AN ENVIRONMENTAL PROFILE OF THE WATER SECTOR OF THE ERONGO REGION, NAMIBIA

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and finally my parents for making all this possible and for all their support and encouragement.

SYNOPSIS

The aim of this dissertation is to is to provide an environmental overview of the water sector in the study area of the Erongo region. Water is a very scarce resource in the study area and has been singled out to be the greatest obstacle to the development of the study area. As such, this study was developed to assist the identification of the various critical issues affecting the water sector.

This study was agreed upon by the Ministry of Environment and Tourism of Namibia with the help of funding from DANCED. The study is the follow up of an environmental baseline report on the Erongo region in Namibia. The baseline report was commisioned to gather data on the region which would assist the creation of an Integrated Coastal Zone Management Plan. This baseline report was undertaken by the whole MPhil class as a group exercise. Individual dissertations were then carried out by the members of the Mphil class. The students had to choose topics that were relevant to the study area.. This study is one of these dissertations.

The study was guided by the principles of Integrated Water Resources Management and the need to be of use in the planning process for water resource utilisation in the study area. To achieve this, the Integrated Environment Management theory is used together with the principles of Integrated Water Resource Management. This will ensure that the study

- Uses a broad definition of the environment so as to identify all key opportunities and constraints of the water sector.
- Would help towards the creation of a plan to manage the water sector in order to optimise the benefits of the sector while at the same time minimising or mitigating the financial, environmental and social costs.

The study aims to identify the critical environmental impacts of the water sector in the study area. These impacts are then assessed but not evaluated. This is mainly due to a

lack of specialist input and proper public participatory exercise without which evaluation is futile.

So as to facilitate analysis, the water sector in the study area was broken down into three subsections namely water supply, water demand and legislative and policy issues. These were then assessed according to the criteria of efficiency, equity and. Sustainability.

The efficiency criteria states that an action is efficient, if it makes at least one person of today's society better off without anyone else being made worse off, i.e. benefits exceeds costs. An action may also be regarded as efficient if gainers could potentially compensate losers and still be better off.

Under the equity criterion an action is equitable if it serves to bring about a situation in which the distribution of costs and benefits to present members of society is considered to be improved, i.e. the benefits and costs are distributed fairly among the individuals of the present day society.

The final criterion, that of sustainability or intergenerational equity, states that an action is acceptable if the prospects for improvement in the future well being are not diminished by the action, i.e. benefits exceed costs over intergenerational time periods.

The results of the assessments summarised in the three following tables

CRITICAL COMPONENT	IS IT EFFICIENT ?	IS IT EQUITABLE ?	IS IT SUSTAINABLE ?
SOURCE OF WATER SUPPLY ELEMENT			
UNDERGROUND AQUIFERS	Not efficient. Because of the potential loss of this source of water to salinisation. Moreover, the financial cost of extracting water increasing while benefits remain the same.	Equitable because the costs and the benefits are distributed equally among a majority of inhabitants. Topnaars are an exception as they have no potable source of water. This issue needs to be addressed.	Unsustainable because aquifers will become useless due to salinisation This threat will increase with the lowering of the water table.
DESALINATION	Initially inefficient because of 250 % price increases. More efficient in the long term as savings made from reduced water consumption neutralise the effects of the price hikes.	Equitable, if the big water users subsidise the low water users who are generally poor. Moreover, mitigating measures during the construction and operation of the desalination plant need to be implemented.	Sustainable because it is a limitless source of water and it will help improve the conditions of the underground aquifers in the region
TRANSMISSION AND STORAGE ELEMENT	Inefficient because of excessive water losses due to leakage.	Equitable as a majority of the inhabitants of the region have a reliable water supply. However, the Topnaar community needs to be supplied with potable water.	Unsustainable because of a lack of qualified personnel, the operational lifespan of the network is reduced.
DISTRIBUTION ELEMENT (Walvis Bay and Swakopmund)	Inefficient because of excessive water losses due to leakage.	Equitable as a majority of the inhabitants of the region have a reliable water supply. However, the Topnaar community needs to be supplied with potable water.	Unsustainable because of a lack of qualified personnel, the operational lifespan of the network is reduced

