that could include authorities, specialists, NGO's, business and community organizations. For the research in this thesis, it was logistically costly to bring together such a steering committee. As a substitute, identified key interested and affected parties were visited door-to-door by the researcher. Key interested and affected parties that were accessible during this stage of the study and were visited were:

- The Department of Environmental Affairs (DEA), Gaborone (one Natural Resource Officer).
- The Department of Mines (DOM), Gaborone (one Technical Officer).
- The Water Utilities Corporation (one water officer).
- Community leaders at Metsimotlhabe village (four *dikgosana*s)

The DEA and DOM fitted in the category of authorities. The research contained in this thesis was given permission by the Department of Environmental Affairs (see Appendix 1) and, therefore, the Scoping of issues to address began as early as during the application process for permission. The Water Utilities Corporation was in the category of business, although it is a parastatal. The role of 'specialists' was filled by University academics and researchers at North West University, South Africa, who gave comments during seminar presentations.

Open-ended discussions were used in order to scope the SEA with the interested and affected parties (structured interviews later formed part of a separate stage in the SEA – the Sustainability Parameters stages in the identification of environmental impacts). These initial consultations scoped the SEA, as presented in Sections 3.3.1 and 3.3.2 of the thesis.

3.3.1 Applicable legislation

Three pieces of legislation were identified as relevant to the SEA, which were:

- The Environmental Assessment Act, 2011 (briefly outlined in Section 2.4.1.1.3 of this thesis).
- The Environmental Assessment Regulations, 2012 (briefly outlined in Section 2.4.1.1.4 of this thesis).
- The Mines and Minerals Act of 1999, governs all mining activity in Botswana. It defines procedures for the issuance of mining permits, and specifies that EIA is required for mining activity, which has resulted in comprehensive EIA guidelines for mining projects.

The Botswana Police Act was also identified as applicable to some extent, in so far as it refers to, "*...apprehend offenders, bring offenders to justice, duly enforce all written laws...*" (Cap 21:01 section 6 (1)). Non-adherence to the three pieces of legislation listed above would render the violator as an offender and, thereby, make this section of the Botswana Police Act applicable to this SEA.

3.3.2 Components of the environment at risk

The components of the environment that were identified as being at risk during scoping were:

i. River flow (discharge).
ii. Soil (erosion in areas along the river).
iii. Riparian flora (both aquatic microphytes and macrophytes).
iv. Fauna (zoo plankton, fish, aquatic birds, land fauna ecologically related to the river).
v. Water availability and quality for human use – water turbidity, water quantities.
vi. Ground water – through effects on ground water recharge.

The scope of the SEA was, therefore, identifying environmental impacts from sand mining with focus on these identified environmental components at risk, for sustainability purposes, as well as how applicable legislation (as in Section 3.3.1 of the thesis) would be utilised to make the sand mining on Metsimothlabe River situation environmentally sustainable should the Department of Mines decide to start issuing sand mining licenses that were suspended in 2010. The sustainability would include identifying alternative means of meeting the need for sand for construction in Greater Gaborone and the surrounding villages. Decision making would involve whether or not sand mining should be permitted again on Metsimotlhabe River. Monitoring and auditing considerations would involve deciding on the environmental parameters to monitor and audit should sand mining be allowed or should the status quo continue with no sand mining being permitted.

3.4 Situation assessment and baseline environmental conditions

In this section the environmental conditions in the locality of Metsimotlhabe River are described. The description of the environment serves to identify the environmental indicators that can be used in assessing sustainability of the sand mining, in the context of environmental constraints and opportunities. The baseline environmental conditions were obtained mainly from secondary sources, given the time and financial constraints during this research. This could have been a source of limitations for the research, because in reality accurate and detailed information about the environment is needed for the rest of the SEA processes to be accurate, including a reliable decision and monitoring and auditing measures.

3.4.1 Geology and soils

The geology of the area comprises of medium grey reddish sandstone that overlies the Gaborone Granite (Department of Mines, 2004). Key (1982) indicates that the predominant rocks in this part of Botswana are the early Proterozonic Gaborone Granite and Gaborone Rapakivi granite in particular. The Gaborone Granite complex is represented by different lithological phases that show spatial variations (Department of Mines, 2004). In the outer margins are the micro-granite and feldspar porphyry rocks, followed by Kgale granite which is medium grained, and eventually there is the inner medium-course grained porphyritic K-

feldspar Rapakivi granite known as Thamaga granite. Thamaga granite is also further characetised by complex multi-phase intrusive history (Department of Mines, 2004). Elsewhere in Botswana, basement rocks are covered mainly by the Kalahari sands while in small areas in the east by Karoo rocks with high coal potential (Masundire *et al.*, 1998; Sefe *et al.*, 2000).

According to Department of Mines (2004), the soils of the Metsimotlhabe catchment area are derived in situ from the granitic rock. A small proportion of the soils are derived from alluvium along the river. The alluvial soil consists of deep imperfectly drained grayish brown and brown sandy loams and sandy clay loams in association with pockets of well drained brown and brown yellowish brown sandy loams to clays (Department of Mines, 2004). The imperfectly drained alluvial soils, according to the FAO classification, are gleyic, vertic and calcic luvisoils while the imperfectly drained are chromic and orthic luvisoils.

3.4.2 Climate

Masundire *et al.* (1998) describe the climate of Botswana as semi arid and being characterized by low rainfall, high temperatures, low humidity, high rates of potential evapotranspiration and the near absence of permanent streams. The rainfall is not only low but also unreliable, unevenly distributed and highly variable from year to year (Masundire *et al.*, 1998; Batisani and Yarnal, 2010).

Generally, the rain season lasts from October to April. The average rainfall for the city of Gaborone is 500mm per year (Sefe *et al.*, 2000). The temperatures can go as high 32°C in summer and go down to 2°C in winter (Sefe *et al.*, 2000).

Stream flow is common around Gaborone but it is not continuous during the wet season. The streams are ephemeral and flow only after heavy rains, for 10 to 75 days per year on average (Masundire *et al.*, 1998).

3.4.3 Hydrology of Metsimotlhabe River

Metsimotlhabe River originates in the hilly areas near Moshupa village south west of Gaborone and drains eastward towards the Notwane River (Figure 3.1a). Its longitudinal

profile is shown in Figure 3.1b. It drains a catchment area of 3 570km^2 lying solely in Botswana (Sefe *et al.*, 2000). The river has permanent and semi permanent wetlands along its course. Its flow, however, is of very short duration during the year, mainly during the rainfall peak between January and February. Therefore, Metsimotlhabe River is ephemeral, its flow dictated by the amount and duration of rains in the rain season.

The Metsimotlhabe is a tributary of the Notwane River which originates in South Africa and forms the border between Botswana and South Africa in the eastern part of Botswana. Notwane River drains in the easterly direction to confluence with Limpopo River. The Metsimotlhabe, therefore, forms part of the Limpopo River basin.

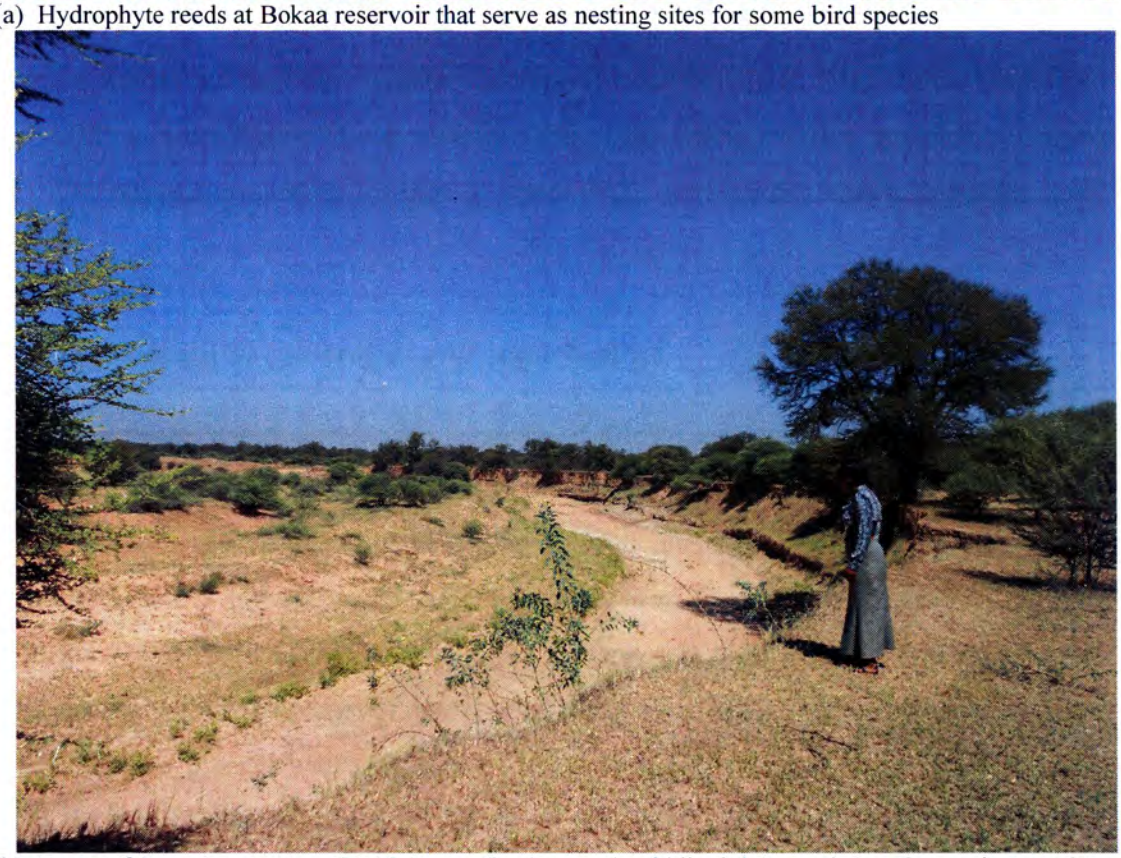
3.4.4 Flora

Tree savanna is prevalent in the undisturbed areas along the river (e.g. see river bank trees in Figure 3.2a). Common tree species in the area are *Ziziphus mucronata, Acacia tortilis, Combretum apiculatum, Euclea undulata* and *Grewia flava.* The bottom land riverine sites have a variety of grassland species such as *Cynodon dactylon*, and a variety of hydrophytic reeds (e.g. see Figure 3.3a) like *Polygonum senegalense* and *Cyperus papyrus*. The hydrophytic reeds shown in Figure 3.3a, though at the artificial Bokaa Dam reservoir, should occur along Metsimotlhabe River when it has water, but are absent if the river is dry (e.g. see Figure 3.2a). The water also carries phytoplanktons that include blue-green and green algae.

3.4.5 Fauna

Limnological information about Metsimotlhabe River could not be determined first hand during the period of this study and was sketchy in the literature. However, inferences about aquatic fauna in the river can be drawn from nearby rivers whose species have been documented (e.g. Alonso and Nordin, 2003; Siziba *et al.*, 2012), because the river is unlikely to be completely different from these rivers that are in the same climatic zone since it is not a geo-isolated system. They are likely to include the invertebrate fish species observed by Siziba *et al.* (2012) that included cladocerans, copepods and ostracods. There are also vertebrate tropical fish species in the river.

(a) Hydrophyte reeds at Bokaa reservoir that serve as nesting sites for some bird species



(b) A water fringe *Acacia* tree with bird nests (background, middle right), a safe location against predators

Figure 3.3 Pictorial illustration of the Metsimotlhabe River's ecological role to avian fauna (photos by author, taken in March 2013).

A number of bird species utilise Metsimotlhabe River. Some of the bird species are terrestrial and use the riparian vegetation for nesting and perching (e.g. see Figure 3.3b), while water birds actually live on the water during river flow.

3.4.6 Settlements and demography

The major human settlements along the Metsimotlhabe River are the villages of Moshupa, Thamaga, Metsimotlhabe, Kopong and Bokaa, in addition to Greater Gaborone farther south east (Figure 3.1a). Thamaga is the most developed and most populated (Department of Mines, 2004). According to Majelantle (2011), accommodation needs in Greater Gaborone cause people to turn to these nearby villages and, as a result, the population is growing rapidly in the villages within the proximity of Gaborone. The population growth rate for Metsimotlhabe is 7.1%, and that for Kopong is 5.3%. Between 2001 and 2011, the population of Metsimotlhabe almost doubled (Majelantle, 2011). The increase in population in the villages tends to relate to distance from the city. Villages in the proximity of Gaborone had a total population of 194 574 in 2011, increasing from 116 165 in 2001. The total population of Gaborone and its surrounding (Greater Gaborone) was 427 709 in 2011, an increase from 186 007 in 2001 and the figure represented 20.98% of the country's total population (Majelantle 2011). The population density for the city was 1 345.2 persons per square kilometer in 2011.

3.4.7 Environmental constraints and opportunities

The climate poses severe constraints in terms of aridity, so sustainability of the sand mining activity on Metsimotlhabe occurring together with the water provision ecosystem service of the river is severely constrained. The low rainfall and high temperatures result in water scarcity as the little surface water tends not to last long due to high evapotranspiration rates. The alluvial soils lead to rapid seepage of surface water into the ground water table and would encourage its recharge if there was adequate surface water. However, this quick seepage into the ground water table can result in the early drying up of water in reservoirs such as those at Bokaa and Moshupa.

Droughts are frequent in Botswana (Batisani and Yarnal, 2010), leading to crop failure and water shortages for livestock watering. Figure 3.4 shows the trends in seasonal rainfall as

recorded at Sir Seretse Khama Airport near Gaborone for the period 1991-2012, arranged in hydrological year (October to September). In general the rainfall in Southern Africa has been shown to vary in cycles of wet and dry periods lasting about 20 years (Mason and Tyson, 2000; Mason, 2001). The cycling nature of the rainfall can be seen from the 5- and 10-year moving average trends in Figure 3.4, with low rainfall in almost as short a period as every 5 years. The period 1991-2012 was the only record available from this weather station which is maintained by the Department of Meteorological Services in Gaborone. Low rainfall resulted in the closure of Bokaa Dam reservoir in 2013.

Therefore, any disturbances to the flow regime of Metsimotlhabe River will only worsen these environmental constraints in terms of water shortages both for human use and flora and fauna. The Department of Mines (2004) estimated 769 000m^3 on Metsimotlhabe River, with an annual recharge rate of 81 330m^3/annum. An opportunity for sourcing sand, however, exists farther west from the vicinity of Gaborone, in the Kgalagadi Desert and its fringes that covers most of Kgalagadi, Ganzi and Kweneng Districts (Figure 1.1).

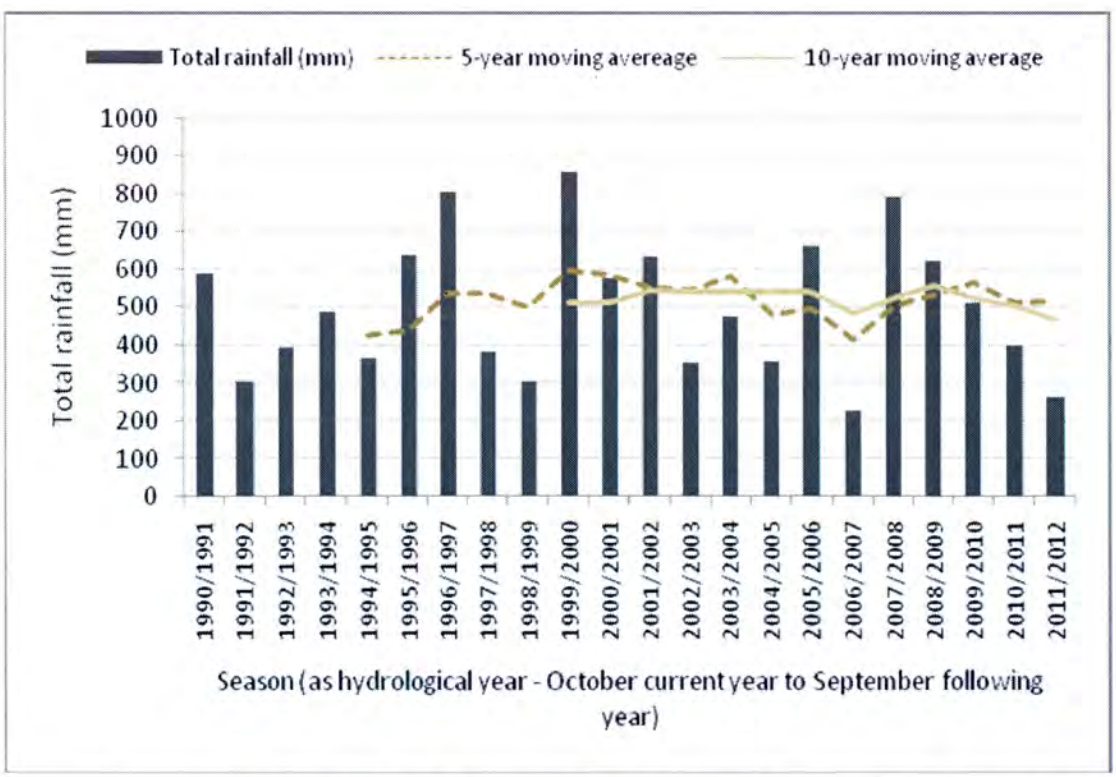


Figure 3.4 Illustration of the periodicity of low rainfall at Gaborone using 1990-2012 rainfall records for Sir Seretse Khama Airport (data: Department of Meteorology, Gaborone).

3.5 Sustainability parameters: identification of sand mining environmental impacts

This stage of the SEA involved identifying the environmental impacts of sand mining from both the legal period before the Department of Mines stopped issuing sand mining licenses in 2010, and the period thereafter during which illegal sand mining has continued. The identified environmental impacts then later served as a basis for formulating sustainability parameters for the sand mining problem. A number of methods were employed in identifying the environmental impacts, as detailed in Sections 3.5.1-3.5.6.2.

3.5.1 Impacts from literature

A number of scientific studies globally have identified environmental impacts from sand mining. The impacts identified from these studies are useful indicators of the environmental impacts that are likely to have resulted or to result from sand mining on the Metsimotlhabe River.

A number of environmental effects of varying physical magnitude and time scale can result from the extraction of river sand, with associated socioeconomic impacts. One impact is the disturbance of the river's erosion and sedimentation activities. The natural evolution of a river involves the migration from youthful stages in which vertical (river bed) erosion is predominant, through older stages in which vertical incision is less prominent than lateral (bank) erosion and then to later stages during which sediment deposition (siltation) predominates (Radhakrishna, 1992). Extraction of sand has the potential to alter these erosion and sedimentation activities of a river (e.g. Kondolf, 1997; Rovira *et al.*, 2005; de Leew *et al.*, 2010; Ferry *et al.*, 2012; Jiang *et al.*, 2013), since it involves mechanical removal of the sand from the river bed and banks. In the arid environment of Mali that is comparable to Botswana's, Ferry *et al.* (2012) established that extraction of building sand from the upper Niger River for use in the capital Bamako has maintained an incision (vertical erosion) tendency by the river, as opposed to siltation, since the early 1980s. Extracting sand from a river bed can cause steep slopes in the river bed and remove up stream sources of gravel (Boudaghpour and Monfared, 2009), as well as lower the river bed in general (Healy and Wo, 2002; Padmalal *et al.*, 2008).

In addition to changing the river channel geometry, river sand extraction can result in changes in the abundance and distribution of fish, riparian plants and birds (Baiju *et al.*, 2009;

Jiang *et al.*, 2013). Fish, for example, are negatively affected as the steep river bed slopes and turbulent waters resulting from sand extraction prevent them from spawning on the river bed (Kondolf, 1994; Boudaghpour and Monfared, 2009; Howson *et al.*, 2010). Other impacts include the collapse of river banks, reduced river water quality (Baiju *et al.*, 2009), and changes in ground water levels and quality (Kondolf, 1994; Rovira *et al.*, 2005; Piyadasa, 2011).

The long term nature of the environmental effects of river sand extraction requires the use of historical data. Long term hydrological data have been utilised in many such studies. However, the availability of historical imagery in archive makes remote sensing imagery potentially useful in the analysis of spatial aspects of the environmental effects, as a supplement to the long term hydrological data. As an example, Santo and Sánchez (2002) used manual image classification of land use and land cover on historical aerial photographs spanning 35 years in assessing environmental effects associated with sand extraction, and established an increase in the impacts.

3.5.2 Long term hydrological and rainfall data

3.5.2.1 Hydrological trends

A number of hydrological and ancillary spatial and demographic data sources (Table 3.1) were utilised for the analysis of environmental effects of extraction of river sand from Metsimotlhabe River. Long term hydrological data from gauging stations on the Metsimotlhabe River were obtained and analysed for long term trends. Unfortunately the records from these gauging stations, which are operated by the Botswana government's Department of Water Affairs, were patchy and did not go far back in history. The gauging stations at Thamaga and Bokaa (located as on Figure 3.1) had the longest and comparatively more complete records and were, therefore, utilised for the analysis. For Thamaga, the records were for the period 1979-2012 and in river discharge (cumecs) units, while for Bokaa they were only for the period 1992-2012 (i.e. commencing with the commissioning of the dam) and in river height (meters) units (Table 3.1a). Due to the incompleteness of the records (Table 3.1a), the length of period that was utilised in the actual analysis was shorter than these respective total lengths of records. All the records were in hydrological year pattern, arranged from October in a given year to September the following year.

Monthly mean river discharge and height values for the two gauging stations with relatively more complete records (Thamaga and Bokaa, respectively) were plotted in order to establish whether there was deterioration in river flow in the long term. The plots of these monthly hydrological data (Figure 3.5) revealed that, on average, the peak river discharge and highest river levels were in February and March. This hydrological peak lagged about a month behind the peak rainfall month, which was established to be January (Figure 3.6). The analysis then sought to establish where there had been a long term decline in the peak river discharge. The records at Thamaga, which were longer than those at Bokaa, were utilised for this analysis. In the analysis, the mean monthly river discharges in February and March in the respective hydrological years in the record (Figure 3.5b) were analysed for departure from the record's respective long term mean monthly discharges by computing the standardised departure from the mean as in equation 1.

$$Month's\ standardised\ departure\ from\ mean\ discharge = \frac{\bar{\alpha} - \sigma}{\sigma} \qquad (1)$$

where $\bar{\alpha}$ = month's mean discharge (cumecs),

σ = long term mean discharge for month (cumecs)

From the 16 hydrological years that had complete records and were utilised in the analysis (Figure 2b), the first 8 years before 1992/93 were grouped as an 'older' period (i.e. 1983/1984 to 1990/1991 all inclusive) and those from 1992/93 to 2000/2001 as the 'newer' period. The eight hydrological years in the newer period were 1992/93, 1993/94, 1994/95, 1995/96, 1996/97, 1998/99, 1999/2000, and 2000/2001. The frequencies of positive and negative standardized departures from the long term mean as computed using equation 1 were then compared for statistical significance using the chi-square (χ^2) test.

3.5.2.2 Rainfall trends

In this semi-arid, low rainfall environment, rainfall has a critical influence on river flow. Therefore, long term rainfall data for the area were obtained from the Botswana government's Meteorology Department. The rainfall records covered the period 1990-2012 only, as recorded at the main airport in Gaborone, Sir Seretse Khama Airport (Table 3.1a). Originally in calendar year records, the monthly rainfall totals were rearranged into the pattern October in current year to September the following year in order to fit the pattern of

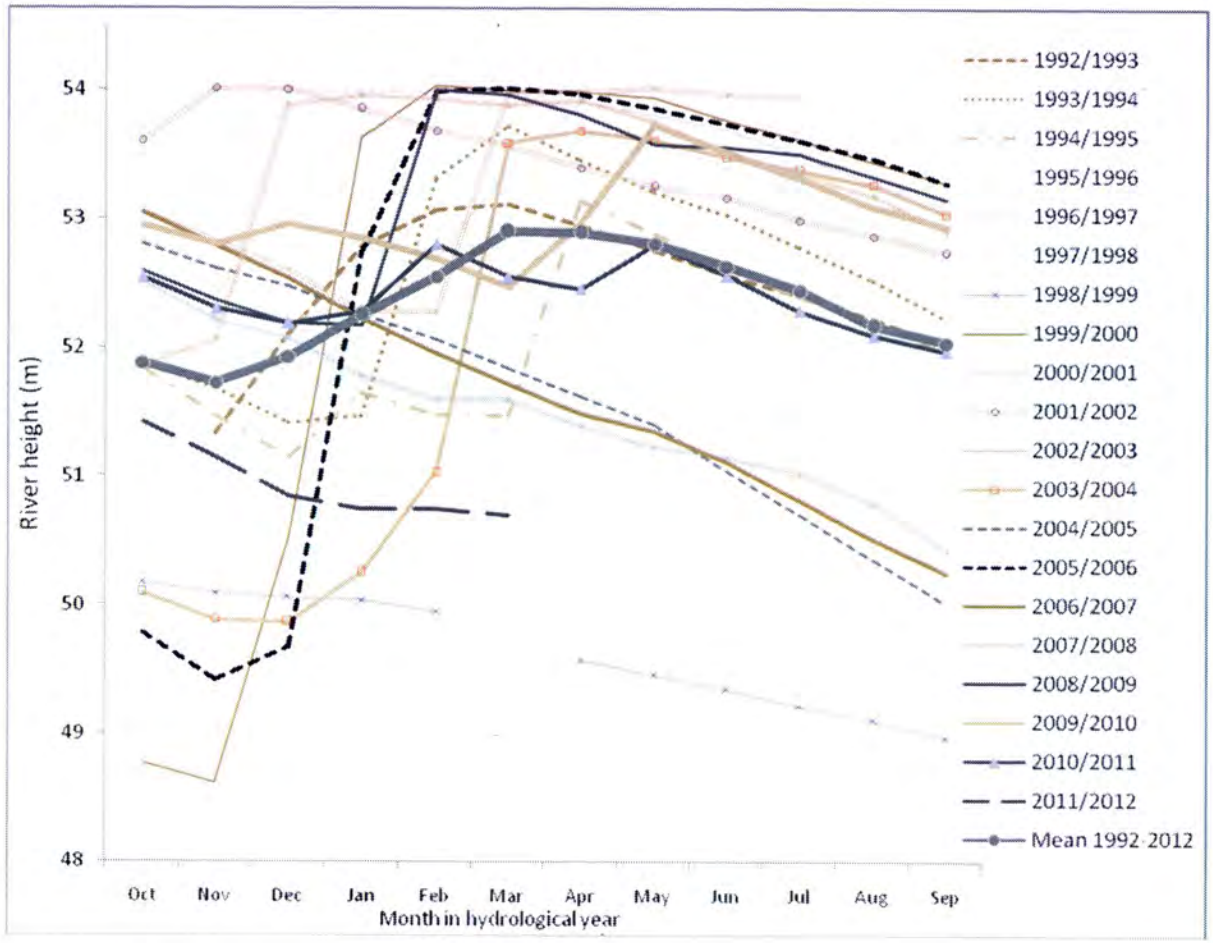
Table 3.1 List of data utilised in the analysis of Metsimotlhabe environmental impacts.

(a) Environmental and demographic attribute data

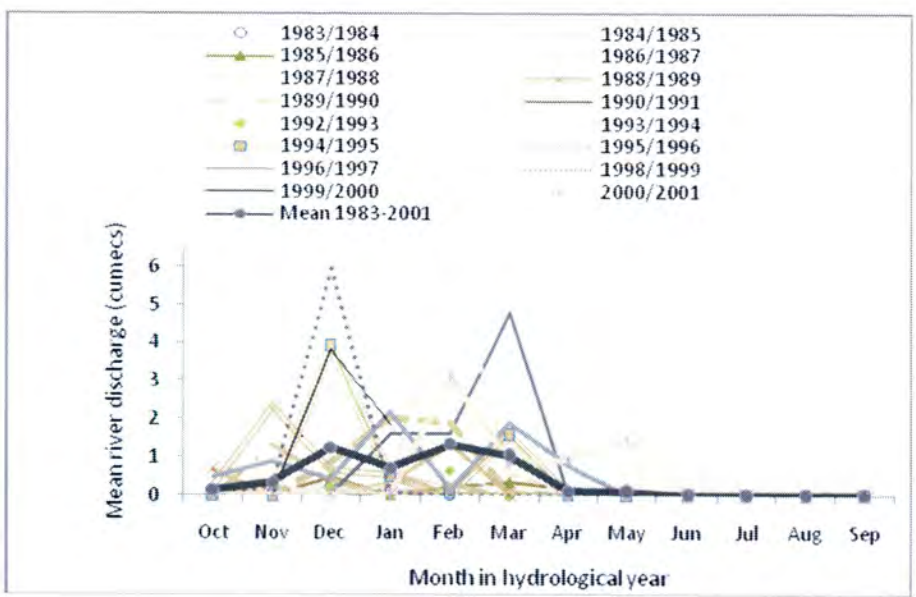
Data	Botswana Government source	Completeness of data
1. Daily river flow (cumecs) of Metsimotlhabe River at Thamaga (Figure 1; Station Number 2421), 1979-2012.	Department of Water Affairs	Records blank for the hydrological years 1979/1980, 1980/1981, 1981/1982, 1982/1983, 1991/1992, 2001/2002, 2002/2003, 2003/2004, 2004/2005, 2005/2006, 2006/2007, 2007/2008, 2008/2009, 2009/2010, 2010/2011, 2011/2012; incomplete records for 1997/1998; no records before 1979.
2. Daily river heights (meters) of Metsimotlhabe River at Bokaa (Figure 1; Station Number 2422), 1992-2012.	Department of Water Affairs	No data for October 1992, April-September 2012, occasional incomplete records within months; no records before 1992.
3. Monthly rainfall totals recorded at Sir Seretse Khama Airport, Gaborone (Figure 1; Station Number 035-SSKA), 1990-2012 arranged January – December per year.	Meteorology Department	No records before 1990.
4. Demographic data: - Population at Metsimotlhabe Village 1991, 2001, 2011 censuses.	Central Statistics Office	
5. GIS data of the study area (shape files): - Height contours (5m vertical interval). - Rivers and water bodies. - Built up areas. - Administrative boundaries.	Department of Surveys and Mapping	Metadata missing.

(b) Digital remotely sensed imagery

Sensor	Reference	Date	Spatial resolution
SPOT 4 HRV	K/J 127/399	12 February 2011	20m
SPOT 4 HRV	K/J 127/399	16 June 2002	20m
Landsat TM	WRS 172/077	04 March 1991	30m (band 6: 120m)



(a)



(b)

Figure 3.5 Long term hydrological variations in the Metsimotlhabe River: (a) monthly mean river levels (height above datum) at Bokaa dam per hydrological year, 1992-2012, (b) monthly mean river discharge (cumecs) at Thamaga per hydrological year, 1983-2001 (Data: Department of Water Affairs, Gaborone, Botswana; see Figure 3.1 for station locations).

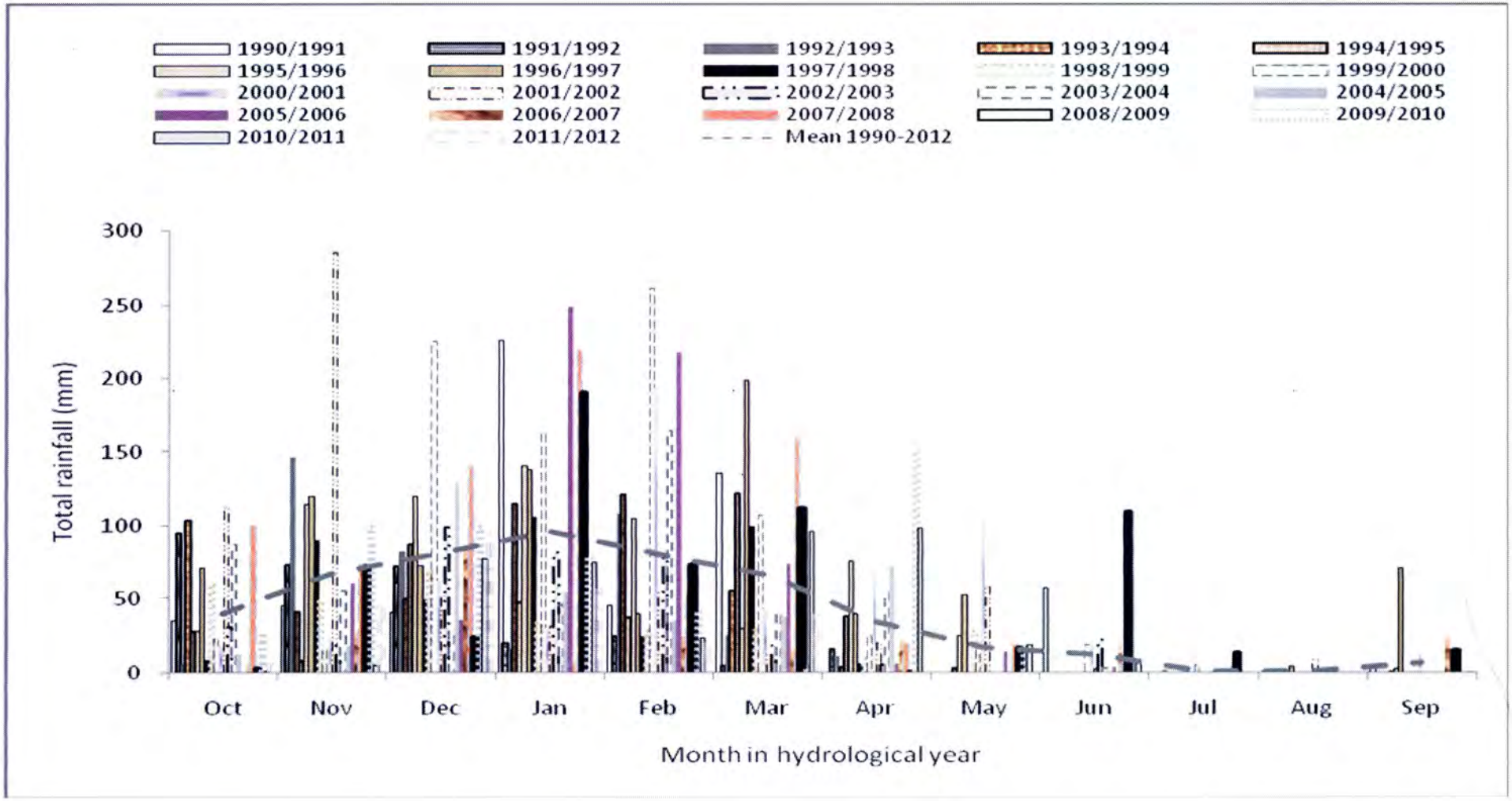


Figure 3.6 Rainfall fluctuations in monthly totals per hydrological year in the Gaborone area based on 1990-2012 data recorded at Sir Seretse Khama Airport (Raw data: Meteorology Department, Gaborone, Botswana). Monthly rainfall data arranged in hydrological year to facilitate comparison with river discharge data as in Figure 3.5.

the hydrological data. The rainfall data were analysed for trends (5 and 10-year moving averages) as a supplement to the analysis of long term hydrological change in the gauging station data. The analysis of rainfall trends was undertaken in order to determine whether deteriorations in the flow of the Metsimotlhabe River were due to human factors or rainfall.

3.5.3 Demographic, GIS and other ancillary data

Population data for Metsimotlhabe village from the 1991, 2001 and 2011 censuses were obtained from the Central Statistics Office for purposes of interpreting manifestation of environmental deterioration in the context of human causes. Geographic Information System (GIS) spatial data shapefiles of the study area were obtained from the Department of Surveys and Mapping, which aided mapping and the analysis of satellite images covering the area. Bokaa Dam siltation and water quality data were obtained from the Water Utilities Corporation in Gaborone, but were of too short a duration (2011-2013) for long term analysis.

3.5.4 Multitemporal remote sensing image analysis

3.5.4.1 Image Data

Three images covering the study area and on a 20-year time span (Table 3.1b) were obtained for analysis of long term spatial change in land cover attributes, primarily riparian vegetation as one of the environmental components identified during Scoping as being at risk from the sand mining. The images were obtained from the South African National Space Agency (SANSA) in Pretoria, South Africa. Given the small size of the river channel under study and the need for spatial detail in terms of vegetation cover, it was judged that high spatial resolution imagery (of at least 20m resolution) were ideal for the analysis.

The image dates were selected so as to go as far back in time as the availability in the SANSA archive allowed. However, high spatial resolution images are only available since the 1980s. Within these limitations, imagery from 1991, 2002 and 2011 were obtained (Table 3.1b).

The 20m resolution SPOT (***Systemé Pour l'Observation de la Terre***) images would have been ideal for all three dates in Table 1b. However, SPOT 4 imagery was not available for dates before the date of the 2002 image, due to a technical problem. For this reason, a lower spatial resolution (30m) Landsat TM image was used instead. During image processing, these differences in the spatial resolution of the images were addressed by reducing the resolution of the SPOT images to that of the Landsat image.

3.5.4.2 Image processing and change detection

3.5.4.2.1 Image processing

ERDAS Imagine 2013 software was utilised for image processing. ArcGIS 10.1 was utilised for supporting mapping and GIS processing of the spatial layers listed in Table 3.1a.

3.5.4.2.1.1 Pre-processing

Accurate geometric registration is a pre-requisite for change detection using remote sensing (Lu *et al.*, 2004). Therefore, all the images were registered to a common map projection, the UTM WGS84 (zone 35 South) projection. The spatial registration error was less than a pixel, as required (Lillesand *et al.*, 2008). Due to differences in spatial resolution for the image dataset, the two 20m resolution SPOT images were resampled to the 30m resolution of the Landsat TM image.

The analysis of environmental degradation was primarily targeted at the Metismotlhabe River and its immediate surroundings. Therefore, other parts of the river's valley were excluded from the analysis and locations within 5km of the river were chosen for use in the analysis. This was accomplished by generating a 5km buffer on either side of the river, using the buffering function in ArcGIS. This buffer area was then used to subset the three images so that only locations within 5km of the river were subsequently utilised.

3.5.4.2.1.2 Image classification

Image classification is the process of organising image data into themes or classes (Lillesand *et al.*, 2008). Until the recent development of newer sub-pixel and segmentation techniques, there were two main and contrasting approaches to image classification: supervised

classification and unsupervised (automated) classification (e.g. Thomson *et al.*, 1998). In supervised classification, the analyst generates class spectral signatures by drawing polygons at sample locations that represent the classes of interest in the image scene, using on-screen digitising. The spectral statistics of these 'training areas' are then specified to the image classification algorithm, which then compares the spectral values of the rest of the pixels in the image with the sample statistics in order to assign the pixels to the class that they are statistically closest to. One advantage of supervised classification is that the image data are organised into classes that are meaningful to the analysis at hand.

Using the supervised classification approach, the images were separately classified into five thematic classes that were of relevance to detecting environmental degradation. In addition to the vegetation (subdivided into two classes) that was the main interest of the analysis with remotely sensed images, three other classes were used, bringing the total to five classes. The five classes were: water, healthy vegetation, built up area, sand, and other dry/sparsely vegetated land (Table 3.2). The Gaussian maximum likelihood classifier (Lillesand *et al.*, 2008) was employed as the algorithm during the process of the actual classification following the identification of the training areas.

Table 3.2 Image classification classes.

Class	Description and characteristics
Class 1 – Water	Water bodies (both deep, clear water and shallow turbid water).
Class 2 – Healthy vegetation	Healthy vegetation covering most of the pixel.
Class 3 – Built up	Built up areas – concrete/metal surfaces, with bare ground and healthy vegetation in between.
Class 4 – Sand	Bare sand surfaces.
Class 5 – Other dry / sparsely vegetated land	Dry land with very sparse healthy vegetation.

The spectral separability of the class spectral signatures that were generated was assessed by plotting band mean values (Figure 3.7) and using Euclidean Distance separability values (Table 3.3). In a graphical plot of the spectral signature mean values per image band, ideally the respective lines should be separate if the classes are separable. High Euclidean Distance values also indicate high class separability. Water (Class 1) had the highest Euclidean Distance values against the other classes followed by healthy vegetation (Class 2). Although the mixture of riparian vegetation and water resulted in slight spectral confusion between the two, both the graphical plots and the Euclidean Distance values indicated that healthy vegetation was spectrally distinct from the other classes. The presence of healthy vegetation and bare soil patches in built up areas made built up area and other dry/sparsely vegetated land (Class 5) somewhat spectrally similar, which resulted in misclassification (Table 3.4). Therefore, because of its generally more unique spectral signature and high delineation (user's) accuracy of about 86%, the change in cover by the healthy vegetation class on the three dates was subsequently utilised in the assessment of environmental degradation (change detection). Although water had high Euclidean Distance separability values, change in cover by water was not used in the change detection due to water's temporary and highly variable nature as a land cover class in this semi-arid environment.

3.5.4.2.2 Change detection

GIS overlay analysis using Boolean analysis was then utilised in analysing change in vegetation cover in the vicinity of Metsimotlhabe River. The healthy vegetation thematic layers on the classified 1991, 2002 and 2011 classified images were separated using image recoding in ERDAS. These layers (Figures 3.8a-3.8c) were then coded as 2, 3, and 4 for 1991, 2002 and 2011 healthy vegetation, respectively. These codes gave more unique results with the Boolean addition algorithm that was subsequently utilised for mapping changes in the cover of healthy vegetation on the three dates.

The Boolean addition algorithm was implemented using the Model Maker facility within ERDAS. On the map that resulted from the addition, the resulting healthy vegetation codes were interpreted as follows: 2 indicated 1991, 3 indicated 2002, 4 indicated 2011, 5 indicated 1991 and 2002, 6 represented 1991 and 2011, 7 represented 2002 and 2011, and 9 represented healthy vegetation on all three dates.