TABLE 7.1 SUMMARY OF ASSESSMENT RESULTS FOR THE WATER SUPPLY SECTION

CRITICAL COMPONENTS	IS IT EFFICIENT ?	IS IT EQUITABLE ?	IS IT SUSTANAIBLE ?
CURRENT WATER CONSUMPTION			
DOMESTIC	Inefficient because per capita consumption is four times the accepted average of 100 litres per person per day.	Not equitable because high income earners consume more than five times more water than low income earners.	Unsustainable because the current levels of water consumption cannot be maintained as it exceeds the rate of recharge of the aquifers.
NON DOMESTIC	Efficient because the two largest non domestic users of water have implemented or will implement ways to increase efficiency of water usage.	Equitable because the two largest consumers i.e. Rossing and the fishing industry are sharing the responsibility of water saving measures. For the long term, it is essential that any new non domestic heavy water user implement similar measures.	Unsustainable because the current levels of water consumption cannot be maintained as it exceeds the rate of recharge of the aquifers.
WATER DEMAND MANAGEMENT	Inefficient because per capita rate of water consumption still high. Will improve with the introduction of higher tariffs for big water users.	Equitable because methods aimed at reducing water consumption ensure that the savings will be shared equitably by everyone.	Unsustainable because of the failure to reduce the actual rate of water consumption which is unsustainable.

TABLE 7.2 SUMMARY OF ASSESSMENT RESULTS FOR THE WATER DEMAND SECTION

CRITICAL COMPONENTS	IS IT EFFICIENT ?	IS IT EQUITABLE ?	IS IT SUSTAINABLE ?
WATER ACT	Inefficient due to a deficient enforcement mechanism due to a lack of qualified manpower.	Inequitable because it fails to recognise the water demand of the environment and gives too much power to the minister.	Unsustainable because it fails recognise the environment as the downstream user of water and the act is not properly enforced.
WATER AND SANITATION POLICY (WASP)	Efficient because of its participatory and multidisciplinary approach.	Equitable because through the participatory approach it ensures accountability of decisions and the equal sharing of assets and benefits.	Sustainable but low priority given to the needs of the environment counters the sustainability objective.
PRIVATISATION	Efficient because of the ability to pay for the best skills in the business and because of long term planning.	Equitable only if the Public Utilities Commission is established to monitor the private water company.	Sustainable because of long term planning and qualified personnel.

TABLE 7.3 SUMMARY OF ASSESSMENT RESULTS FOR THE LEGISLATION AND POLICY SECTION

From the assessment the following conclusions were drawn

- the water sector in the study area is inefficient because of the combined effect of an inefficient water supply section coupled with a demand for water that is unsustainable. This imposes a severe threat to the continued sustainable utilisation of the aquifers supplying water to the study area.
- there will be an improvement in the water sector in the region with the privatisation of the bulk water supply, the adoption of the WASP principles and the use of desalinisation to supplement the regional water supply.
- from the analysis of the SEA procedure, it is observed that if the suggestions mentioned in chapter 6 were adopted, the efficiency of the water sector in the country and in the study area would improve dramatically.

Based on the findings and conclusions of this report the following recommendations are made

- In the short term, it is essential that the desalination plant be built to ensure that the underground aquifers do not become permanently damaged. This measure needs to be applied in conjunction with an aggressive water demand management campaign based on increased tariffs and a more proactive awareness campaign.
- the study has helped to identify critical issues concerning the water sector in the study area and should be useful when a water resources management plan is drawn up for the Erongo and Namibia.
- A relatively simple analysis based on principles of Sectoral Environmental Assessment revealed the numerous flaws in the water sector of the Erongo and Namibia. As such, it is recommended that a more detailed SEA be carried out, so that all the strengths and weakness of the water sector can be identified, and a proper management plan drawn up as a long term solution.

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ABBREVIATIONS

EBS	Environmental Baseline Study
MET	Ministry of Environment and Tourism
DANCED	Danish Co-operation for Environment and Development
IEM	Integrated Environmental Management
I&AP'S	Interested and Affected Parties
WASP	Water and Sanitation Policy
PPPs	Policies, Plans and Projects
IWRM	Integrated Water Resources Management
EPZ	Export Processing Zone
WASCO	Water and Sanitation Committee