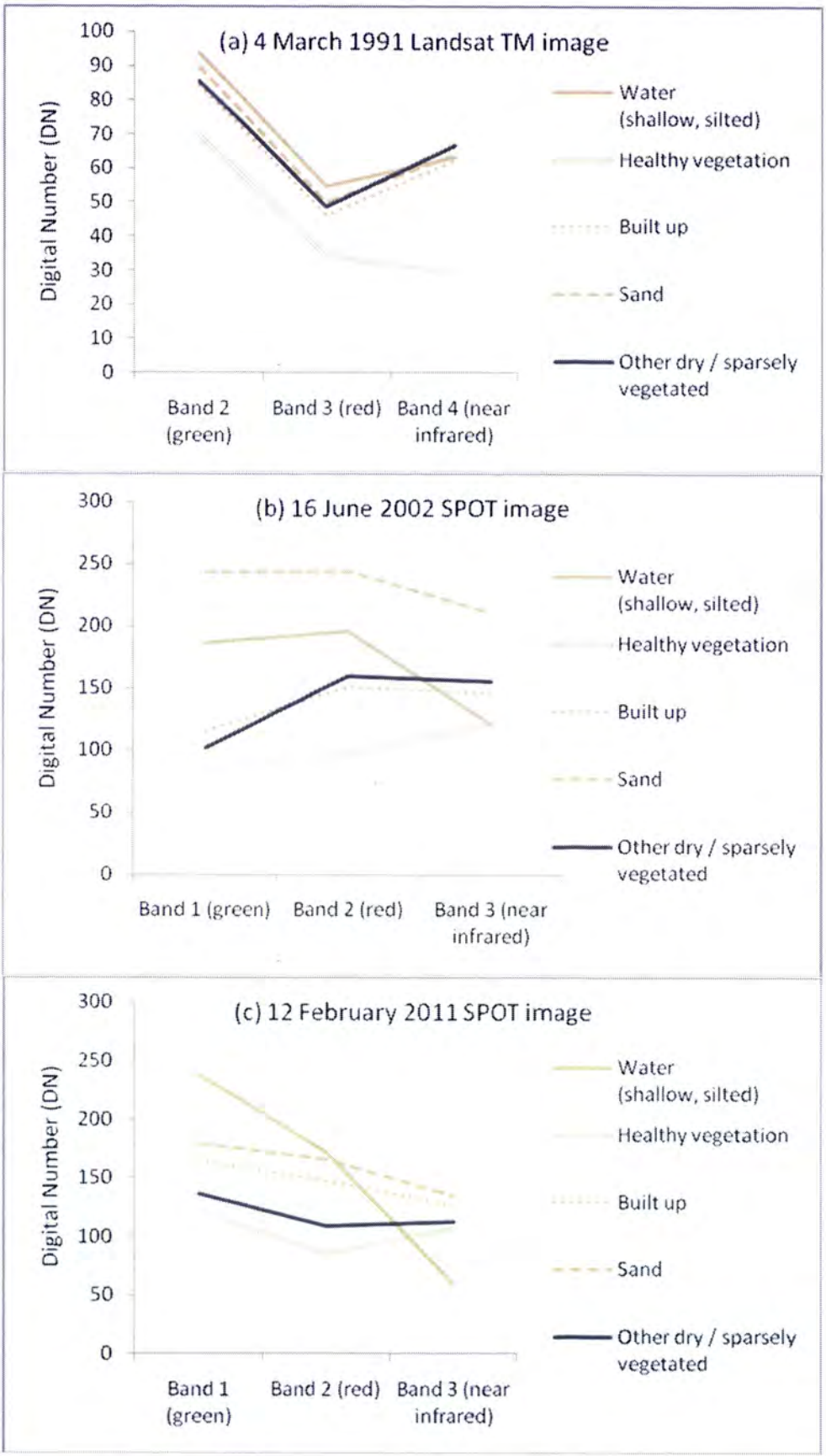


Figure 3.7 Illustration of image classification class spectral separability for the three images that were used.

Table 3.3 Summary of Euclidean Distance separability of the image classification classes in Table 3.2 on the images that were utilised.

(a) 4 March 1991 Landsat TM image best average separability

	Class 1	Class 2	Class 3	Class 4
Class 2	118			
Class 3	155	92		
Class 4	165	103	13	
Class 5	191	124	37	27

(b) 16 June 2002 SPOT HRV image best average separability

	Class 1	Class 2	Class 3	Class 4
Class 2	144			
Class 3	99	73		
Class 4	123	236	171	
Class 5	125	95	36	178

(b) 12 February 2011 SPOT HRV image best average separability

	Class 1	Class 2	Class 3	Class 4
Class 2	160			
Class 3	129	85		
Class 4	143	118	36	
Class 5	153	43	51	79

Table 3.4 Illustration of classification error and spectral confusion among the image classification classes that were used based on the newest (12 February 2011) image.

Classification data	Reference data						
	Class 1	Class 2	Class 3	Class 4	Class 5	Total	User's Accuracy
Class 1 (Water)	2				1	3	66.6
Class 2 (Healthy vegetation)		18	2		1	21	85.7
Class 3 (Built up)			9	2	5	16	56.3
Class 4 (Sand)			2	2	3	7	28.6
Class 5 (Other dry/sparsely vegetated)		7	9	2	35	53	66.0
Total	2	25	22	6	45	100	
Producer's accuracy (%)	100	72.0	40.9	33.3	77.8		

Overall accuracy = 66%
Overall Kappa, $\hat{K}$ = 49.2%

3.5.5 Public and government environmental authority participation

Public participation in SEA is recommended. In this case study, the public participated through focus group discussions and answering questionnaires. Representatives of key environmental management authorities in Botswana government departments were interviewed using interview guides.

3.5.5.1 Interviews with Botswana Government authorities

Representatives from Botswana Government departments were interviewed using interview guides (Appendix 2), purposefully selected as key informants. They were (totals in brackets):

- Department of Environmental Affairs (5): Principal Natural Resource Officer, Senior Natural Resource Officer, Natural Resource Officer I, and two Natural Resource Officers.
- Department of Mines (5): Chief Mining Engineer, 2 Mining Engineers, 2 Technical Officers.
- Sub-district administration offices, Mogoditshane Sub-district Council (5): 2 Environmental Health Officers, 1 Principal Architect, 2 Roads Department officials.

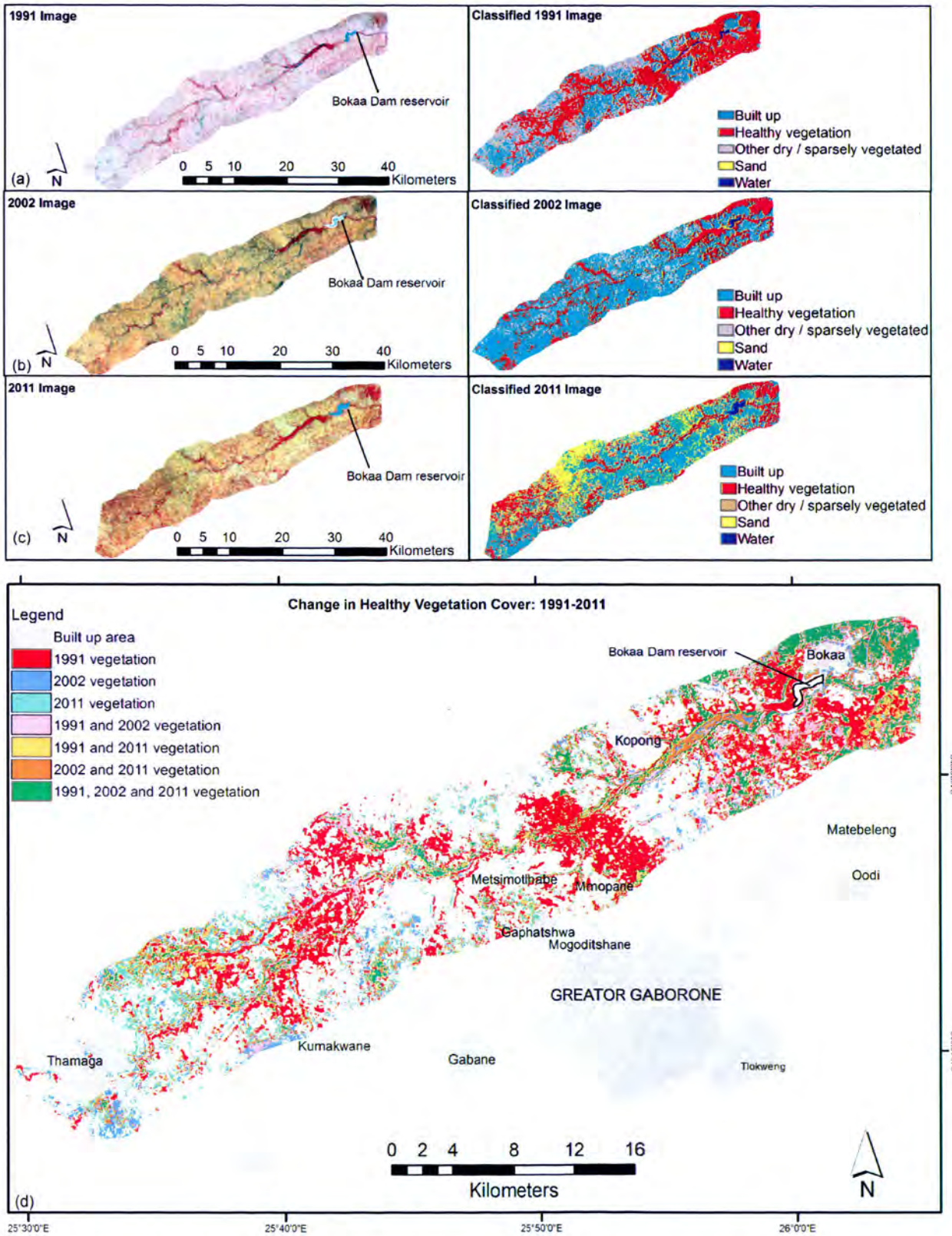


Figure 3.8 Change in vegetation cover in the vicinity of Metsimotlhabe River using the healthy vegetation class on classified multitemporal images: (a) 4 March 1991 Landsat TM image (RGB:432), (b) 16 June 2002 SPOT image (RGB:321) and (c) 12 February 2011 SPOT image (RGB:321). In (d) a change detection of the healthy vegetation class is depicted (interpretation is presented in the text; Section 4.1.1.3).

3.5.5.2 Village Development Committee focus group discussions

Focus group discussions (FDGs) were held with Village Development Committee members and *dikgosana* (community leaders) at the *Kgotla* (court place) in Metsimotlhabe (Figure 3.9). The meeting was attended by members of the Botswana Police Service. A general introduction of the problem of sand mining on Metsimotlhabe River was presented by the researcher. Thereafter a discussion ensued as the VDC members deliberated, with the researcher guiding the discussions using the schedule shown in Appendix 3. The researcher recorded the discussions for later reference, with the permission of the focus group discussion participants.

Figure 3.9 A focus group discussion at Metsimotlhabe village. The discussion was held during the field collection of information about sustainability parameters and environmental impacts of sand mining. In the photo *dikgosana* (community leaders) and members of the Village Development Committee are listening to the researcher introducing the issue for discussion.

3.5.5.3 Community questionnaires

The questionnaire that was designed for the community members is shown in Appendix 4. The questionnaire primarily sought to obtain information about the environmental concerns of community members who live along Metsimotlabe River, as well as the environmental impacts that they had noticed. The questionnaire was administered to 94 households in Metsimotlhabe village. The respondents were chosen purposefully, as the households that were closest to the river. Following a brief introduction on arrival at the household, respondents were invited to participate in the questionnaire interview if they were judged to have lived in the area long enough to provide answers to the questions in the questionnaires, given that some of the questionnaires required historical information.

Although the questionnaire is in English, the questions were asked in the local language *SeTswana*, in order to ensure comprehension. The researcher personally conducted the administration of the questionnaire and recording of the answers. The questionnaires were completed right there with the respondent present and were, therefore, not left at the household for completion by the respondent. Although this approach can have the disadvantage that respondents might not provide the right answer given the little time to think about their responses, it had the major advantage that the response rate was 100% for all the questionnaires administered and also that misunderstood questions were quickly clarified by the interviewer. The presence of the interviewer could have somewhat influenced the respondents, but this was minimized by not seeming to lead the respondents to answer a certain way by reading the options in an unpredictable order from time to time.

3.5.6 EIA impact identification tools

The SEA guidelines for Botswana (Department of Environmental Affairs, 2009) recognize the need for diagnostic tools in identifying impacts, and the guidelines include checklists in addition to matrices and network diagrams. However, checklists have the disadvantage of inability to indicate higher order impacts such as synergistic impacts. In addition, with a checklist there is no way of weighting the comparative significance of environmental impacts identified (World Bank, 1997).

The other two impact identification tools – matrices and network diagrams – were considered. Therefore, this study opted to use what was judged as more accurate diagnostic

tools. These tools were a matrix and a network diagram. The tools are usually designed by experts for specific contexts and have to be adapted for the analysis at hand, as was undertaken in this study. Department of Mines (2004), for example, used the RIAM Matrix developed by Pastakia and Jensesn (1998). One of the most renowned matrices in the literature is the Leopold Matrix (World Bank, 1997) and it was applied to the case study. A dredging network diagram was identified as being applicable to the study and was, therefore, applied.

3.5.6.1 Matrix

The Leopold Matrix (Table 3.5) was adopted for use. The matrix consists of columns and rows, with the columns listing impact-causing activity and the rows showing possible environmental components that can be affected by the activities. The intersection between an activity (column) and an environmental component (row) shows a possible impact, and scores are entered at the intersection with regard to the impact's *magnitude* (on the top left in the cell) and severity or *importance* (on the bottom right in the cell). The magnitude score varies from 1 to 10 based on objective evaluation of facts and can be positive or negative, while the importance score also varies 1 to 10 but is based on subjective judgement (World Bank, 1997). The scores can be totaled (summed) in order to permit comparison of the impacts.

From the Leopold Matrix, two activities appeared relevant to the sand mining activity on Metsimotlhabe River and these were 'Surface excavation' and 'Use of heavy machinery, equipment and traffic movement'. These two activities applied to the case study because extracting sand from the river bed amounts to surface excavation, and the trucks used to ferry the sand (see Figure 3.2a) qualify under the 'Use of heavy machinery, equipment and traffic movement' category. Scores were subsequently entered into the Leopold Matrix with respect to these two column entries in the Leopold Matrix.

3.5.6.2 Network diagram

A network diagram applicable to water course dredging projects (Figure 3.10) was adopted for use in the case study. This is because the extraction of sand from the river bed of

Table 3.5 A Leopold Matrix adopted for environmental impact identification.*

Project Actions / **Environmental Characteristics**	***Occurrence of PMF***	***Use of explosives***	***Solid waste disposal***	***River dumping***	***Surface excavation***	***Use of heavy machinery, equipment and traffic movement***	***Obstruction of water flow in aflage***	***Reservoir operation***	***Provision of water for irrigation purpose***	***Development of construction camp***	**Total**
Water supply											
Surface water											
Ground water											
Air climate											
Erosion											
Sedimentation											
Flora/fisheries											
Fauna											
Agriculture											
Noise											
Aesthetics											
Social health and safety											
Structure safety/damage											
Slope instability											
Green house effect											
Resettlement											
Economic growth											
Employment											
Total											

*SOURCE: World Bank (1997).

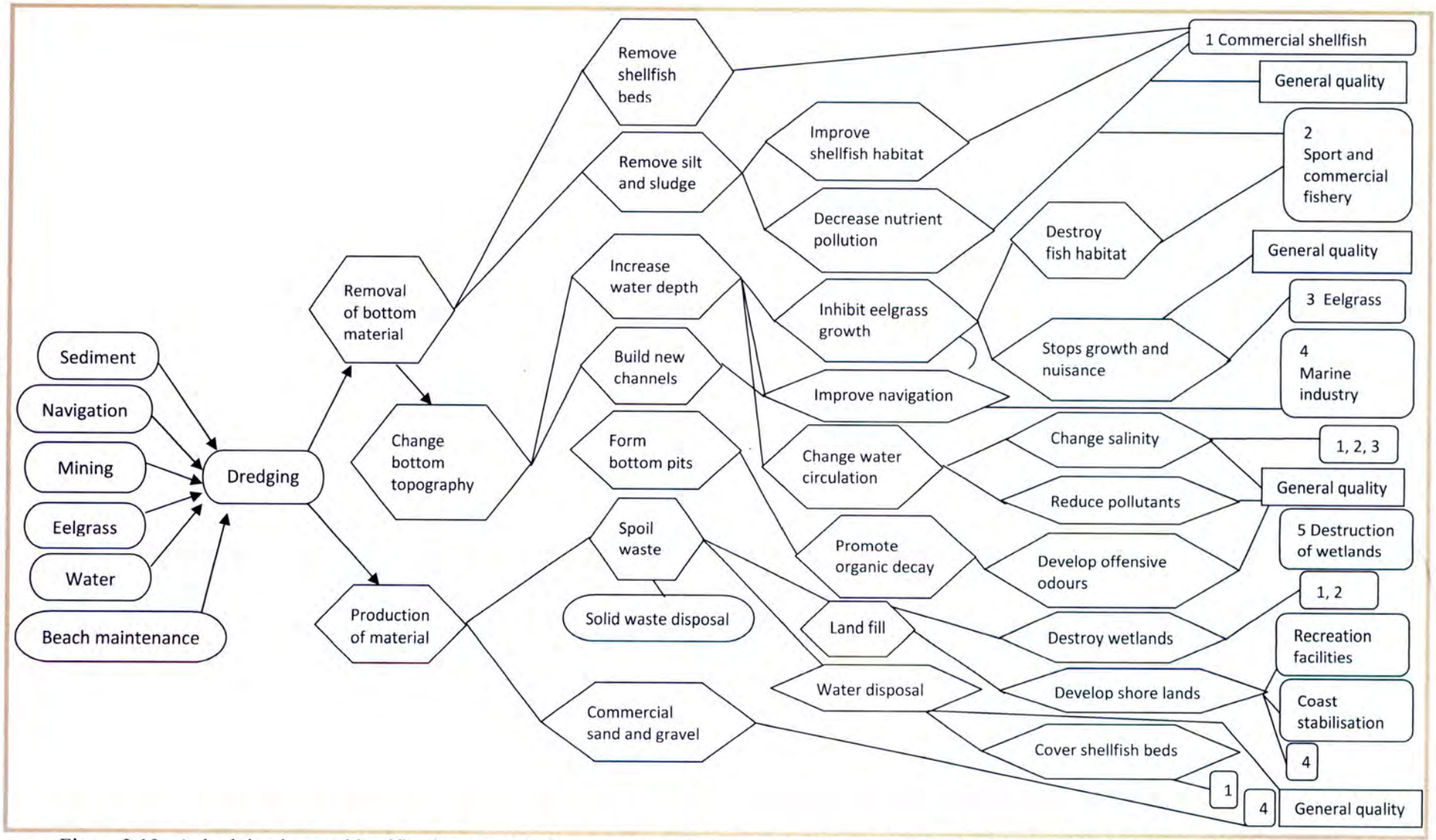


Figure 3.10 A dredging impact identification network diagram utilised in impact identification for sand mining on Metsimotlhabe River (source: World Bank 1997).

Metsimotlhabe River involves removing river bed material, which is equivalent to dredging. No network diagram that was specific to river sand mining was available in the literature.

The network diagram was used as a supplement to the matrix in Table 3.5. This was because, although able to weight the different impacts for comparative severity, the matrix was unable to identify impact linkages which would permit identification of impact synergy. As shown in Figure 3.10, the network diagram that was adopted was able to identify impact linkages as well as indirect (synergistic) impacts. The network diagram was designed for marine dredging, but components of it are applicable to dredging any water body or water course. The component of the network diagram that was found to be applicable to the sand mining activity on Metsimotlhabe River was:

Mining ⟶ *Dredging* ⟶ *Removal of bottom material*⟶

Using this component of the network diagram, impacts of sand mining on Metsimotlhabe River could then be identified and the identified impacts are stated in Chapter 4.

SEA CASE STUDY RESULTS AND RECOMMENDATIONS FOR DECISION MAKING

4.0 Introduction

In chapter three sand mining on Metsimotlhabe River was introduced as the SEA case study that was used by this research in evaluating the effectiveness of the SEA process in Botswana. The SEA process follows that recommended by the Department of Environmental Affairs in Botswana, as summarized in Figure 2.1. In Chapter three, the first four stages of SEA as applied to the sand mining case study are addressed.

With the exception of the Sustainability Parameters stage (Step 4 in the SEA process), the results of each stage of the SEA case study are presented in Chapter three. The results from the Sustainability Parameters step and the rest of the SEA are detailed in this chapter. The main issues emerging from the SEA in terms of addressing the aim, objectives, research questions and hypothesis of the research outlined in Sections 1.5 to 1.8 of the thesis are then summarized at the end of the chapter.