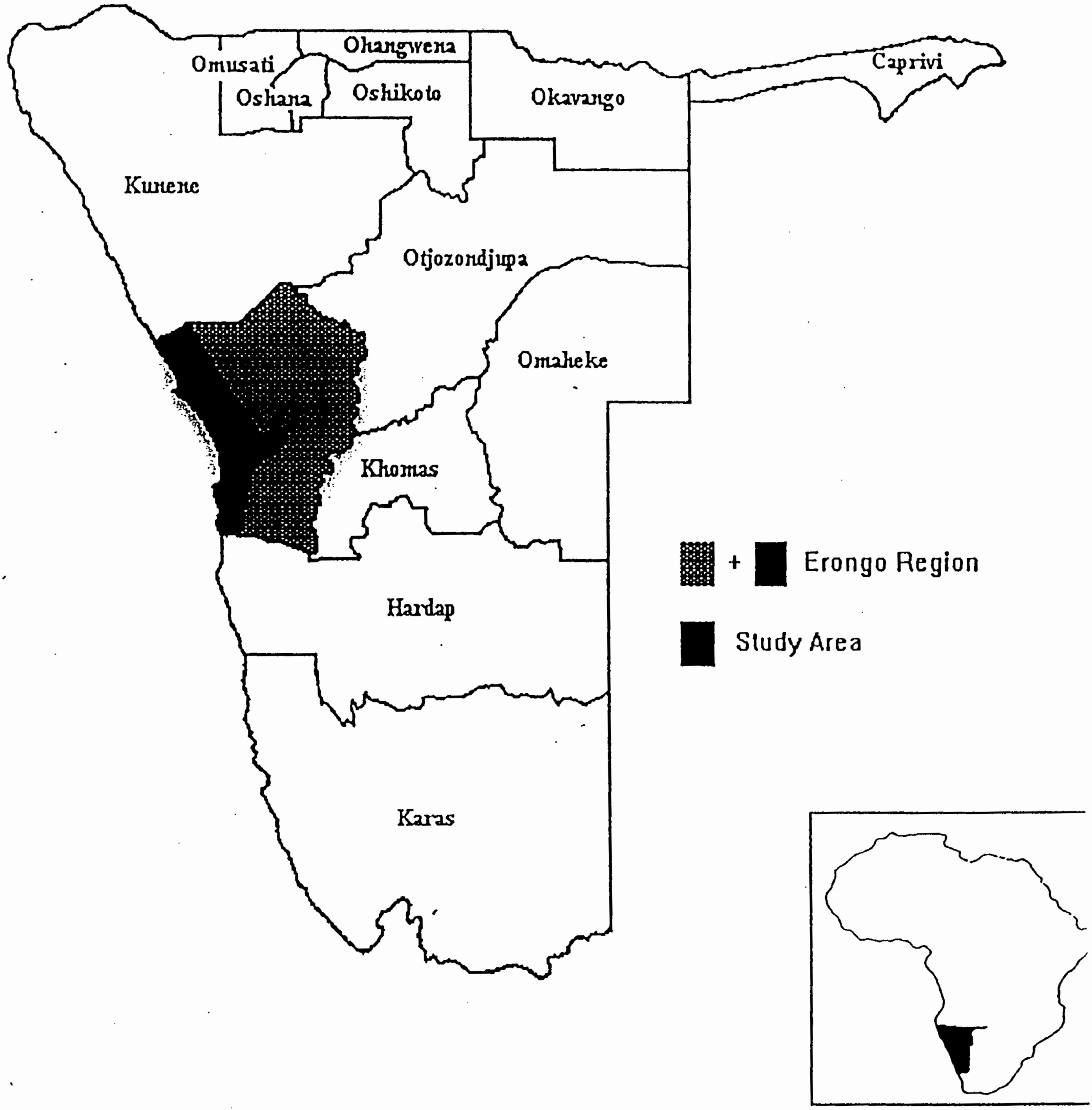
CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

The Erongo is one of the twelve regions of Namibia (see Map 1). It is situated on the mid-western coast of the country and includes the towns of Walvis Bay and Swakopmund, the second and third largest town in Namibia respectively. This is an arid area and with less than thirty millimetres of rainfall per annum (EBS, 1996), it is one of the driest regions in Namibia. The major industries in this region are the fishing and mining industry. This is mainly due to the presence of Walvis Bay harbour, Namibia's only deep water port, and Rossing Uranium Mine, the largest in the country. Moreover, this region also comprises the only stretch of Namibian coastline open to the public. This enhances the tourist potential of the region.

It is clear from the above paragraph that this region is under great pressure to develop further, especially with the emphasis placed by the Namibian government on the promotion of employment opportunities (EBS, 1996). The opening of the Trans-Kalahari and the Trans-Caprivi highways that will link the region to the rest of Southern Africa will exacerbate the developmental pressure.

To accommodate these pressures and at the same time maintain a healthy environment, there is a need for an integrated and holistic planning process. However, there is currently no such plan in place. Consequently the Ministry of Environment and Tourism (MET), with funding from the Danish Co-operation for Environment and Development (DANCED) commissioned a study which would ultimately result in a Coastal Zone Management Plan for the study area. As part of this process, DANCED is supporting a baseline study of the study area by the University of Cape Town's Environmental Masters Class. This three month baseline study was completed in March 1996. DANCED also agreed that each student submit an individual dissertation relating to the environmental



Map 1 Erongo Region and Study Area

issues in the area. This individual study would draw on the data from the baseline study and any other source available in the three months provided for the study.

This study is one of the individual dissertations of the study area. It analyses the water sector in the region. The reasons motivating this study and its objectives are discussed in the following section.

1.2 PURPOSE OF THIS STUDY

The Erongo with an average precipitation of less than 30 mm is one of the driest regions of Namibia. The economy of the study area is based on the fishing, mining and tourism industries (EBS, 1996). These three sectors have been identified by the Namibian government as being critical to the future growth of the economy and will help to absorb the present and future labour supply. (NDP1, 1995). Moreover, the Namibian government has embarked on a campaign to promote the increased utilisation of Walvis Bay harbour for regional trade (EBS, 1996). It is expected that the completion of the Trans Kalahari and Trans Caprivi Highways will significantly increase the volume of cargo handled by the Walvis Bay harbour (*ibid.*). This is because Walvis Bay will be the only reliable and accessible deep sea port on the west coast of Sub Saharan Africa (*ibid.*).

However, all of these future developments could be severely hampered by the scarcity of water in the region. In fact, the National Planning Commission (NPC), has identified the scarcity of water as the single most important obstacle to development in the Erongo region (NDP1, 1995). In order to ensure that water resources are properly utilised, there is a need to formulate a management plan for the water resources in the Erongo region. Currently, there is no such holistic management plan available to ensure the sustainable utilisation of the water resources of the region. However, before any such plan is drawn up, there is a need to identify the various impacts of the water sector in the study area.. Within this context, this study was carried out with the following objectives:

- Firstly, to identify the critical environmental impacts of the water sector in the study area;

- Secondly, to examine the identified impacts and attempt to assess them;

- Thirdly, to provide an academically rigorous report that will help decision-making regarding the sustainable use of water resources in the study area.

1.3 ASSUMPTIONS AND LIMITATIONS

1.3.1 Assumptions

The assumptions made at the outset of this study are listed below:

- This study will contribute to the drawing of a Coastal Zone Management Plan for the study area;

- The data in the baseline document are correct and thus the assumptions of the baseline document are valid. In this regard, the following assumptions are made:
  - factual information gathered during interviews with the various technical experts is correct;
  - individual interested and affected parties' (I&AP's) opinions and views mirror those of the organisation which they represent;

- The extra factual information (over and above the baseline data) gathered for this study during interviews with various technical experts is correct.

1.3.2 Limitations

The limitations that influenced this study are listed below:

- Limited specialist input was possible, due to the time and money constraints, in this study and on the baseline study. This has limited the determination of the critical controlling factors influencing the water sector in the study area;

- Due to the absence of a proper public participatory exercise and because of the author's own limited experience, this study will not evaluate but only assess the identified critical factors. This is so because any attempt at weighing up the data would be developed in a void and would not relate to the actual conditions in the study area. This study, therefore, is limited to an attempt to obtain an environmental profile of the water sector in the study area.

- Currently, there is no Integrated Coastal Zone Management Plan for the study area. The recommendations of this plan, when made, will have major implications for the water sector in the study area. As such, this limits the credibility of the suggestions made by this report to manage the water resources in the study area.

1.4 STRUCTURE OF DISSERTAION

Chapter one of this dissertation provides a general overview of the study area. It deals with the background, the purposes, the assumptions and limitations of the study.

The theoretical framework which the study contains is discussed in chapter two. The concepts and issues raised in this chapter are used throughout the dissertation.