4.1 Sustainability parameters based on identified environmental impacts

4.1.1 Identified environmental impacts of sand mining on Metsimotlhabe River

A number of sources, methods and tools for identifying the environmental impacts of sand mining on Metsimotlhabe River were used, as detailed in Section 3.5. They included theoretical impacts from scientific studies in literature, analysis of long term hydrological data, GIS and Remote Sensing analysis, public and government environment authority interviews (guided interviews with authority representatives, VDC focus group discussions, and community questionnaires), the Leopold Matrix, and a network diagram.

The impacts that were identified were then used in formulating sustainability parameters for the sand mining activity on Metsimotlhabe River.

4.1.1.1 Impacts from literature

Impacts from sand extraction from river beds have been identified by researchers globally as outlined in Section 3.5.1. These theoretical impacts of sand extraction from rivers are summarised in Table 4.1, and are equivalent to the "expert opinion" impact identification method (World Bank, 1997). The methodological procedures and tools that were used in the case of Metsimotlhabe River (Sections 3.5.2 – 3.5.6.2) sought to confirm the impacts.

Table 4.1 Summary of environmental impacts of sand mining based on global examples.

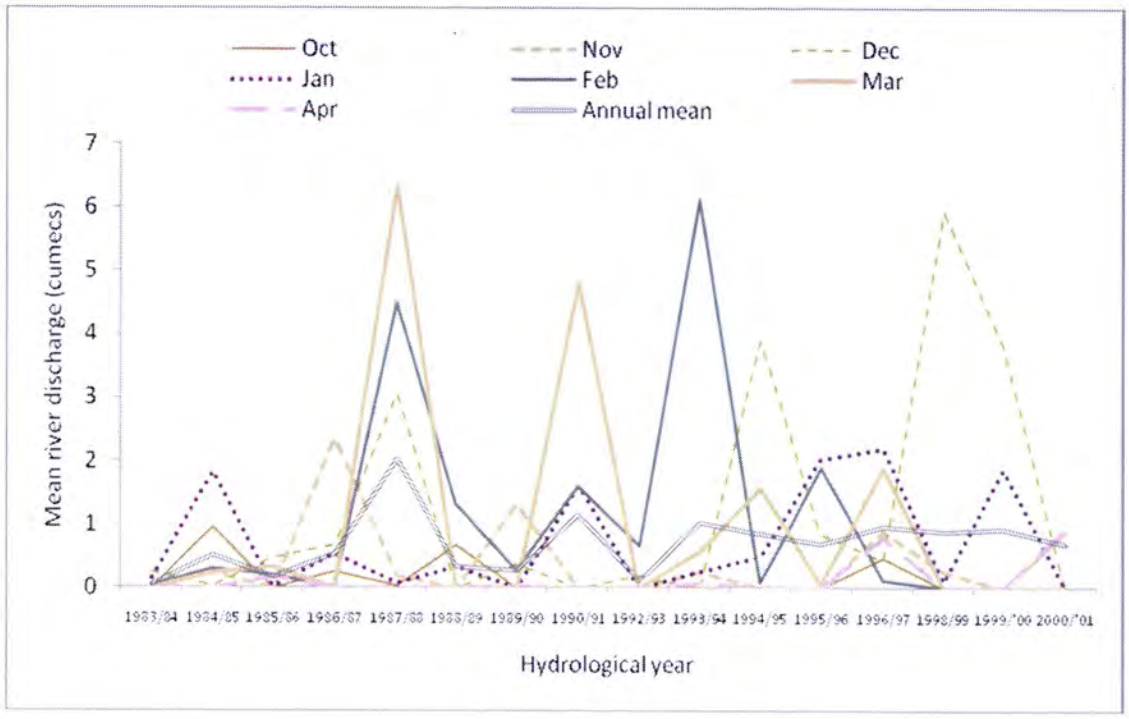
Impact	Literature source(s)
1. Alteration of river's erosion and sedimentation activities in general.	Rovira *et al.*, 2005; de Leew *et al.*, 2010; Ferry *et al.*, 2012; Jiang *et al.*, 2013.
2. Inducing and maintaining upstream vertical incision (bottom erosion) by river.	Kondolf, 1997; Department of Mines, 2004; Ferry *et al.*, 2012.
3. Development of steep slopes in the river bed and removal of upstream sources of gravel.	Boudaghpour and Monfared, 2009
4. General lowering of the river bed.	Healy and Wo, 2002; Padmalal *et al.*, 2008.
5. Changes in the abundance and distribution of fish, riparian plants and birds.	Baiju *et al.*, 2009; Jiang *et al.*, 2013.
6. Prevention of fish spawning on river bed due to steep river bed slopes.	Kondolf, 1994; Boudaghpour and Monfared, 2009; Howson *et al.*, 2010
7. Collapse of river banks.	Baiju *et al.*, 2009.
8. Reduced river water quality.	Baiju *et al.*, 2009
9. Changes in ground water levels and quality	Kondolf, 1994; Rovira *et al.*, 2005; Piyadasa, 2011.

4.1.1.2 Impacts on river flow

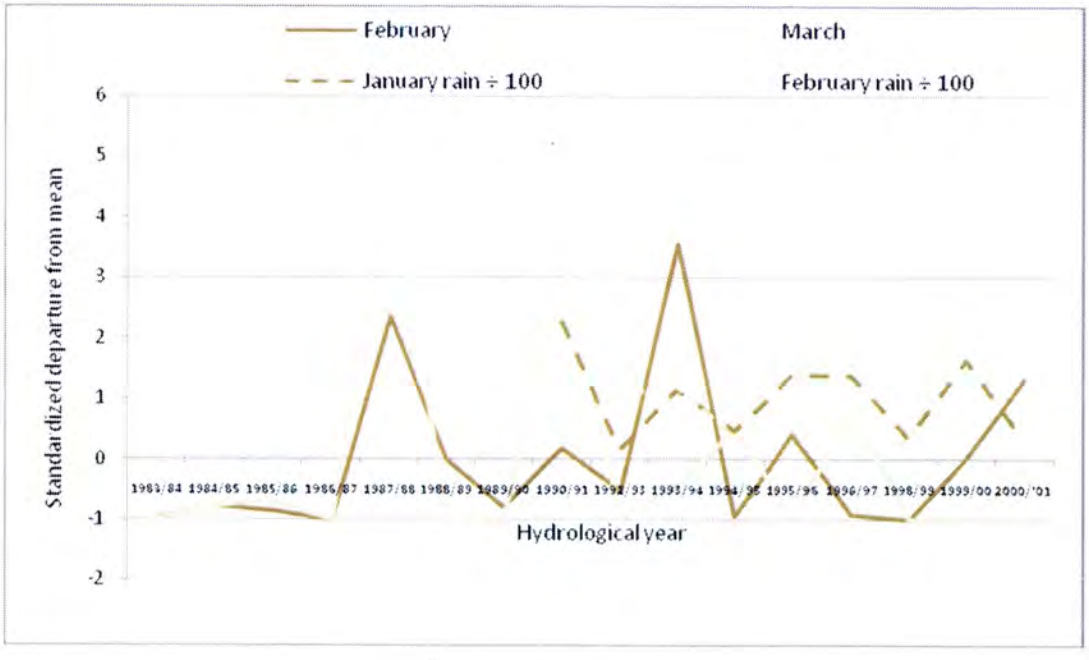
Long term hydrological data were analysed for trends as detailed in Section 3.5.2.1. The analysed data confirmed a strong influence by rainfall on the discharge of Metsimotlhabe River, as was expected for this semi-arid environment. The peak discharge of the river in February (Figure 3.5b) follows the rainfall peak in January (Figure 3.6), i.e. with a one month lag period. For the hydrological years 1990/1991-2000/2001 when there were data on both rainfall (Figure 3.4) and river discharge (Figure 3.5b), the total seasonal rainfall had a positive but weak correlation with mean annual discharge at Thamaga gauging station which, however, was not statistically significant ($r = 0.306$; $P > 0.05$).

The waterlevels at Bokaa (Figure 3.5a) were unreliable as indicators of long-term degradation because the discharge from the dam is regulated. This explains why some hydrological years in Figure 3.5a departed from the normal pattern of having the highest river levels in March but had them in October and November instead. The departure from the normal pattern applies to the hydrological years 1997/1998, 1998/1999, 2001/2002, 2002/2003, 2004/2005, 2006/2007 and 2011/2012 as shown in Figure 3.5a, all of which generally coincided with low total rainfall (Figure 3.4). This leads to the deduction that the river levels at Bokaa are unreliable for observing long-term indications in the natural flow pattern of Metsimotlhabe River as influenced by sand extraction, because in dry years the discharge through the dam is likely to be restricted in order to retain water in the reservoir for human use.

Long term discharge data for Thamaga gauging station indicated that, based on the annual mean discharge, the discharges were low in the 1980s but that they stabilised at a higher discharge level after the 1992/93 hydrological year (Figure 6a). The non-peak discharge months December and January followed a similar pattern to the annual mean discharge in the long-term (Figure 6a). Comparing the period before the threshold 1992/93 hydrological year with that afterwards, there was a large difference in the frequency of positive and negative standardised departures from the long-term mean river discharge as computed by equation 1. During the peak discharge months of February and March (Figure 6b), the period before the 1992/93 hydrological year had more negative departures than that after. This indicates that the river's peak discharge was lower in the 1980s than in the mid 1990s and thereafter. However, these differences in frequency of positive and negative standardised departures from the long-term mean were not statistically significant (February: $\chi^2 = 0.291$, $P > 0.05$; March: $\chi^2 = 0$, $P > 0.05$).



(a)



(b)

Figure 4.1 Long term fluctuations in the flow of the Metsimotlhabe River at Thamaga gauging station on Metsimotlhabe River, 1983-2001: (a) trends in monthly discharge during river flow period (river dry in May, June, July, August and September), (b) standardised monthly departures from long-term mean as indicators of extremes in the peak (February, March) discharge, computed using equation 1 on page 59. The rainfall figures are divided by 100 in order to fit them on the same Y-axis scale as the standardised departures values.

Therefore, the long term hydrological data held by the Government of Botswana's Department of Water Affairs do not allow the derivation of conclusive, statistically significant indicators of hydrological environmental degradation in the Metsimotlhabe River. The period covered by the data (since the 1980s only; Table 3.1a) is too short for meaningful long term inferences to be derived.

The trends in standardised departures from the respective months' means in Figure 6b were then analysed in conjuction with monthly rainfall totals. Due to the approximately one-month hydrological time lag between rainfall and river discharge (compare the mean curves in Figures 3.5b and 3.6) the February discharge is influenced by January rainfall and the March discharge by February rainfall. Therefore, monthly rainfall totals for these two months were plotted together with the standardised departures curves, for the hydrological years after 1989/90 for which there were rainfall data.

The results of plotting the rainfall (Figure 6b) indicate that the standardised departures were not always in syncrony with the respective prior rainfall totals that were supposed to be influencing them. For example, February 1993/94 had a high positive (>3.0) standardised departure compared to hydrological years thereafter, like 1996/97 and 1998/99 with negative departures, despite higher rainfall in the latter period (Figure 6b). High rainfall in this latter period did not seem to result in high river discharge.This points to other factors that have come to play in influencing the flow of the river, for example a subtle disturbance to the flow of the river due to the extraction of sand.

The high mean annual river discharge through the upper gauging station at Thamaga in the mid 1990s and low discharge during the 1980s is most likely a result of the generally low rainfall in Southern Africa in the 1980s (Mason and Tyson, 2000; Batisani and Yarnal, 2010). The rainfall record that was available for the analysis was too short to ascertain this but it indicated a period of rainfall stability in the area in the 1990s, judging from the seasonal rainfall moving averages (Figure 3.4). It is not certain where the 1990s and 2000s belong in the long-term wet and dry rainfall cycle that has been established for Southern Africa (Mason and Tyson, 2000). They are probably in the high rainfall phase that could be followed by a low rainfall period similar to that in the mid-1980s.

However, high rainfall did not seem to always result in high river discharge through the upper gauging station at Thamaga in the mid 1990s and thereafter (Figure 6b). This points to the possibility of an impact on the flow of the river from the scouring of sand from the river bed

downstream of Thamaga and towards Metsimotlhabe village. Disturbance in the flow of the river has been established by other studies (e.g. Department of Mines, 2004; Olesitse, 2009). The gradual vertical profile of the river (Figure 3.1b) could have been disturbed in this section of the river; perhaps the extraction of sand has made it somewhat even in places. A more even gradient in turn could result in seepage of water into the groundwater table on the river bed at the expense of runoff in the form of river discharge. This could have resulted in low river discharge despite high rainfall in the months leading up to the normal peak river discharge in February and March. Reduced flow in the river is, therefore, likely to have resulted from the extraction of sand from the Metsimotlhabe River, both during the legal period up to June 2010 and during the illegal sand mining period thereafter.

4.1.1.3 Change in vegetation cover

Change in cover of healthy vegetation in the vicinity of Metsimotlhabe River (Figure 3.8d) appeared to give more conclusive evidence of environmental degradation, compared to the hydrological analysis. The absolute values of area of cover by healthy vegetation on the respective image dates were less meaningful than the changes in actual location of the vegetation. The analysis using multitemporal satellite imagery indicates that there was a loss of riparian vegetation on the Metsimotlhabe River in the sections at Metsimotlhabe village and downstream towards Bokaa reservoir dam. The location of the lost vegetation is indicated as 1991 vegetation in Figure 3.8d.

The reduction in cover by riparian vegetation that was established using multitemporal images is a more reliable indicator of degradation in the river's environment. The vegetation had high delineation accuracy on all the three images, compared to the other classes like sand and built up area that had high spectral confusion (Table 3.4) and were not accurately delineated (Figures 3.8a-c). Built up area and sand were, as a consequence of their non-unique spectral signatures, considerably over estimated on the 2002 and 2011 images (Figures 3.8b, 3.8c) which partly caused the low overall classification accuracy of 66%. The difference in dates (season) at image acquisition (Table 3.1b) is likely to have affected the delineation of the vegetation that was located away from the river fringe. This is because some trees could have been entering senescence on the June 2002 image scene, since June is nearly in the Southern Hemisphere winter. The other two images were acquired during the rainy season, and in the rainy season both trees and grass are in near full vigour. The error

introduced by this season difference was reduced by restricting the analysis to the vicinity of the river, where moisture stress in the vegetation is of lower magnitude due to the availability of water from underground sources.

The loss in riparian vegetation in the vicinity of Metsimotlhabe village could have resulted from the combination of the collapse of the river banks and physical removal of the vegetation by sand miners. The riparian vegetation consists of river bank woody (tree) vegetation and riparian weeds and grass (see Figures 3.2a, 3.3). Its reduction and the reduced flow of the river in turn could have caused reduced bird life on the river. Currently water birds are only abundant at the Bokaa Dam reservoir (Birdlife Botswana, 2013), as was observed during a field check. Ironically, being a source of negative environmental impacts in itself, the dam has produced something of a positive environmental effect in providing a refuge for this birdlife.

4.1.1.4 Impacts identified using EIA impact identification tools

The following component of the network diagram in Figure 3.10 allowed the identification of impacts of river sand mining on Metsimotlhabe River:

Mining ⟶ *Dredging* ⟶ *Removal of bottom material*⟶

Removal of bottom material results in two impacts:

1. Removal of fish spawning beds at the river bottom (as opposed to "remove shellfish beds" in Figure 3.10), and invertebrate fish like cladocerans, copepods and ostracods.
2. Change in river bottom topography, which results in lowering of the river bed and development of steep river bed slope (as opposed to "increase in water depth" in Figure 3.10), as well as drying of the river due to disturbance to sand bed aquifers.

These two impacts are equivalent to impacts 6 and 4, respectively, in Table 4.1, which confirms the usefulness of the network diagram although it was developed for the coastal environment.

Table 4.2 shows the Leopold Matrix with score entries of impacts identified for sand mining on Metsimotlhabe River. The scores are based on the researcher's perception of severity. They show that the most severe impacts of the sand mining are on flora and fauna.

Table 4.2 A Leopold Matrix with environmental impact scores as applicable to sand mining on Metsimotlhabe River.

Project Actions / **Environmental Characteristics**	***Occurrence of PMF***	***Use of explosives***	***Solid waste disposal***	***River dumping***	***Surface excavation***	***Use of heavy machinery, equipment and traffic movement***	***Obstruction of water flow in aflage***	***Reservoir operation***	***Provision of water for irrigation purpose***	***Development of construction camp***	**Total**
Water supply											
Surface water					+6 2						+6 2
Ground water					-1 0						-1 0
Air climate											
Erosion						+2 2					+2 2
Sedimentation					+1 4	+2 1					+3 5
Flora/fisheries					+7 8						+7 8
Fauna					+7 8						+7 8
Agriculture											
Noise						+1 2					+1 2
Aesthetics					+1 2						+1 2
Social health and safety											
Structure safety/damage											
Slope instability											
Green house effect											
Resettlement											
Economic growth											
Employment											
Total					+21 24	+5 5					

*Scores are Magnitude (top left)/importance (bottom right) per cell, on scale 0 to 10. Magnitude can have negatives).

The impact scores in Table 4.2 can be explained as follows:

- 'Surface excavation' of the river bed and 'Use of heavy machinery, equipment and traffic movement' to transport the sand are the activities in sand mining on Metsimotlhabe River that cause environmental impacts. Based on a higher total magnitude score of +21, surface excavation of the river bed has higher impacts compared to the +5 for 'Use of heavy machinery, equipment and traffic movement'. It also has higher importance or severity, based on its total score of 24 compared with the 5 for 'Use of heavy machinery, equipment and traffic movement'.

- The total magnitude and severity scores for the two activities 'Surface excavation' and 'Use of heavy machinery, equipment and traffic movement' are derived from totaling the magnitude and severity scores for the environmental impacts that they cause.

- 'Surface excavation' of the river bed causes the following environmental impacts:

  - It impacts on surface water supply for human use by disturbing the river's flow. Therefore, it is given a magnitude score of +6. However, human use of the water in Metsimotlhabe River (through Bokaa Dam) in Gaborone is only supplementary to that in Gaborone Dam, hence the low severity score of 2.

  - It has linkages with the ground water table in that water in the river is encouraged to seep to the water table due to the sand pits excavated by sand miners (e.g. see Figure 3.2a). These pits are isolated, hence the low magnitude score of -1. Given other sources of groundwater recharge for the presumably large aquifer below the Gaborone area, the importance is also given a low score of 0.

  - Sedimentation in that lowering the river bed in places encourages upstream vertical down cutting of the river, which raises the sediment content of the water. Sediments ending up in Bokaa Dam reservoir are of concern to the Water Utilities Company that has to purify the water prior to supply to Gaborone. This impact is, therefore, given the importance score of 4 but a magnitude score of only +1 since the vertical profile of the river is broken by dam reservoirs.

  - Impacts on flora/fisheries and fauna: the disturbance of the river bed by excavation destroys fish spawning areas which could result in low fish abundance in the river given that the lower Bokaa Dam is a barrier to upstream migration of fish from the

Notwane River. Low abundance of fish in turn affects the abundance of water birds that feed on the fish. Therefore, these impacts are given high magnitude scores of +7 and high importance scores of 8.

- Negative impacts on the aesthetic appearance of the Metsimotlhabe River due to the pits in the river beds (see Figure 3.2a compared to no bottom pits in Figure 3.3b). The pits are, however, not discernible from distance, hence the low magnitude score of +1. They are also only a small component of the aesthetic beauty of the area since it includes the vegetation which is also aesthetically pleasant, hence the low severity score of 2.

- 'Use of heavy machinery, equipment and traffic movement' has the following environmental impacts:

  - Side erosion of the river band due to the access paths created by the trucks and other machinery (e.g. see Figure 3.2a). These access paths are limited in location, hence the low magnitude score of +2. There is also natural erosion of the river bank and, therefore, the access roads are only a supplement, hence the low importance score of 2.

  - Sedimentation: the erosion caused by the access roads for trucks and other machinery contributes to the sediment load of the river. Sediments ending up in Bokaa Dam reservoir are of concern to the Water Utilities Corporation that has to purify the water prior to supply to Gaborone. The limited nature of the prevalence of these roads led to the low magnitude score of +2 and importance score of 1.

  - Noise: the machinery and truck engines cause noise that can disturb fauna and human beings. Its short duration nature (only when the truck passes or the machine is excavating sand to fill up a truck) led to the low magnitude score of +1. However, given the presence of other disturbances to fauna, there is synergy between this impact and them, hence the slightly large importance score of 2.

These scores are arguable depending on the perception of the analyst, particularly the severity (importance) scores that are subjective by nature. In the best judgement of the researcher and without exaggeration, the respective scores were appropriate at the time of the research. The

scores could then be totaled to derive the most severe impacts from sand mining on Metsimotlhabe River. In order of magnitude they were (see Table 4.2):

i. Flora/fisheries impacts, fauna impacts (magnitude scores of +7 for both).

ii. Impact on surface water (magnitude score of +6).

iii. Sedimentation (magnitude score of +3).

iv. Erosion (magnitude score of +2).

v. Noise and negative aesthetics impacts (magnitude scores of +1).

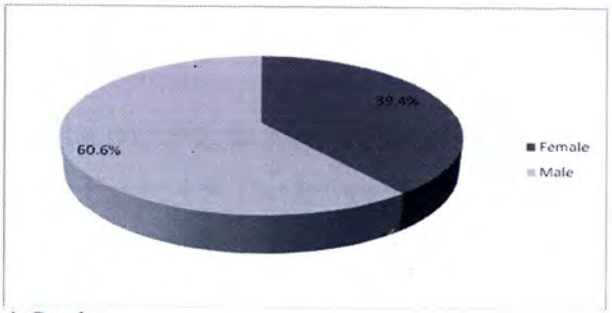
vi. Groundwater impacts (magnitude score of -1).

4.1.1.5 Impacts identified from interviews

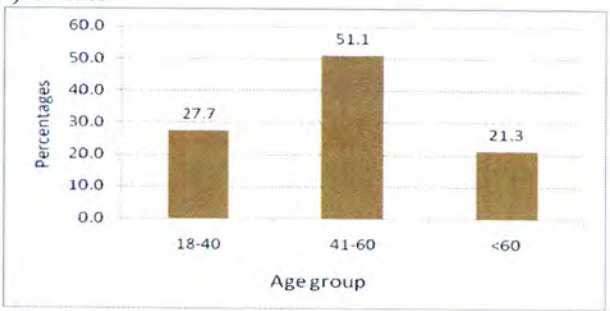
4.1.1.5.1 Community questionnaires

The 94 community members of Metsimotlhabe village to whom the questionnaire in Appendix 4 was administered had the characteristics summarised in Figure 4.2. Their questionnaire responses were coded and entered into spreadsheets in the Statistical Package for Social Sciences (SPSS). The majority of the respondents (60.6%) were female, which represented the demographics of Metsimotlhabe village that show females to be in the majority (Majelantle, 2011). Most of the respondents (51.1%) were of middle age (41-60), the majority (>76%) had some level of education (primary or higher), most were unemployed (66.0%) and the majority (>93%) had lived in Metsimotlhabe for more than 20 years (since 1990 or earlier).

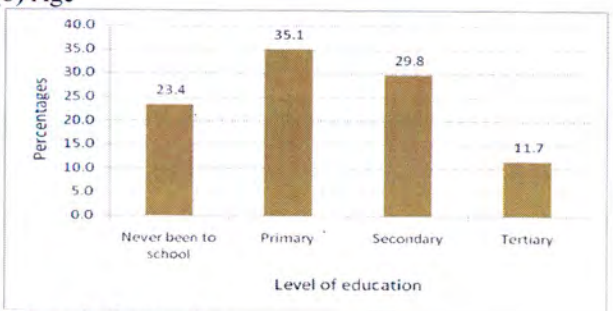
Given that the majority of the respondents had some level of education and had lived in the area for long, the respondents were quite ideal for the responses required because they could understand environmental issues and could bear witness to environmental degradation on Metsimotlhabe River. The fact that the majority were unemployed and female could be due to the fact that the administering of the questionnaires was conducted during daytime when the employed household members were away at work, or if unemployed were out on social travels. This applied to the weekend days when some of the questionnaires were administered.



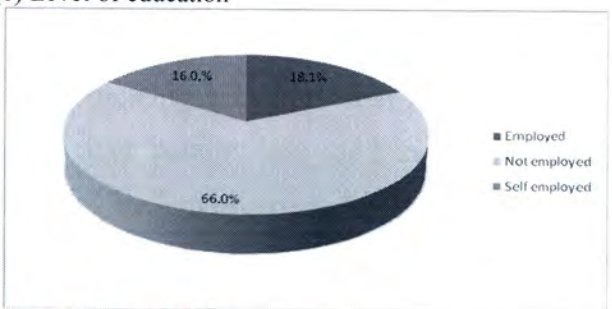
(a) Gender



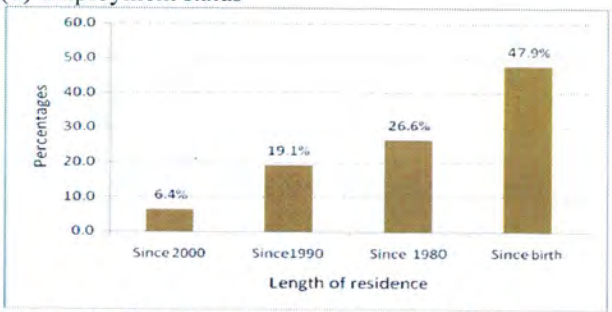
(b) Age



(c) Level of education



(d) Employment status



(e) Length of residence in Metsimotlhabe village

Figure 4.2 Characteristics of community member questionnaire respondents.

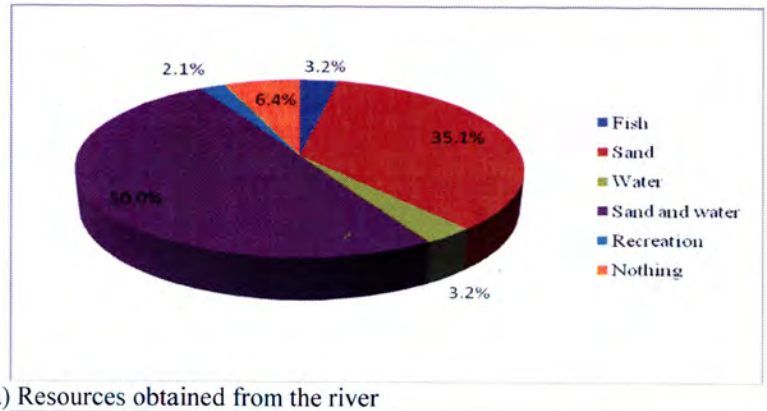
4.1.1.5.1.1 Environmental aspects of sand mining

As a way of gauging the importance of Metsimotlhabe River to the community, the questionnaire sought from the respondents information about their use of the river, and their responses are summarised in Figure 4.3. This information was important to the SEA as it was judged to contribute to decision making about the continuation of sand mining for human benefit, in comparison with negative impacts on the non-human components of the environment.

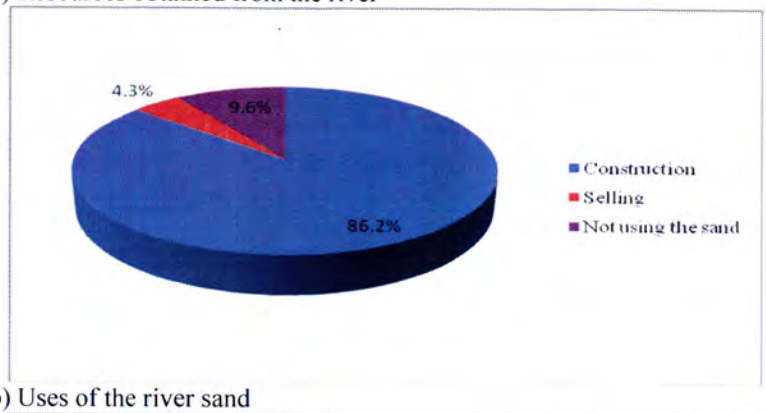
Half (50%) of the respondents indicated that they obtained sand and livestock water from the river (which they obtained through hand-dug wells on the river bed for the animals to drink from), and 35. 1% indicated that they obtained sand only, resulting in the total of 85.1% of the respondents obtaining sand from the river (Figure 4.3a). The majority (86%) of the respondents indicated they had used river sand for construction (Figure 4.3b). The questionnaire responses indicated that sand had been obtained from the river before the 1980's by the respondents (Figure 4.3c). Most of the respondents used the sand in small quantities of less than $\leq 40m^3$ (Figure 4.3d).

The next group of questions in the questionnaire sought information on environmental awareness, and the results are summarised in Figure 4.4. The respondents appeared to be well aware of the negative effects of sand mining in the river, with 58.5% indicating that the river had dried up, and 21.3% indicating a combination of negative impacts (decreased water quality, burrow pits in the river bottom, less sand in the river; Figure 4.4a). Most of the respondents (60.6%) indicated the environmental effects of river sand mining that they had noticed as reduced bird life, reduced vegetation and reduced recreational use (reduced bird life - 3.2%, reduced vegetation - 21.3%, reduced recreational use - 8.5%; Figure 4.4b). A total of 93.6% of the respondents, therefore, indicated some form of environmental effects of sand mining.

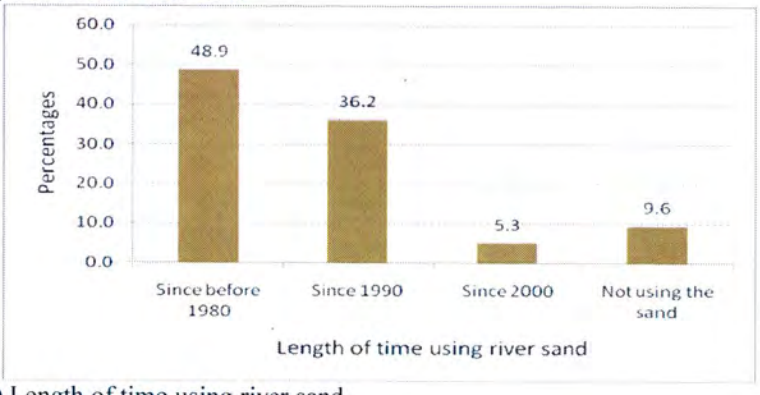
Most of the respondents (46.8%) noticed the existence of sand mining before 2000, while 9.6% indicated that they had not noticed any negative environmental impact (Figure 4.4c). The majority of the respondents who had noticed negative environmental impacts indicated that they had noticed them since the 1990s. These responses, therefore, indicated that negative environmental impacts from sand mining on Metsimotlhabe River had been noticed over twenty years before the time of this study.



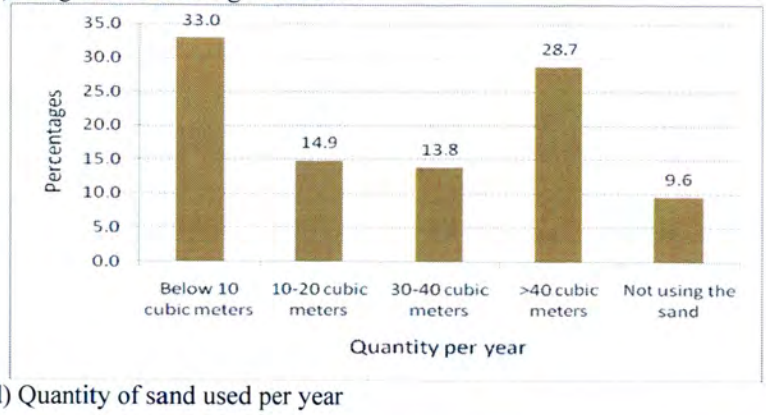
(a) Resources obtained from the river



(b) Uses of the river sand

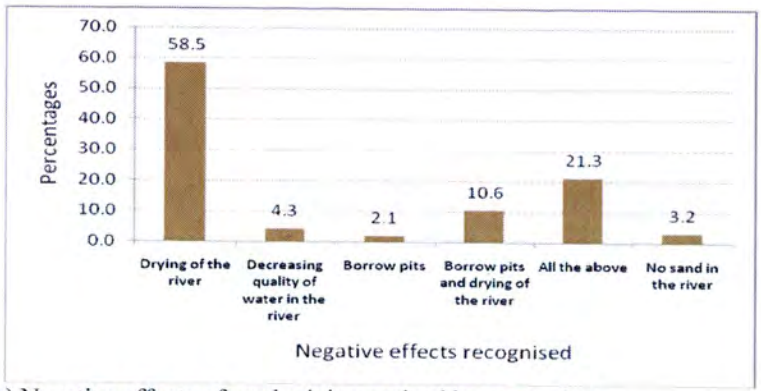


(c) Length of time using river sand

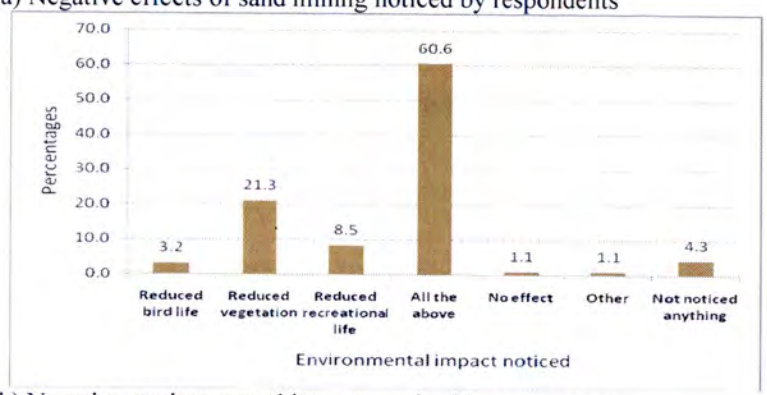


(d) Quantity of sand used per year

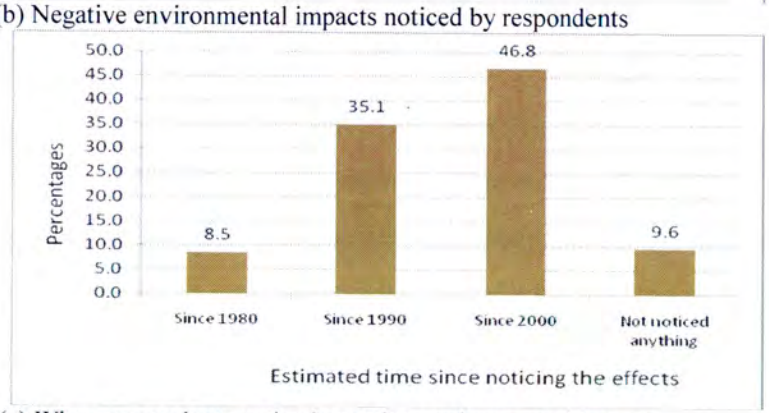
Figure 4.3 Community questionnaire responses on the uses of Metsimotlhabe River by Metsimotlhabe residents.



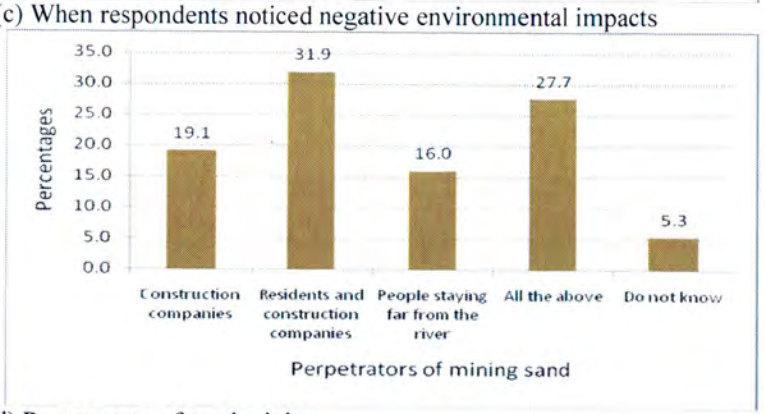
(a) Negative effects of sand mining noticed by respondents



(b) Negative environmental impacts noticed by respondents



(c) When respondents noticed negative environmental impacts



(d) Perpetrators of sand mining

Figure 4.4 Community questionnaire responses on the perpetrators of sand mining and awareness of negative environmental impacts from sand mining on Metsimotlhabe River.

4.1.1.5.1.2 Punitive measures against illegal sand mining

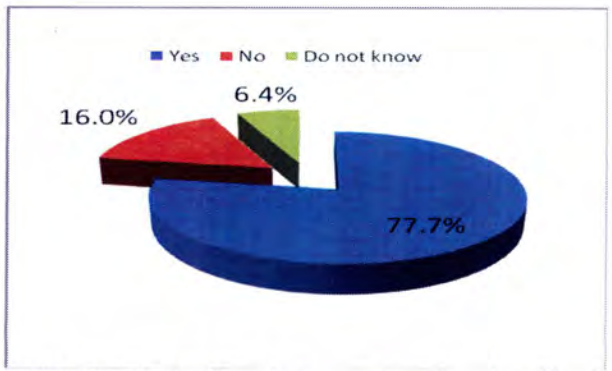
The questionnaire also sought from the community respondents information on the punitive regime being implemented against illegal sand miners, given that since 2010 sand mining is illegal on Metsimotlhabe River. This information was deemed important to the SEA as part of finding ways to make sand mining sustainable, and an integral part of the process in terms of the public participation requirement in SEA.

The majority (77%) of the respondents agreed with the statement that the river was being monitored to control illegal mining, with only 16% indicating that they did not know, while 6.4% stated that the river was not being monitored (Figure 4.5a). It was, therefore, deduced that the river was being monitored against illegal sand miners. The evidence from the questionnaires was that the monitoring was not frequent, as nearly 50% of the respondents indicated seeing officials once in a month and only 14.9% estimating the patrols to be once a week (Figure 4.5b). Though monitoring was not very frequent, there was evidence from the respondents that illegal sand miners got arrested: 67 % of the respondents were aware of the arrests (Figure 4.5c).

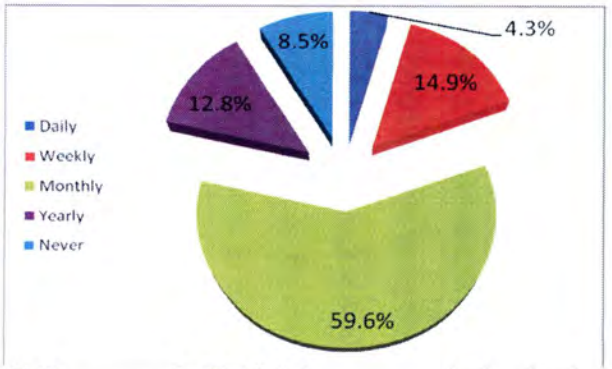
The community was also aware of the punitive measures against illegal sand mining, with 56.4% of the respondents indicating awareness (Figure 4.5d). The respondents who had not seen illegal sand miners being arrested indicated that they did not know why the culprits did not get arrested, while 36.2% indicated that illegal sand miners escaped before capture, 4.3% thought the legislation was inadequate, and 3.2 % thought there were inadequate law enforcement officers (Figure 4.5e).

The respondents who were aware of punitive measures against illegal sand miners indicated that the culprits were fined (Figure 4.5f), and none mentioned imprisonment. It was, therefore, deduced that illegal sand miners do get caught and get fined, as indicated by the questionnaire respondents.

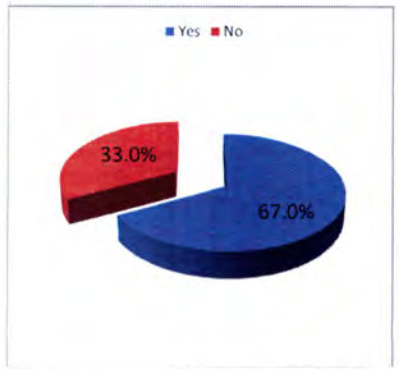
The responses to the questions in the community questionnaire (Appendix 4) that had options as answers were assigned numerical codes (e.g. 1 = male, 2 = female for question 1 in Section A; and the age groups in question 2 were assigned the codes 1 for 18-40, 2 for 41-60, and 3 for >60; etc for the other questions). This then facilitated correlation analysis, for purposes of determining the reliability of the answers (i.e. response cross-validation). Correlations that were deemed meaningful are presented in Table 4.3.



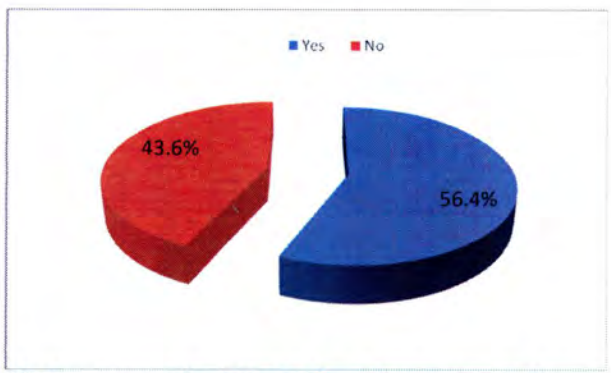
(a) Metsimotlhabe River being monitored against illegal sand miners



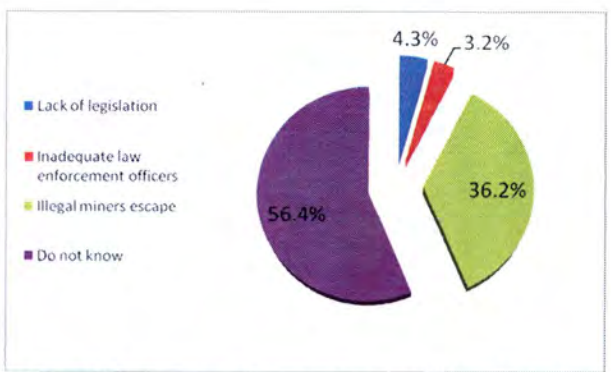
(b) Frequency of officials being seen monitoring the river



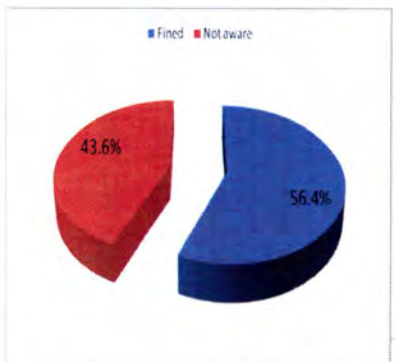
(c) Awareness of arrests of illegal sand miners



(d) Awareness of existence of punitive measures for illegal sand mining



(e) Possible reasons for no arrests of illegal sand miners



(f) Punitive measures for illegal sand miners

Figure 4.5 Community questionnaire responses on awareness of a punitive regime against illegal sand miners on Metsimotlhabe River.