Chapters three to five examine and assess the water supply, the water demand and the legislative and policy sections of the water sector in the study area.

Chapter six motivates the need for a management plan and will make suggestions to implement one.

Concluding the dissertation, chapter seven summarises the issues raised during the study. Conclusions and recommendations arising from the assessment are also presented.

CHAPTER 2: THE THEORETICAL FRAMEWORK CONTAINING THE STUDY

This study has used the principles of Integrated Resource Management (IRM) to obtain an environmental profile of the water sector in the Erongo region and to analyse the impacts associated with the water sector. The principles of Integrated Environmental Management (IEM) are in many ways similar to those of IRM. This chapter will illustrate these similarities by briefly describing the principles behind IEM and Integrated Water Resources Management. It will then proceed to describe the method used to analyse the various issues associated with the water sector in the Erongo region. This study will however not aim to evaluate the various impacts and the reasons for this will be discussed in this chapter. Moreover, this chapter will also describe the limitations inherent in this analysis of the water sector in the study area.

2.1 THE IEM PROCESS

The IEM procedure was developed from the principles derived from the procedure for Environmental Impact Assessment in the United States of America in 1968. Since then the EIA process has been adopted by many countries who have modified the process to suit their needs. However, despite each country having its version, the underlying principles of the EIA process are the same. The South African version of the EIA has been developed into a structured procedure called Integrated Environmental Management (IEM).

The main goal of IEM is to ensure that environmental consequences of development proposals are understood and adequately considered in the planning process (Dept of Environmental Affairs, 1992). The term `environment' is also defined in a broad sense to not only include biophysical components but also socio-economic components (*ibid.*). This illustrates the holistic approach the IEM process embraces. Fuggle and Rabbie (1992) state that the basic principles underpinning IEM are:

- "a broad understanding of the term `environment';
- informed decision-making;
- accountability for decisions and for information on which they are based;
- an open participatory approach in the planning proposals; and,
- proactive and positive planning."

In short, the IEM process can be said to be a co-ordinating process which aims to ensure that the social costs of development (those borne by society) are outweighed by the social benefits (the benefits to society as a result of the development)(*ibid.*). This ultimately results in development that is sustainable, efficient and equitable.

2.2 THE INTEGRATED WATER RESOURCE MANAGEMENT PROCESS (IWRM)

The main goal of IWRM can be said to be the sustainable utilisation of water resources which respect the social and environmental interests (Hufschmidt, 1993). In the context of IWRM, sustainable utilisation is defined as "use that assures that the value of services provided by a given water source will satisfy the objective of future generations" (UNESCO, 1993). Service in this context is defined as comprising of a broad array of water uses from domestic, agricultural, industrial to recreational and maintenance of ecosystems (*ibid.*). To achieve the goals of IWRM, Hufschmidt (1993) proposed a framework. This framework is illustrated in Figure 1.1 below.