Table 4.3 Correlation analysis of selected community questionnaire responses for response cross-validation.

Variables	Correlation coefficient (r)	Probability	Significance
Length of stay in Metsimotlhabe versus usage of sand	-0.461	P = 0.000***	Very highly significant
Age versus when sand mining was noticed	0.317	P = 0.002**	Highly significant
Length of stay in Metsimotlhabe versus length of usage of sand	0.458	P = 0.000***	Very highly significant
Awareness of monitoring versus awareness on arrests.	0.396	P = 0.000***	Very highly significant
Awareness of punitive measures versus awareness of arrests	0.443	P = 0.000***	Very highly significant

The statistically significant negative relationship between the length of time the respondent had been staying in the area and how long they had been obtaining sand from the river (r = -0.461, P = 0.000) is meaningful in that the newer the respondent was in the area, the more sand they used, and vice versa. This was logical as new inhabitants were probably still building their homes while the older inhabitants had completed the construction. Therefore, these responses were cross-validated as being reliable. The significant positive correlation (r = 0.317, P = 0.002) between age and when sand mining was noticed meant that the older a person was the farther in the past was the date when they had first noticed sand mining.

The significant positive correlation (r = 0.458, P = 0.000) between the length of stay in the area and the duration of sand use meant that respondents who had been in the area for long had been using the sand for long. This was logical as the earlier one settled in the area, the earlier they began to build their houses. There was a weak but significant positive correlation (r = 0.396, P = 0.000) between awareness of monitoring and awareness of arrests. The interpretation of this is that people who were aware of the monitoring were also aware of the arrests. The significant positive correlation between awareness of punitive measures and

awareness of arrests (r = 0.443, P = 0.000) meant that people who were aware that punitive measures existed were also aware of arrests. This was logical because a person who has not seen anyone being arrested was not likely to be aware of punitive measures. Given these meaningful cross-validations, the community questionnaires responses were judged to be useful in indicating environmental impacts of sand mining and the effectiveness of controlling illegal sand mining, and subsequently in formulating sustainability guidelines as part of the SEA.

4.1.1.5.2 Interviews with environmental authority government officials

The government officials were interviewed mainly about awareness of SEA as an environmental assessment method that can contribute to sustainability. The results from these interviews are summarised in Table 4.4. In general, there seemed to be lack of awareness of SEA. The respondents also point out staff shortages in terms of environmental officers as contributing to poor performance of environmental assessment processes.

4.1.1.5.3 Focus group discussions

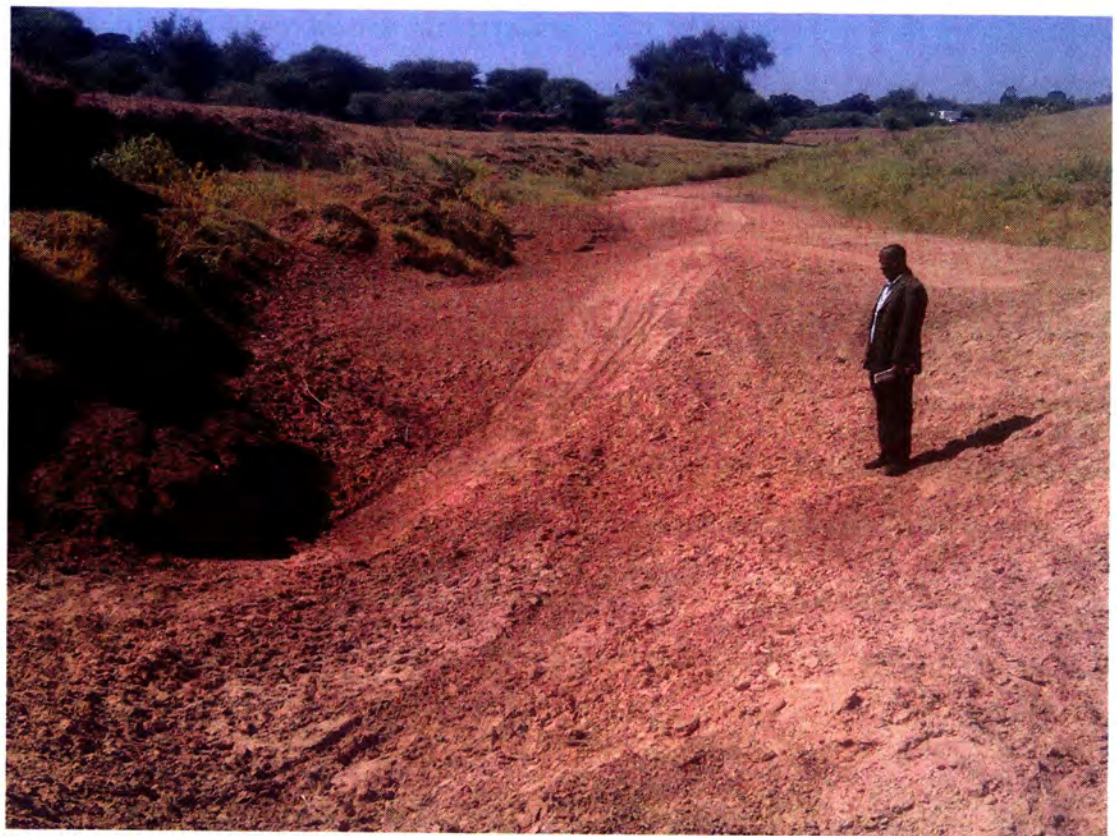
The Village Development Committee participants in the focus group discussions were generally unaware of either EIA or SEA. However, they were well aware of the environmental problems caused by sand mining, as well as the causes of the sand mining problems. General points from the VDC focus group discussions were:

- Sand mining causes aesthetic problems through the scars left in form of pits (e.g. see Figure 4.6a).
- The pits dug on the river bed by sand miners pose a safety risk to the community through death of children who drown in them.
- Sand mining destroys the river by striping bare to its bedrock (e.g. see Figure 4.6b).
- The illegal sand miners are mainly outsiders who don't live in Metsimotlhabe.
- There was a general weakness in the punishment and apprehension of illegal sand miners.

Table 4.4 Summary of results from SEA awareness interviews with government officials.

SEA and EIA issues	Government Department / Section		
	Department of Mines (DOM)	**Department of Environmental Affairs (DEA)**	**Mogoditshane Sub-district Council**
	Aware / Not aware / Total interviewees*	Aware / Not aware / Total interviewees*	Aware / Not aware / Total interviewees*
1. Awareness of SEA	0 / 5 / 5	5 / 0 / 5	0 / 5 / 5
2. Awareness of EIA	5 / 0 / 5	5 / 0 / 5	5 / 0 / 5
3. Place of SEA in legal framework	- None (interviewees unaware).	- SEA is performed by districts. - Non-compliance with SEA attracts fines stipulated in the EIA Act 2005 ranging between P100 000 and P1 000 000 (US$11390-113900).	- None (interviewees unaware).
4. Place of EIA in legal framework	- DOM only issues mining license if applicant has DEA-approved EIA. - Punitive measures for non-compliance as in EIA Act 2005.	- The EIA Act 2005 lists all projects that must undergo an EIA. - All large scale projects undergo an EIA. - EIA a legal requirement, only Minister of Environment, Wildlife and Tourism can waive it for certain projects for certain reasons, in this case DEA acts as Minister's technical arm. - Non-compliance leads to litigation and fines up to P1 000 000 (US$113 900) applicable. - Non-rehabilitation of land after projects attracts a charge. - Consultants who falsify EIA information liable for a charge.	- EIA for all projects (big or small) a legal requirement according to the EIA Act. - DEA approves EIA's.
5. Effectiveness of SEA	Not aware.	SEA too new to be assessed.	Not aware.
6. Botswana projects with SEA	Not aware.	Okavango Delta Management Plan.	Not aware.
7. Botswana projects with EIA	Gravel borrow pits for Gaborone City Council.	Several.	District development plans.
8. Effectiveness of EIA	Potentially effective but poor inadequate staff and monitoring a concern.	Very effective in preventing environmental degradation if enough staff to monitor.	EIA effective at preventing environmental degradation but poor monitoring a problem.
9. Recommendations for EIA effectiveness	- More involvement of communities. - Better monitoring since DEA too busy. - More environmental officers needed.	- Decentralise issues of SEA to district level. - Decentralise small EMP/EIA's to district level. - District staff needs training on EIA monitoring. - Separate body to check on DEA's auditing. - More environmental officers needed.	Involve communities in monitoring of projects since DEA unable to adequately monitoring, leading to non compliance and environmental degradation.

*See Section 3.5.5.1 for designations of officials interviewed.



(a) A member of the Village Development Committee inspecting a river bed pit caused by sand mining

(b) Aesthetically unpleasant scars on Metsimotlhabe River caused by sand mining

Figure 4.6 Pictorial illustration of negative impacts of sand mining on Metsimotlhabe River.

4.1.1.6 Summary of environmental impacts

A number of negative environmental impacts have resulted from sand mining on Metsimotlhabe River. These impacts are summarised in Table 4.5. Based on the negative environmental impacts, sustainability parameters can be drawn.

4.1.2 Sustainability parameters

The sustainability parameters and guidelines that can be drawn for the sand mining activity on Metsimotlhabe River, based on the negative environmental impacts (Table 4.5) are:

1. *Limits on sand extraction volumes* – the river has a limited ability to replenish the extracted sand through its natural erosion and abrasion fluvial processes. The rate of extraction of sand should, therefore, be within these natural rates of replenishment if sustainability is to be achieved.

   The river's annual sand recharge rate was estimated by Department of Mines (2004) as 81 330m^3/annum. This recharge rate appears to be for the entire river, from source to mouth. The population of the villages outside Greater Gaborone was estimated to be 194 574 in 2011 (Majelantle, 2011). Assuming an average household size of 6, this works out to roughly 32 429 households. From the questionnaires responses, about 29% of the respondents indicated that their households used >40m^3 of sand per year and 33% indicated that they used <10m^3 per year (Figure 4.3d). Taking 25m^3 as the average of 40m^3 and 10m^3, then the 32 429 households utilised an estimated combined total of 810 725m^3 per year (= 25m^3 per household *x* 32 429 households). This rate of extraction of sand is about 10 times the maximum sustainable yield (MSY) of Metsimotlhabe River. In order to achieve the MSY value, the permitted sand use per household should be limited to 2.5m^3 per year per household, assuming 32 429 households in all the villages along the river. Given that not all households are building something and utilising sand, then an allowance can be made to accommodate this by limiting each household to one truck load of sand per year (about 11m^3; Figure 3.2). This quota should be enforceable, and can be achieved if the Department of Mines issued only the number of licenses that can amount to the total natural recharge capacity of the river, which is 81 330m^3/annum. Economics values can then come into play; the restrictions can result in more prudent use of the limited resource through demand and supply principles (Pearce and Turner, 1990).

Table 4.5 List of negative environmental impacts that have resulted from sand mining on Metsimotlhabe River.

Impact	Section of the thesis where explained / depicted
1. Inducing upstream channel down cutting.	Sections 4.1.1.1, 4.1.1.4
2. Reduced river flow.	Sections 4.1.1.2, 4.1.1.5.1.1; Figures 4.1, 4.4b
3. Disturbance to fish spawning areas.	Section 4.1.1.1
4. Development of steep profiles in river bed.	Section 4.1.1.1
5. Lowering river bed.	Sections 4.1.1.1, 4.1.1.4
6. Loss of riparian vegetation cover.	Sections 4.1.1.3; Figures 3.8, 4.4b; Table 4.2
7. Reduced water quality.	Section 4.1.1.4, Table 4.2
8. Reduced surface water due to ground water recharge.	Sections 4.1.1.4, 4.1.1.5.1.1; Figure 4.4b
9. Reduced birdlife.	Sections 4.1.1.4, 4.1.1.5.1.1; Figure 4.4b, Table 4.2
10. Reduced aesthetic quality.	Sections 4.1.1.4, 4.1.1.5.1.1, 4.1.1.5.3; Figures 4.4b, 4.6; Table 4.2
11. Noise from sand excavation machinery	Section 4.1.1.4, Table 4.2

2. *Restrictions on timing of sand extraction from the river bed* – given that the river bed serves as fish spawning bed, sand extraction from the river bed should not be permitted during the fish breeding season. The fish breeding season is usually during the rainy season (about October to April; Figure 3.6), but this can be confirmed scientifically by the Department of Wildlife and National Parks (DWNP) which has jurisdiction over fisheries and is part of the institutional framework for environmental management in Botswana (Figure 1.2; Section 1.11). Therefore, sand mining should not be permitted during the rainy season. This could be achieved if the Department of Mines restricted the issuing and validity of sand mining permits to the months May-September only.

3. *Reducing river flow impacts by controlling the location of sand mining* – the Department of Mines (DOM) could help in controlling the negative impacts of sand mining that results in river flow disturbances by perhaps restricting the actual locations at which sand can be extracted. These locations should be carefully selected with due recognition of the river's longitudinal profile (Figure 3.1b) and its side (bank) erosion activities, for example the site in Figure 3.3b shows the river is eroding on the outside of the river bend, depositing inside and mining the inside of the curve where the river is depositing would probably not affect the river's flow much given that the active channel of the river is on the outside of the curve. Such analytical determination of where sand mining should be located should be made by DOM.

4. *Development of alternative, supplementary sources of sand* – the pressure on Metsimotlhabe River can be eased by encouraging the use of alternative sources of sand. The Department of Mines could then encourage large-scale sand miners (e.g. construction companies) to source their sand from such sources, and only permit the local communities to extract sand from the river since they may not have the means to transport the sand from farther away. This would help towards achieving sustainability, based on the economics principle of increasing supply (Pearce and Turner, 1990).

5. *Incorporating aesthetic sensitivity to sand mining* – the issuance of sand mining licenses by the Department of Mines should incorporate the requirement for reducing aesthetic impacts by leveling the borrow pits. This would be in line with the Department of Environmental Affairs' requirement of rehabilitating land after a project has ceased. The sand miners should make the undertaking to somewhat level the sand mining area instead of leaving aesthetically unpleasant pits (e.g. Figure 4.6b).

6. *More effective control and punitive measures against illegal sand miners* – questionnaire responses, interviews and discussions in the field (Sections 4.1.1.5.1.2, 4.1.1.5.2 4.1.1.5.3; Figure 4.5; Table 4.4) revealed that there are general loopholes in patrolling the sand mining areas along Metsimotlhabe River. All the proposals for sustainability suggested above require enforcement to be achievable. There is, therefore, a role for the Botswana Police Service to play for sustainability to be achieved, since they are somewhat part of the environmental management institutional framework (Figure 1.2; Section 1.11). There may be a need for legal amendments to the existing legislation, which would bring in roles for the Parliamentary Office.

4.2 Alternatives to mitigate sand mining on Metsimotlhabe River

This stage of the SEA process (Step 7; Figure 2.1) requires the development and assessment of alternative plans and programmes, based on the sustainability parameters and guidelines developed in Step 6. These can now be developed and assessed for the sand mining activity on Metsimotlhabe River.

4.2.1 Modifications of sand mining for sustainability

The sustainability parameters and guidelines stated in Section 4.1.2 lead to the following proposals for mitigating sand mining on Metsimotlhabe River:

1. *Leveling borrow pits* – the aesthetically unpleasant pits that have been left by the sand mining excavation (e.g. Figure 4.6) need to be leveled over to create a more aesthetically pleasant environment that can restore the recreation value of the river. Such restoration work will be costly, but the Village Development Committee can perhaps lead the way with assistance from the Department of Environmental Affairs.

2. *Limits to the period of sand mining activity* – the sand mining should be restricted to the dry season only, as rainy season sand mining leads to destruction of fish spawning sites and subsequent impacts on fish-eating birds, thereby reducing bird life.

3. *Restrictions on locations for sand mining* – sand mining should be restricted to sections of the river where the natural activity of the river is deposition as opposed to erosion. Department of Mines (2004) proposes three sections of Metsimotlhabe River near Thamaga village as sand mining exclusion zones. These should be incorporated into the sand mining restrictions as part of a way to achieve sustainability.

4. *Revegetating eroded damaged river banks* – sections of Metsimotlhabe River that have been damaged by sand mining, particularly river banks (e.g. Figure 4.6b) and riparian areas near villages like Metsimotlhabe (e.g. see Figure 3.8d) need revegetating with native vegetation. This activity can be spearheaded by the Village Development committees and led by the Department of Environmental Affairs. Funding can perhaps be sourced by the sub-districts, in line with recommendations

from staff at the Department of Environmental Affairs that more environmental assessment and management tasks should be decentralized to districts.

4.2.2 Substitutes and trade-offs

Alternative sources of sand for the construction industry need to be identified and exploited. In this regard, the vast desert sand deposits farther west in Ghanzi, Kgalagadi and Kweneng Districts (Figure 1.1) need to be considered. If the sand there is of lower grade, as was suggested during interviews in the field, then perhaps mixing it with river sand might be a trade-off worth considering.

There might be possibilities to source sand in smaller streams that are tributaries of the Metsimotlhabe and Notwane Rivers. Exploiting them would ease the pressure on the Metsimotlhabe.

Another possible alternative is the use of crushed stones as a substitute for sand. Crushed stones require blasting of solid rock such as that which is intruding in hills, or that which can be sourced by large excavations. Stone can also be sourced from old mine spoil heaps. The stone can then be ground using specific machinery. Using crushed stone has its own environmental concerns at the stone source sites, but the sites can also be subjected to the SEA process prior to final exploitation.

Clay bricks appear to be a viable alternative to sand bricks and would ease the demand for sand from the building construction industry (houses, office blocks, etc). They can be sourced from Lobatse Clay Works, a company based in Lobatse to the south of Greater Gaborone (Figure 1.1).

4.3 Decision making for sand mining activity on Metsimotlhabe River

Sand mining on Metsimotlhabe River was suspended in June 2010 when the Department of Mines stopped issuing sand mining licenses to allow the river to rehabilitate. Since then, illegal sand mining has continued, as was verified during field checks (e.g. see Figure 3.2). The decision then has to be made as to whether sand mining should be legalised on Metsimotlhabe River.

Evidence from identifying environmental impacts of sand mining on Mesimotlhabe River indicates a lot of negative environmental impacts (see Section 4.1.1.6). In this study a quantitative analysis of positive socio-economic impacts of sand mining was not undertaken because the benefits from sand mining are easily conceivable. The construction of home using the sand (e.g. see Figure 3.2b) is undoubtedly beneficial. Legal sand mining also creates employment opportunities to unemployed youths. However, there are too many negative environmental impacts for legal sand mining to be permitted again without substantial rehabilitation of the river along the recommendations made in Section 4.2.1. Department of Mines (2004) came to a similar recommendation after analysis of the negative environmental impacts and even taking into consideration positive socio-economic impacts. A Cost – Benefit Analysis (CBA) would be a useful part of decision making to supplement SEA, but CBA was not in the scope of the study. Therefore, the SEA process at this stage recommends and endorses the discontinuation of sand mining on Metsimotlhabe River.

4.4 Monitoring and auditing

Steps 9-11 of the SEA process (Figure 2.1) would normally be undertaken should the decision be taken that the programme, plan or policy should go ahead and be implemented. In the case of sand mining on Metsimotlhabe River, Step 8 (Decision-making) recommended that sand mining should not be implemented. However, there is on-going illegal sand mining that continues to be a source of negative environmental impacts. The Department of Mines discontinued the issuing of sand mining permits so as to allow the river to rehabilitate. Therefore, a monitoring and auditing porgramme needs to be implemented by the Department of Mines in order to determine whether the river does rehabilitate. Recommendations are made in this stage of the SEA process for the monitoring and auditing of environmental attributes on Metsimotlhabe River.

4.4.1 Monitoring

Data on the following environmental attributes needs to be monitored using some of the methods and analytical approaches utilised in this study where applicable:

1. River discharge levels at gauging stations along Metsimotlhabe River - to be monitored by the Department of Water Affairs. More reliable recording is needed in order to avaoid incomplete records that lead to errors in deducing trends.

2. Dam water heights (above sea level) at Bokaa and Moshupa Dams - to be monitored by the Department of Water Affairs.

3. Riparian vegetation cover - to be monitored by the Department of Environmental Affairs, using remote sensing and GIS methods.

4. Fish abundance and spawning rates to be monitored by the Department of Wildlife and National Parks (DWNP).

5. Bird abundance - to be monitored by the Department of Wildlife and National Parks (DWNP) perhaps in conjuction with environmental organizations such as Birdlife Botswana and Conservation International Botswana.

6. Water quality in Bokaa and Moshupa Dams as indicators of river erosion activity - to be monitored by the Department of Water Affairs in conjuction with the Water Utilities Corporation.

7. Ground water table depths in the vicinity of Metsimotlhabe River - to be monitored by the Department of Geological Surveys.

8. Negative visual impact - to be monitored by the Department of Environmental Affairs.

4.4.2 Auditing

The environmental variables that need to be monitored as listed in Section 4.4.1 need to be audited in order to determine whether they continue to be negative impacts as established in this study (see summary in Table 4.5). This auditing system needs to be implemented almost immediately since the negative environmental impacts were established long in the past and, therefore, the verification is needed almost immediately.

4.5 Possible sources of SEA process ineffectiveness identified from the SEA case study

The following possible sources of ineffectiveness of the SEA process were identified from the SEA case study and will be addressed in proposing a more effective SEA process in Botswana:

1. *Limitations in baseline environmental data* – accuracies in baseline environmental data form the backbone of the rest of the SEA process. However, there is usually very little time and resources to obtain the required up to date data and reliance is made on old secondary sources. This becomes a serious limitation to the SEA process.

2. *Limitations in methods of identifying and assessing environmental impacts* – there is usually a tendency to identify impacts on the basis of own opinion without the use of the necessary analytical rigour. In this study, some measure of analytical rigour was undertaken using statistical analysis of hydrological and rainfall data, Remote Sensing and GIS techniques, and statistical spreadsheets in analysing information from the public participation component of the SEA.

3. *Lack of a centralised agency with personnel to perform the SEA* – interviews at the Department of Environmental Affairs indicated limitations in staff, with the result that consultants perform the bulk of monitoring and auditing tasks in SEA (and EIA). The end-product drive by the consultants seeking the payment at the end of the task rather than thoroughness in investigating environmental issues can lead to compromises on the accuracy of SEA.

4. *Possibility of biased (socially oriented) decisions* – there is the possibility to take a decision for a project to proceed on the basis of pressing socio-economic priorities at the expense of considering environmental consequences.

TOWARDS MORE EFFECTIVE SEA IN BOTSWANA

5.0 Introduction

This chapter presents and discusses proposals to make the SEA process in Botswana more effective at preventing environmental degradation in the country. The SEA case study that was utilised by this research identified a number of areas in the SEA process as implemented in Botswana that can make the process less effective, and these are stated in Section 4.5. One of the areas of concern is the lack of a centralised agency with personnel to conduct Strategic Environmental Assessments in the country, with the result that EIA and SEA tasks are assigned to consultants. This will be the starting point in the formulation of proposals to make EIA more effective in the country. This top-to-bottom approach in addressing the problems with SEA in the country will make it easier to formulate specific aspects for improvement in the process itself, once a streamlined institutional framework to oversee the process is suggested.

5.1 Institutional framework

The institutional framework for environmental management in Botswana (Figure 1.2) appears to be adequate. There are sections of government to deal with all the components of the environment, e.g. wildlife and fisheries (DWNP jurisdiction), water (DWA jurisdiction), minerals (DOM jurisdiction), forests (DFRR jurisdiction), and land and soils (jurisdiction in other ministries outside MEWT). There is also an adequate legal framework in the country. However, what would benefit the SEA process is a central agency that oversees the process and has independent staff members who are specialised and trained in environmental management and would oversee the SEA process, separate from the Department of Environmental Affairs. Interviews with staff in the Department of Environmental Affairs confirmed this need, as well as the need for more staff (Table 4.4). For this reason, a separate environmental protection agency is proposed in this thesis. This environment protection agency, tentatively referred to as the Botswana Environment Agency in this thesis, should be envisaged to be structured and to function along the lines of the Environmental Protection

Agency (EPA) of the United States of America (USA). The main characteristics of the EPA are summarised in Table 5.1.

Table 5.1 Summary of the Characteristics of the US Environmental Protection Agency*

Characteristic	Detail
1. History and mandate	Established on 2 December 1970 to consolidate in one agency a variety of federal research, monitoring, standard-setting and enforcement activities to ensure environmental protection.
2. Organisation structure	- Headed by the EPA Administrator. - Headquarters with 13 divisions: i. Office of the Administrator ii. Office of Administration and Resources Management iii. Office of Air and Radiation iv. Office of Chemical Safety and Pollution Prevention v. Office of the Chief Financial Officer vi. Office of Enforcement and Compliance Assurance vii. Office of Environmental Information viii. Office of General Counsel ix. Office of Inspector General x. Office of International and Tribal Affairs xi. Office of Research and Development xii. Office of Solid Waste and Emergency Response xiii. Office of Water
3. National representation	Has headquarter offices and 10 regional offices spread around the USA.
4. Activity in line with mandate	- When Congress writes an environmental law, EPA implements it by writing regulations. - Often, EPA sets national standards that states and tribes enforce through their own regulations. - If states and tribes fail to meet the national standards, EPA can help them. - EPA also enforces its regulations, and helps companies understand the requirements.

*Source: summarised from EPA (2014).

There are key characteristics of the EPA that the proposed Botswana Environment Agency would benefit from, principally the following:

- Widespread national representation in terms of offices.
- Specialised scientific units.
- Enforcement capabilities.
- Consolidation in one agency the research, monitoring, standard-setting and enforcement activities to ensure environmental protection.

The proposed Botswana Environment Agency should, therefore, borrow these aspects. The proposed Botswana Environment Agency, in order to acquire the above listed advantageous characteristics, could be structured as summarised in Figure 5.1.

The proposed Botswana Environment Agency would be headed by a Chief Executive who reports to the Minister of Environment, Wildlife and Tourism. In addition to an administration section, the agency could then consist of a Scientific Services Division with scientific officers who are trained in the key environment fields related to wildlife, fisheries, water, minerals (geology), soils, atmosphere, and forests and rangelands (botany). These would serve as inspectors who do the actual monitoring and auditing as part of the SEA in their respective fields of specialisation for projects that have impacts in their sphere of the environment. The inspectors would also handle the baseline studies as part of the SEA. The proposed environment agency should also have a Legal Division that would have the powers to prosecute, in liaison with the Administration of Justice Department (Figure 1.2). There should also be an Enforcement Division, with powers to patrol and apprehend violators of restricted environmental services, such as illegal sand miners in the case of the Metsimotlhabe sand mining case study that was used in this research. The personnel in this division should be independent law enforcement staff but who are answerable to the overall authority of the Botswana Police Services. In South Africa, for example, there exists a special environment policing unit called the "Green Scorpions" within the South African Police Services. The proposed Botswana Environment Agency should then have nationwide representation in the form of district offices and the districts should be staffed with the scientists, which would be in line with recommendations of decentralisation that were made during interviews with government officials (Table 4.4). The agency should then be superior to government department such as DEA, DOM, DFRR, DWNP, who would report to it.

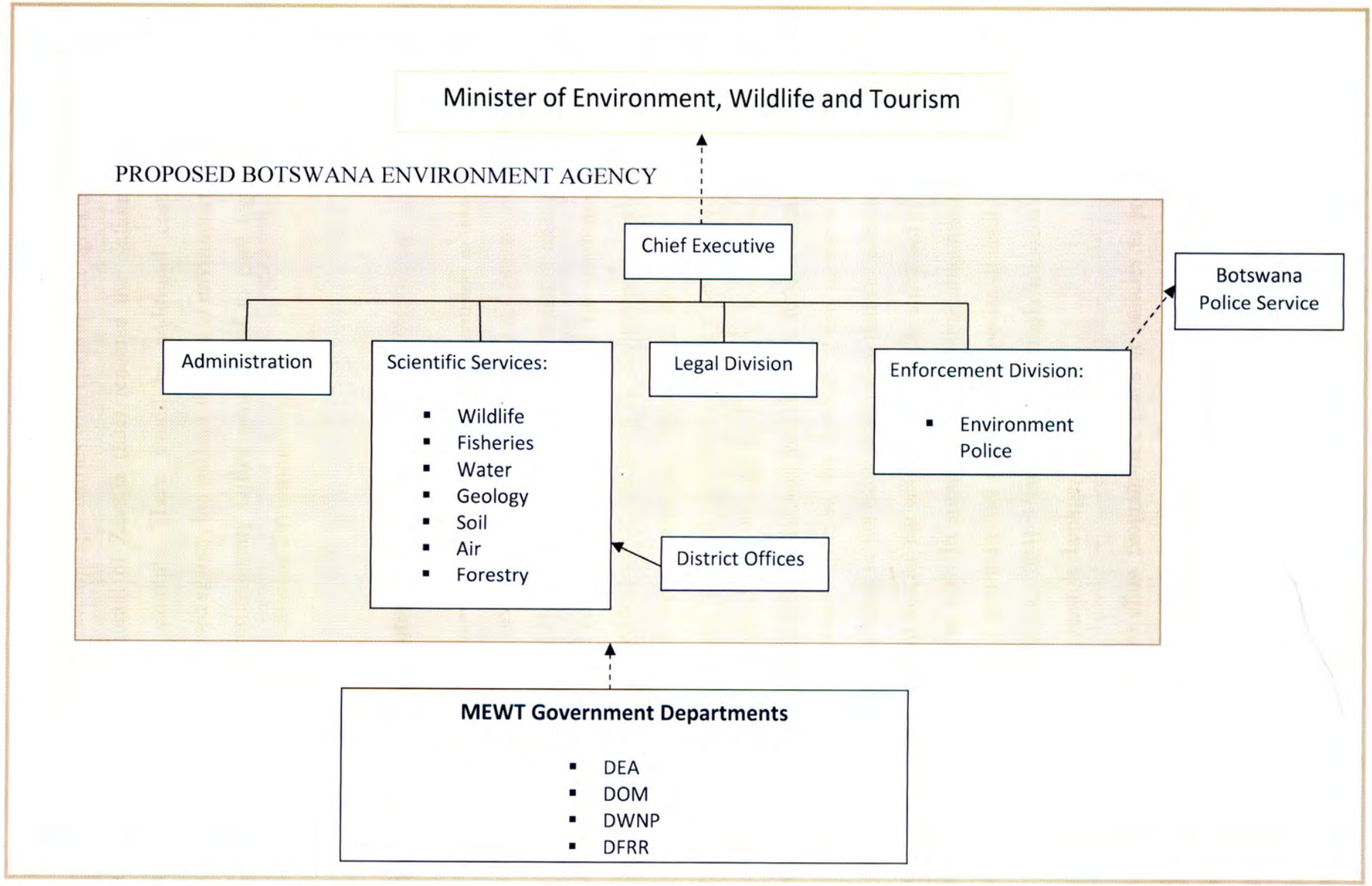


Figure 5.1 Structure of a proposed coordinating environment agency as part of streamlining SEA in Botswana.

It could be argued that utilising a blue print structure such as that of the EPA of the USA, which is a rich country, is not ideal. The proposed structure in Figure 5.1 is scaled down from the EPA structure in Table 5.1 in cognizance of the fact that Botswana has fewer resources than the USA. There are some developing countries with environment agencies. In the SADC region, the Environmental Council of Zambia (later renamed the National Environment Management Agency) is an example. There would be additional costs from central government to set up the proposed agency, but perhaps the cost of environmental degradation would outweigh them. The Parliamentary Office would need to pass legislation for the establishment of the proposed Botswana Environment Agency.

5.2 Strengthening SEA methodological aspects

One of the sources of ineffectiveness of the SEA process as identified in this study is the use of inadequate data on baseline environmental conditions. Often old reports are utilised as the current state of the environment. With the proposed environmental agency (Figure 5.1), specialist scientific staff would conduct detailed description of the environment required by the SEA. This way the use of inadequate reports about the environment would be avoided. In this study for example, there was inadequate information about the fish species in Metsimotlhabe River. Staff in the proposed environment agency would have helped provide the required baseline environmental data through field surveys. It could be argued that the required detailed baseline environmental surveys would be too time consuming and would, thereby, lengthen the SEA process. However, the duration of the survey would perhaps be worth the delay in releasing the result of the SEA considering that some environmental harm is to sections of the environment that are not easily visible to the untrained eye. For example, an endemic species could be at risk. In some reports, relative abundance of fauna is a criterion for non-significance of environmental impacts and species diversity seems to be of priority (e.g. Department of Mines, 2004). However, a seemingly minor component of the environment could result in irreversible damage.

Decision making on whether to allow programmes, plans or policies to proceed or not is sometimes influenced by political factors. For this reason, public hearings should be encouraged to be swayed by the view of the knowledgeable environment experts rather than mere crowd views. Similarly, the final decision should be swayed by facts from the SEA, not opinions from meetings alone. Where socio-economic benefits are deemed more important,

they should be weighed against the environmental costs, which can be valued using economic valuation techniques such as the Contingent Valuation Approach, the Travel Cost Approach, and Hedonic Pricing (Pearce and Turner, 1990).

Identification of environmental impacts should utilise more analytical approaches than mere site visit based opinions. Expertise in the required techniques should be sought. In this study, analytical techniques such as GIS and Remote sensing, and statistical analysis were employed.

Given that there is a legal basis for environmental assessment in Botswana, the SEA process satisfies the first requirement of an SEA system in Table 2.1. The SEA process has the remaining 14 requirements too as shown in Figure 2.1, but if the proposed Botswana Environment Agency was realised the SEA process would be even more effective in achieving them. Financial penalties need periodic revision since they can be overtaken by currency devaluations and inflation, for example the P100 000 fine for non-compliance with the SEA requirement in Botswana.

CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

In this chapter, the conclusions arising from the research are stated. The conclusions are stated against the initial objectives of the research. Recommendations about SEA in Botswana and suggestions for future research in the topic or related work are then made.

6.1 Conclusions

The first objective of the research was to evaluate the existing status of SEA as applicable to Botswana. It can be concluded that SEA is unknown in Botswana and is not addressed directly in legislation but the process does have a legal basis through EIA legislation.

The second objective of the research was to examine the existing institutional framework for SEA in Botswana. It can be concluded that there is an adequate institutional framework for SEA, but the institutional framework has inadequacies in terms of staffing and possibly lack of coordination.

The third objective was to formulate approaches that are required to make SEA more effective in Botswana, based on gaps and weaknesses identified in the process. It can be concluded that a new environment agency to help coordinate the SEA process would improve SEA in Botswana. The agency would have adequate staff to monitor, audit, inspect, and enforce in the context of SEA. The agency would also remove methodological ineffectiveness in the SEA process.

6.2 Recommendations for SEA awareness in Botswana

There is an apparent lack of awareness of SEA in Botswana. This is evidenced by the lack of awareness of SEA by some of the government officials who were interviewed in this

research, with the exception of officials from the Department of Environmental Affairs (Table 4.4). Officials from the Department of Mines and those from local government were completely unaware of SEA. The focus group discussions involving members of the Village Development Committee at Metsimotlhabe village were also not aware of SEA. This points to the need for concerted effort to promote the awareness of SEA in Botswana.

Part of the reason for the lack of awareness of SEA in Botswana is the fact that there is no specific mention of SEA in all the pieces of the environmental legislation in the country. Three applicable pieces of legislation were examined in this research: The Environmental Impact Assessment Act of 2005 (Section 2.4.1.1.2 of this thesis); The Environmental Assessment Act, 2011 (Section 2.4.1.1.3 of the thesis); and The Environmental Assessment Regulations, 2012 (Section 2.4.1.1.4 of this thesis). All the three pieces of legislation would seem to be interpreted as referring to project EIA and not SEA, although SEA qualifies in the legislation as part of 'environmental assessment' referred to by The Environmental Assessment Act, 2011 and The Environmental Assessment Regulations, 2012. The Environmental Assessment Act, 2011 (part of which is in Appendix 4) would, therefore, summarily be interpreted to be an update of The Environmental Impact Assessment Act of 2005 to the ordinary government official since it too does not mention SEA in particular but mentions EIA.

The lack of awareness of SEA in Botswana is not unique to Botswana, since literature review indicated similar problems even in other countries, for example in New South Wales, Australia (Kelly *et al.*, 2012) and in South Africa (Retief *et al.*, 2008). Given the low awareness of SEA at the time of this study, the following recommendations can be made to improve awareness:

- There is need for amendments to the current environmental assessment legislation to make specific mention of SEA.
- The Government of Botswana, through the Department of Environmental Affairs, should promote SEA awareness to other government departments. This can be achieved for example through training workshops about SEA.
- The Department of Environmental Affairs should promote the conducting of SEA as an option to project EIA at the time applicants apply for permission to undertake projects.

6.3 Suggestions for future work

There is scope for researching the possible role of economic valuation techniques in the decision-making process for programmes, policies and plans in Botswana. Valuation techniques such as Cost-Benefit Analysis (CBA) could contribute to the decision making process, in order to provide objective criteria for decision making where a PPP is deemed to be highly desirable socio-economically.

There is also scope for research into alternatives to sand in the building construction industry in Botswana.

This study was restricted by time and finances in studying the baseline environmental conditions at Metsimotlhabe River. Future research in the area should avoid using old reports on the baseline environmental conditions and conduct detailed studies wherever possible.

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APPENDICES

APPENDIX 1

Research Permit Issued by the Department of Environmental Affairs, Botswana, Permitting this Research Project

TELEPHONE: 3647900
TELEGRAMS: MEWT
TELEX:
TELEFAX: 3908076

REFERENCE: EWT 8/36/4 XXIV (109)

REPUBLIC OF BOTSWANA

MINISTRY OF ENVIRONMENT,
WILDLIFE AND TOURISM
PRIVATE BAG BO 199
GABORONE
BOTSWANA

ALL CORRESPONDENCE MUST BE ADDRESSED TO
THE PERMANENT SECRETARY

12th July 2013

LEBOGANG P. MAKABA

Tel: 7269112/74012222
Email: pmakaba1974@gmail.com

APPLICATION FOR A RESEARCH PERMIT: EFFECTIVENESS OF ENVIRONMENTAL ASSESSMENT PROCESS IN BOTSWANA: EWT 8/36/4 XXIV (103)

We are pleased to inform you that you are granted permission to conduct a research entitled: **"Effectiveness of Environmental Assessment process in Botswana"**

The research will be conducted at **Metsimotlhabe and Gaborone.**

This permit is valid for a period effective from **12th July 2013 to the 31st August 2013.**

This permit is granted subject to the following conditions:

1. Signing and submission of an Agreement between Government of Botswana and Independent Researchers.
2. Progress should be reported periodically to the **Department of Environmental Affairs.**
3. The permit does not give authority to enter premises, private establishments or protected areas. Permission for such entry should be negotiated with those concerned.
4. You conduct the study according to particulars furnished in the approved application taking into account the above conditions.
5. Failure to comply with any of the above conditions will result in the immediate cancellation of this permit.
6. The research team comprises of **Miss Lebogang P. Makaba and James James.**
7. The applicant should ensure that the Government of Botswana is duly acknowledged.

8. Copies of videos/publications produced as a result of this project are directly deposited with the Office of the President, National Assembly, Ministry of Environment, Wildlife and Tourism, Department of Environmental Affairs, National Archives, National Library Service, and the University of Botswana Library.

Thank you.

Yours faithfully

Mable Bolele
FOR/PERMANENT SECRETARY

cc: Director, Department of Environmental Affairs
District Commissioner, Gaborone

APPENDIX 2

INTERVIEW GUIDE FOR GOVERNMENT OFFICIALS

1. Category of official

   .....

2. Awareness of SEA

   .....

   .....

   .....

3. Place of SEA in legal framework

   .....

   .....

   .....

4. Applicable punitive measures for non-compliance with SEA

   .....

   .....

   .....

5. Any previous projects that have gone through SEA

   .....

   .....

   .....

6. Effectiveness of SEA in preventing environmental degradation

   .....

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   .....

7. Awareness of EIA

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8. Place of EIA in legal framework.

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9. Applicable punitive measures for non-compliance with EIA.

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10. Any previous projects that have gone through EIA

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11. Effectiveness of EIA in preventing environmental degradation

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.....

APPENDIX 3

FOCUS GROUP DISCUSSIONS GUIDE

1. Awareness of SEA

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.....
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2. Effectiveness in preventing environmental degradation

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.....
.....

3. Awareness of EIA

.....
.....
.....

4. Applicable punitive measures for non-compliance

I.EIA.....
.....

II.SEA.....
.....

6. Amount of sand obtained from the river

.....
.....
.....

7. What negative environmental effects are you aware of that arise from the extraction of river sand

.....
.....
.....

8. Suggestions on what should be done to ensure sustainable mining of sand

.....

.....

.....