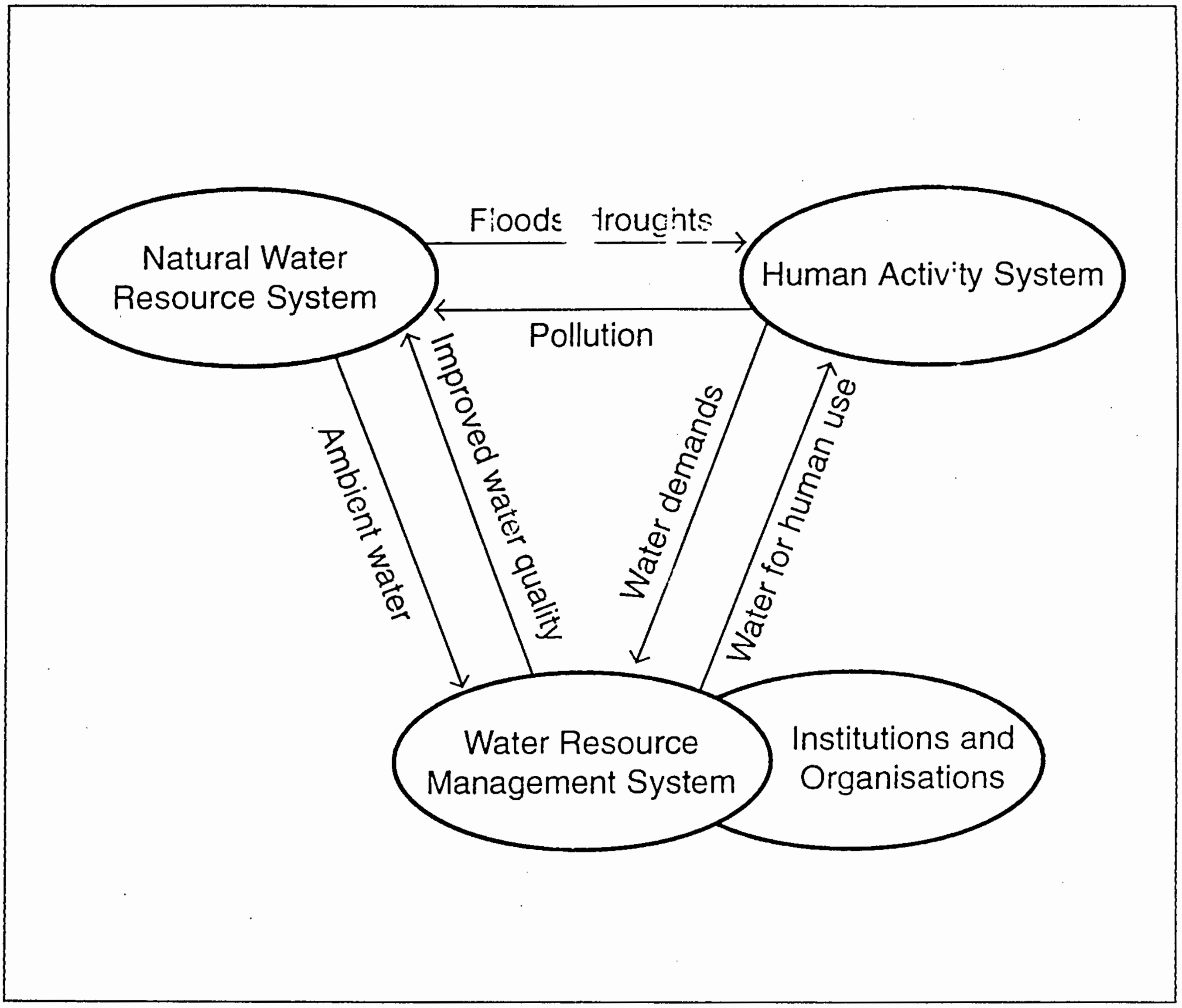


Figure 1.1: Integrated Water Resource Management: Proposed Framework (Hufschmidt, 1993).

From the diagram, it can be observed that three major systems have been identified namely the Human Activity System, the Natural Water Resource System and the Water Resource Management System.

The Natural Water Resource System is made up of the hydrologic cycle with its components of precipitation, evaporation, surface runoff as well as the `hydrologic whole or continuum' which includes soils, biota and atmosphere as well as water (UNESCO, 1993). The second system is the Human Activity System which consists of activities of people that affect or are affected by the Natural Water Resource System (*ibid.*). The Water Resource Management System consists of activities related to harmonising the supply and demand side to satisfy societal needs (*ibid.*). Furthermore, as can be seen in Figure 1.1, an essential support to the Water Resource Management System is the institutional framework for management consisting of the organisations and the rules and codes governing the use and control of water resources.

Hufschmidt (1993) recommended that a systems approach be adopted when using the framework. The relationship between each system also has to be analysed to understand and achieve integration when managing water resources. Integration in this context was defined as "the act of blending or forming regularly interacting or interdependent groups of items, into a whole or incorporating two or more subsystems into a larger overall system" (*ibid.*).

2.3 THE STUDY AND THE THEORY

From the brief descriptions of the IEM and the IWRM theory, it can be said that though they follow different procedures, their fundamentals are similar. This is because both aim to achieve sustainable development and utilise a holistic approach. Moreover, because the IWRM requires constant communication between the Human Activity System, Water Resource Management System and the Institutions and Organisations, it can be deduced that the IWRM favours an open participatory approach and informed decision making. Hence, in this regard, the IWRM is similar to the IEM and this results in both processes being proactive and promoting positive planning.