APPENDIX 4

QUESTIONNAIRE FOR COMMUNITY MEMBERS AT STUDY SITE REGARDING ENVIRONMENTAL ISSUES RELATED TO SAND MINING

SECTION - Information about respondents

1. Gender ☐ male ☐ Female

2. Age group

☐ 18- 40
☐ 41 – 60
☐ Over 60

3. Education level

☐ Never been to school
☐ Primary
☐ Secondary
☐ Tertiary

4. Employment Status

☐ Employed ☐ ot employed ☐ Self employed

5. Length of residence near study site

☐ Since 2000
☐ Since 1990
☐ Since 1980

Section B - Information about environmental issues

1. What resources do you get from the river? Select as many as applicable

- [ ] Fish
- [ ] Sand
- [ ] Water
- [ ] Reeds
- [ ] Recreation
- [ ] Other (specify) .....
- [ ] None

2. If you obtain sand from the river, what do you use it for?

.....

.....

.....

.....

3. If you obtain sand from the river, how long have you been obtaining it?

- [ ] Since before 1980
- [ ] Since the 1990's
- [ ] Since 2010

4. If you obtain sand from the river, approximately how much do you get in a

- [ ] 1 day
- [ ] 1 Week
- [ ] 1 month
- [ ] 1 year
- [ ] Not known

5. What negative effects are you aware of, that arise from the extraction of sand from the river?

- [ ] Siltation of the water
- [ ] Drying of the river
- [ ] Decreasing of water quality in the river
- [ ] No effect
- [ ] Other (Please specify
- [ ] Not known

6. Have you noticed any environmental effects of river sand mining on the surrounding?

- [ ] Reduced bird life
- [ ] Reduced vegetation
- [ ] Reduced recreational life
- [ ] No effect
- [ ] Other (please specify)
- [ ] Not noticed anything

7. How long ago did you start noticing the effects from q. 5 and (or) 6?

- [ ] Since the 1980's
- [ ] Since the 1990,s
- [ ] Since 2000
- [ ] Not noticed anything

8. When did you notice sand mining starting in this place?

- [ ] Since before 1980
- [ ] Since 1990
- [ ] Since 2000
- [ ] Do not know

9. In your opinion, who are the people involved in sand mining?

- ☐ Construction companies
- ☐ Residents along the river
- ☐ People staying far from the river
- ☐ Other (please specify)
- ☐ Do not know

10. Do the authorities monitor the area around the river to control sand mining?

☐ Yes ☐ No ☐ do not know

11. If your answer to question 9 is yes, how often do you notice the authorities patrolling?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Never

12. Are you aware of any arrest because of sand mining?

☐ Yes ☐ ɒ (if yes go to q.13, if no go to q.15)

13. Are you aware of any punitive measures?

☐ Yes ☐ No

14. What were the punitive measures?

- ☐ Imprisonment
- ☐ Fined
- ☐ Other (please specify)

15. Why do you think there have been no arrests?

- [ ] Lack of legislation
- [ ] Inadequate law enforcement officer
- [ ] Illegal sand miners escape \ are not see in the act

THANK YOU FOR YOUR COOPERATION

APPENDIX 4

Part of the Environmental Assessment Act, 2011

ENVIRONMENTAL ASSESSMENT ACT, 2011

No. 10 **of 2011**

ARRANGEMENT OF SECTIONS

SECTION

PART I – *Preliminary*

1. Short title and commencement
2. Interpretation
3. Application of Act
4. Requirements to undertake an activity
5. Ensuring issuance of authorisation

PART II – *Preparation of Environmental Impact Assessment Documentation*

6. Requirements for authorisation
7. Public participation and scoping exercise
8. Terms of reference
9. Environmental assessment and statement

PART III – *Review Process of Environmental Impact Statement*

10. Public review of statement
11. Conduct of public hearing
12. Approval of statement
13. Appeals

PART IV – *Authorisation of a Statement*

14. Validity of an authorisation
15. Revocation or modification of authorisation
16. Transfer of authorisation
17. Decision making by competent authority

PART V – *Post Environmental Impact Assessment of Implemented Activities*

18. Monitoring programme and evaluation report
19. Environmental audit by competent authority

PART VI – *Establishment, Management and Functions of Board*

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21. Seal of Board
22. Membership of Board
23. Association to elect members
24. Powers and functions of Board
25. Tenure of office of member

26. Minister's power to appoint members required to be elected
27. Disqualification, removal and resignation
28. Filling of vacancies
29. Committees of Board
30. Election of Chairperson and Vice Chairperson
31. Meeting of Board
32. Meetings of committees of Board
33. Disclosure of interest
34. Validity of decisions and acts of Board
35. Reports to the Minister

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37. Registration
38. Register
39. Procedures for registration
40. Certificate of practice
41. Registration of non-residents
42. Refusal to register
43. Suspension of registration
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47. Return of practising certificate to Executive Secretary
48. Register to be prima facie evidence
49. Offences in connection with the register

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51. Disregard of summons, etc.
52. Powers of Board at inquiry
53. Disciplinary powers of Board
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58. Financial year
59. Accounts and audit
60. Annual report

PART X – *Miscellaneous*

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62. Public documents and register
63. Confidentiality
64. Conflict of interest by practitioner
65. Protection from personal liability
66. Powers of entry
67. Powers to require information
68. Trans-boundary environmental impact
69. Effect of registration
70. Offence and penalty

71. Exemptions
72. General penalty
73. Regulations
74. Repeal of Cap. 65:07
75. Transitional provisions
76. Act to bind State

An Act to provide for environmental impact assessment to be used to assess the potential effects of planned developmental activities; to determine and to provide mitigation measures for effects of such activities as may have a significant adverse impact on the environment; to put in place a monitoring process and evaluation of the environmental impacts of implemented activities and to provide for matters incidental to the foregoing.

Date of Assent: 17/06/11

Date of Commencement: On Notice

ENACTED by the Parliament of Botswana.

PART I – *Preliminary*

Short title and commencement

1. This Act may be cited as the Environmental Assessment Act, 2010, and shall come into operation on such date as the Minister may, by order, appoint.

Interpretation

2. In this Act, unless the context otherwise requires —

"activity" includes a project, programme, plan or policy;

"Association" means a body registered under the Societies Act, which adequately demonstrates to the Minister that it is representative of the majority of Environmental Assessment Practitioners practising in Botswana at any given time;

Cap. 18:01

"Board" means the Environmental Assessment Practitioners Board established under section 20 of the Act;

"Chairperson" means the Chairperson of the Board;

"committee" means a committee of the Board;

"competent authority", in relation to an activity under this Act, means the Department of Environmental Affairs;

"developer" means a person intending or planning to undertake a new activity or repair or extend an existing activity;

"Director" means the Director responsible for environmental affairs;

"environment" includes the physical, ecological, archaeological, aesthetic, cultural, economic, institutional, human health and social aspects of the surroundings of a person;

"environmental audit" means work done to identify and evaluate compliance of the statement and the residual environmental impact of an existing activity, the effectiveness of mitigation measures and the functioning of monitoring mechanisms;

"environmental impact" means any positive or negative effects caused by an activity on the environment;

"environmental impact assessment" means the process and procedure for evaluating and predicting the likely environmental impact of a proposed activity;

"evaluation report" means a report on studies carried out to ensure that environmental considerations are taken into account when an activity is implemented;

"local authority" includes a land board;

"member" means a member of the Board elected, appointed or nominated under section 22;

"mitigation measures" means the reduction or control of the adverse environmental impact of an activity and includes restitution for any damage to the environment caused by such activity through engineering works, technological improvements, management measures or compensation to ameliorate any loss suffered by a person;

"practitioner" means an Environmental Assessment Practitioner registered under section 37;

"project brief" means a description of the likely environmental impact of an activity provided by the applicant as part of the application;

"register" means a register of practitioners established under section 38;

"relevant technical department" means a government department or local authority responsible for monitoring an activity undertaken under this Act, by virtue of that department or local authority having the necessary technical expertise to do so;

"scoping" means consultations with concerned government departments, local authorities, non-governmental organizations, members of the public and any other interested persons, to determine the extent of the likely environmental impact of a proposed activity;

"statement" means a report of the environmental assessment study;

"strategic environmental assessment" means a process for evaluating the environmental consequences of proposed policy, plan or programme initiatives in order to ensure that they are fully included and appropriately addressed at the earliest stage of decision making, on par with economic and social considerations;

"threshold", in relation to an environmental impact assessment of an activity, means a measurable level or limit of an output resulting from the operation of a proposed activity indicative of the activity's environmental impact; and

"terms of reference" means a document which details the main environmental issues which must be addressed in an environmental impact study.

Application of Act

3. (1) This Act applies to the activities in respect of which the Minister may prescribe by regulations.

(2) Regulations made pursuant to subsection (1) shall prescribe —

(*a*) a list of activities which are likely to cause significant adverse effects on the environment, or the locations that may be environmentally sensitive, in respect of which a statement shall be mandatory;

(*b*) threshold determinations of environmental impact assessment with respect to the activities prescribed under paragraph (*a*); and

(*c*) criteria which shall be used to determine the likely effects of a proposed activity in order to further determine whether or not a statement is required for the activity.

(3) The Minister may, in writing, upon application for exemption by a person implementing an activity referred to under subsection (2), exempt the activity from the provisions of this Act.

Requirements to undertake an activity

4. (1) No person shall undertake or implement an activity prescribed under section 3 unless —

(*a*) such person has applied to a licensing authority for authorization to undertake such activity and authorisation has been issued under section 12; and

(*b*) the environmental impact of the proposed activity is fully taken into account in accordance with the provisions of this Act.

(2) Any person who undertakes or implements an activity in contravention of subsection (1) commits an offence and is liable to a fine not exceeding P100 000, or to a term of imprisonment not exceeding five years, or to both.

(3) A person who contravenes subsection (1) shall rehabilitate the area affected by the adverse environmental impact of the implemented activity.

(4) In this section, "rehabilitate" means the reinstatement or restoration to a normal or functional environmental state.

(5) A person who fails to rehabilitate the area referred to under subsections (3) commits an offence and is liable to a fine not exceeding P1 000 000, or to a term of imprisonment not exceeding 15 years, or to both.

Ensuring issuance of authorisation

5. (1) A licensing authority shall, before issuing a permit, licence, consent or approval to any person who has applied to implement an activity prescribed under section 3, ensure that authorisation has been issued for the proposed activity in accordance with this Act.

(2) In this section, "licensing authority" means any authority vested with the responsibility of issuing permits, licences, consent or approval for any of the activities prescribed under section 3.

PART II – *Preparation of Environmental Impact Assessment Documentation*

Requirements for authorisation

6. (1) Every —

(*a*) application made to obtain authorisation for a proposed activity shall contain or be accompanied by a project brief which shall include a description of the activity; and

(*b*) formulation of a policy, programme, legislation, physical plan, shall contain or be accompanied by an approved strategic environmental assessment, which strategic environmental assessment shall contain a description of a policy, programme, legislation, development plan or physical plan, as the case may be.

(2) An application made under subsection (1) (*a*) shall be in the prescribed form and shall be accompanied by such fee as may be prescribed.

(3) Where the competent authority is satisfied that all relevant information is available in the application and that the activity can be carried out without any adverse environmental impact, the competent authority shall authorise the implementation of the activity.

(4) Where the competent authority finds that information provided in the application is insufficient, the competent authority shall require and specify to the applicant the additional information to be provided.

(5) The competent authority may upon receipt of an application under subsection (1) or at its own discretion request the developer to submit an environmental management plan.

(6) Where the competent authority requests for an environmental management plan under subsection (5) the competent authority may request the developer to consult stakeholders.

Public participation and scoping exercise

7. (1) An applicant shall before undertaking or implementing an activity engage a practitioner to do a scoping exercise.

(2) The applicant shall during a scoping exercise —

(*a*) publicise once the intended activity, its effects and benefits in the mass media using the official languages for a period of not less than 21 days; and

(*b*) after the expiration of the period of 21 days, ensure that the practitioner referred to under subsection (1) holds meetings with the affected people or communities to explain the nature of the activity and its effects.

Terms of reference

8. (1) Where, upon a consideration of all the information submitted by the applicant, the competent authority decides that an environmental impact assessment is required, the authority shall inform the applicant, in writing, to prepare terms of reference for the environmental impact assessment, which terms of reference shall be in the prescribed form.

(2) An applicant shall, after complying with section 7 and subsection (1) of this section, submit the terms of reference and the results of the scoping exercise to the competent authority.

(3) In considering the terms of reference, the competent authority shall consult with relevant technical departments or local authorities, and may —

(*a*) conduct such investigation as it considers necessary to ascertain the validity of the scoping exercise; or

(*b*) request the applicant to provide additional information for a better understanding of the terms of reference.

(4) Where the competent authority is satisfied that the terms of reference will adequately assist in guiding the environmental impact assessment of the proposed activity, the competent authority shall approve the terms of reference within 28 days of receipt of the terms of reference and the scoping report.

(5) An applicant shall prepare the terms of reference for the detailed environmental impact assessment study after the scoping exercise has been undertaken.

(6) Where an applicant requires the services of a practitioner to prepare the terms of reference required in terms of subsection (1), the applicant shall appoint the practitioner at the applicant's own expense.

Environmental assessment and statement

9. (1) Where the competent authority determines that the proposed activity is likely to have a significant adverse environmental impact, it shall require that such activity undergo an environmental impact assessment or a strategic environmental assessment, the costs of which shall be borne by the developer.

(2) An environmental impact assessment shall identify and evaluate the environmental impact of an activity with particular reference to the —

(*a*) health, safety or quality of life of people;

(*b*) archaeological, aesthetic, cultural or sanitary conditions of the environment; and

(*c*) configuration, quality and diversity of natural resources.

(3) Where the competent authority determines that an environmental impact assessment, environmental management plan or a strategic environmental assessment be made under subsection (1), upon being informed in writing about the decision, the developer shall, before undertaking or implementing the activity, engage a practitioner to prepare a statement which shall be submitted by the developer to the competent authority within the period of time prescribed in the approved terms of reference.

(4) The statement prepared under subsection (3) shall be in a form prescribed by the Minister.

(5) A person who contravenes subsection (3) commits an offence and is liable to a fine not exceeding P1 000 000, or to a term of imprisonment not exceeding 15 years, or to both.

PART III – *Review Process of Environmental Impact Statement*

Public review of statement

10. (1) The competent authority shall, within 60 days of receiving a statement from a developer, examine the statement to determine whether such statement complies with the requirements prescribed by the Minister.

(2) Where the statement complies with the requirements prescribed by the Minister, the competent authority shall —

(*a*) place, at the developer's expense, a notification in the *Gazette* and in a newspaper circulating at least once weekly using the official languages, for four consecutive weeks, inviting comments or objections from those persons who are most likely to be affected by the proposed activity and other interested persons, stating the —

(i) nature and magnitude of the activity,

(ii) location of the activity,

(iii) anticipated environmental impact of the activity, and

(iv) proposed mitigation measures to respond to the negative environmental impact; and

(*b*) in its decision making, consider the comments or objections raised by persons who are likely to be affected by the proposed activity and other interested persons.

(3) The competent authority shall carry out or cause to be carried out the review of environmental assessment statements at the competent authority's own expense.

Conduct of public hearing

11. (1) The competent authority may hold a public hearing if —

(*a*) after examining the statement, the competent authority is of the opinion that the activity is of such a nature that the public should have the opportunity to make submissions or comments at a public hearing; or

(*b*) the public concern over the activity is that the activity may have a significant adverse impact on the environment.

(2) The Minister may, in consultation with the competent authority, prescribe the procedure for conducting a public hearing.

(3) The competent authority shall, after a public hearing, consider the findings in determining the adequacy of the environmental impact statement.

Approval of statement

12. (1) Where the competent authority's review of the statement is complete, the competent authority shall —

(*a*) grant authorisation to the developer, on such terms and conditions as the competent authority considers necessary, where —

(i) the competent authority is satisfied that the statement sufficiently identifies the environmental impact likely to be caused, and

(ii) the prescribed mitigation measures in the statement, to avert or minimise the potential adverse environmental impact, are affective and sufficient; or

(*b*) where the competent authority is of the view that —

(i) the statement does not sufficiently identify the environmental impact likely to be caused, or

(ii) the prescribed mitigation measures to avert or minimise the potential adverse environmental impact, are insufficient and ineffective, afford the developer an opportunity to comply with the provisions of the Act; or

(*c*) reject the statement, where the developer fails to satisfy the conditions under paragraph *(b)*.

(2) In deferring or rejecting the statement, the competent authority shall furnish the applicant with a written statement of the reasons for its decision.

(3) The competent authority may, in issuing an authorisation, prescribe, in writing, specific requirements for monitoring during and after implementation of the proposed activity, by the technical departments, local authorities and the developer.

(4) Any person who gives information to the practitioner or competent authority which is false or misleading in an environmental assessment statement, project brief, scoping report, environmental management plan or strategic environmental assessment statement commits an offence and is liable to a fine not exceeding P100 000, or to imprisonment for a term not exceeding five years, or to both.

Appeals

13. (1) A person aggrieved by a decision of the competent authority may appeal to the Appeals Committee within 30 days of receiving the decision of the competent authority.

(2) The Minister, shall by order establish an Appeals Committee referred to under this section.

PART IV – *Authorisation of a statement*

Validity of an authorisation

14. An authorisation granted under section 12 (1) (*a*) shall be valid for such period as may be stipulated therein and may be subject to renewal at the end of such period.

Revocation or modification of authorisation

15. (1) The competent authority may revoke or modify an authorisation to implement an activity where there is an unanticipated irreversible adverse environmental impact, or a developer fails to comply with any term or condition subject to which the developer's authorisation was issued.

(2) The competent authority shall not revoke or modify any authorisation granted to a developer until the competent authority has, by notice in writing, given the opportunity to the developer concerned, to —

(*a*) rectify any contravention; or

(*b*) show cause, within a period not exceeding 21 days from the date of such notice, why the authorisation should not be revoked or modified.

(3) The competent authority shall publish a notice of any revocation or modification made under this section, in two consecutive issues of —

(*a*) the *Gazette*; and

(*b*) two newspapers in circulation in Botswana.

Transfer of authorisation

16. (1) No person shall transfer, assign or encumber in any way, without the written consent of the competent authority, an authorisation issued under section 12 (1) (*a*).

(2) A person who contravenes subsection (1) commits an offence and is liable to a fine not exceeding P2 000, or to imprisonment for a period not exceeding three months, or to both.

Decision making by competent authority

17. In assessing applications for an authorisation under this Act, and in making a decision as to whether it ought to issue or renew an authorisation under this Act, the competent authority shall take into account the contents of the terms of reference, the statement, the recommendations of other government departments, local authorities and the comments and objections of interested persons and the public.

PART V – *Post Environmental Impact Assessment of Implemented Activities*

Monitoring programme and evaluation report

18. (1) The relevant technical department, local authority or developer, shall, during and after implementation of an activity, monitor the implementation of the activity to determine compliance with the agreed mitigation measures.

(2) The developer shall submit an evaluation report to the relevant technical department or local authority, at such times as the department or local authority shall determine.

Environmental audit by competent authority

19. (1) The competent authority shall carry out or cause to be carried out at its own expense, environmental audits.

(2) The competent authority shall determine the scope of the audit carried out under subsection (1).

(3) After carrying out an environmental audit under subsection (1), the competent authority may require a developer to take —

(*a*) specific mitigation measures to ensure compliance with predictions made in the statement; or

(*b*) mitigation measures to address environmental impacts not anticipated at the time of the authorisation.

(4) Where the developer fails to comply with the provisions of subsection (3), the competent authority may revoke or modify the authorization.

PART VI – *Establishment, Management and Functions of Board*

Establishment of Board

20. (1) There is hereby established a Board to be known as the Environmental Assessment Practitioners Board.

(2) The Board shall be a body corporate having perpetual succession and a common seal capable of suing and be sued in its own name and, subject to the provisions of this Act, of performing such acts as bodies corporate may by law perform.

Seal of Board

21. (1) The seal of the Board shall be such a device as may be determined by the Association and shall be kept and applied by the Executive Secretary.

(2) The affixing of the seal shall be authenticated by the Chairperson or Vice Chairperson and the Secretary or any other person authorised in that capacity by the resolution of the Board.

(3) Any contract or instrument which, if entered into, or executed by a person except the Executive Secretary, will not be required to be under seal, may be entered into or executed without seal on behalf of the Board by the Executive Secretary or any other person generally or specifically authorised by the Board in that capacity.

Membership of Board

22. (1) The Board shall consist of the following eleven members —

(*a*) seven persons excluding public servants, who shall be members of the Association and elected by the Association;

(*b*) three persons appointed by the Minister, who may or may not be members of the Association; and

(*c*) a legal adviser, nominated by the Association.

(2) Board members who are non-citizens shall, prior to their appointment, have been resident in Botswana and have been members of the Association for not less than three years prior to their appointment.

(3) The Chairperson and Vice Chairperson shall be elected by the members of the Board from among their number.

Association to elect members

23. The Association shall, within three months of the coming into force of this Act, elect members to the Board in accordance with section 22 (1) (*a*) and (*c*).