For the purpose of this study, the systems approach as proposed by Hufschmidt (1993) will be used to obtain an environmental profile of the water sector in the Erongo region. This will be achieved by analysing the interrelationship of each system and the systems themselves (Figure 1.1). However, for this study, these interrelationships and systems will be grouped under three broad categories namely water supply, water demand and legislation and policy. This will simplify the analysis of the water sector because if the analysis was carried out as per Hufschmidt framework, the systems and their interrelationships would have to be examined separately, and this would have made the analysis tedious. However, it should be noted that simplifying the analysis does not mean that some categories identified in Hufschmidt framework will be ignored. In fact, these will be analysed under one of the three broad categories, where appropriate.

Each of these categories, namely water supply, water demand and policy and legislation will be discussed under three chapter headings. The analysis of each issue will be based on the concept of efficiency, equity and sustainability. These concepts will be discussed in greater detail in the following section. It should be noted that this study will not evaluate the issues associated with the water sector, the reasons for which are discussed in section 2.4.

2.4 EFFICIENCY, EQUITY AND SUSTAINABILITY

In order to aid the assessment of resource management problems, Stauth and Baskind (1992) suggested a set of criteria. This set of criteria is that of efficiency, equity and sustainability. These will be used to analyse the various issues related to the water sector in the Erongo region.

The efficiency criteria states that an action is efficient if it makes at least one person of today's society better off without anyone else being made worse off, i.e. benefits exceeds costs (*ibid.*). An action may also be regarded as efficient if gainers could potentially compensate losers and still be better off. It should be noted that the efficiency criteria is the only one of the three which is independent of judgement (*ibid.*). However it can be argued otherwise because the act of determining the most efficient method involves value judgement (Green and Turnstall, 1991). This means that no two persons will see or assess an action in exactly the same way, because the act of assessing is itself partially dependent on the personality and experiences of the assessor. This, in turn, determines on what issues the assessor will lay more emphasis on in determining efficiency. For example, when looking at a glass of water one person might consider it to be half full while the other might consider it to be half empty. Hence, one person lays emphasis on the concept of fullness, while the other lays emphasis on the concept of emptiness. Therefore, it can be seen that the `objectivity' of this criterion is still a matter of debate.

Under the equity criterion an action is equitable if it serves to bring about a situation in which the distribution of costs and benefits to present members of society is considered to be improved, i.e. the benefits and costs are distributed fairly among the individuals of the present day society (Stauth and Baskind, 1992).

The final criterion, that of sustainability or intergenerational equity, states that an action is acceptable if the prospects for improvement in the future well being are not diminished by the action, i.e. do benefits exceed costs over intergenerational time periods?

Ideally, the determination of the ability of each of these categories (water demand, water supply and policy and legislation) to meet Stauth's criteria should be determined with the active participation of interested and affected parties. In the present study, this was not undertaken and the discussion on the ability of the impacts to satisfy these criteria is based on the author's perception. This perception, naturally, imposes certain limitations which will be discussed further down.

McAllister (1980) indicated that value judgements and biases within the assessment phase are less in evidence than during the evaluation phase of the process. Moreover, the impact of value judgements is exacerbated by the lack of available information in the form of specialist studies on the various impacts of the water sector in the study area. Therefore, the present study only aims at assessing the information collected and not evaluating it. It should be noted that MacAllister's remarks do not mean that the assessment of the water sector is an objective one. In fact, biases and judgement values will occur especially in assigning significance (McAllister, 1980).

2.5 THE PROBLEM OF SIGNIFICANCE

Significance is defined as the subjective measurement of the cost of a predicted impact to society (Thompson, 1990). This study assigns significance by applying three tests namely that of efficiency, equity and sustainability. The major limitations in assigning of significance is the difference in background of the author and the people in the region. The author comes from an Asian background, is well educated, environmentally aware and has an European outlook on issues because of his education. Though it is difficult to characterise the society in that region, it can be said that the people in the study area are generally poor to moderately rich, poorly educated, environmentally illiterate and come from a predominantly African culture. Furthermore, given that the author comes from an engineering background, it is likely that a greater emphasis will be placed on the technical issues impacting the water sector of the region. Therefore, given this divergence of background and resulting underlying values, it is possible that the significance assigned by the author would be different to that assigned by the local inhabitants. This problem can be solved by a major public participation exercise or through a formal workshop using the Delphi group technique. However, because of time and expense this was considered to be beyond the scope of this exercise.

CHAPTER 3: WATER SUPPLY

This section will analyse the supply component of the water sector in the study area. Initially it will describe the functional elements of a public water supply systems. Based on this model, the critical factors relevant to each element will be discussed and assessed.

3.1 FUNCTIONAL ELEMENTS OF PUBLIC WATER SUPPLY SYSTEMS

According to Linsley *et al.* (1992), the public water supply system is made up of six functional elements namely, source of water supply, storage, transmission, treatment, transmission and storage, and distribution. Figure 3.1 below illustrates the various functional elements and their interrelationships.

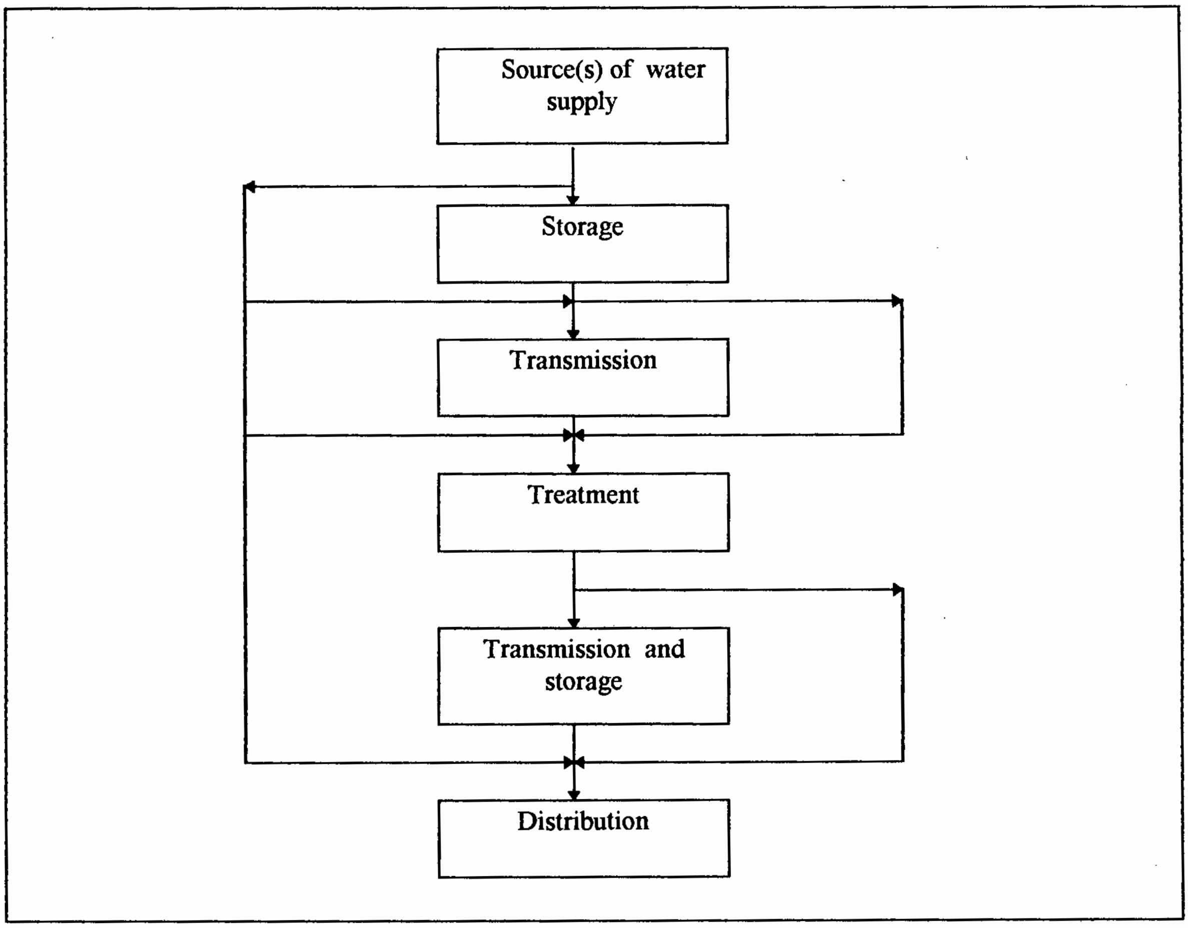


Figure 3.1: Interrelationship of the functional elements of a municipal water supply system (Linsley *et al.*, 1992)

Generally, the source of water supply is a surface water source and/or a groundwater source. In the case of the study area the sources are the underground aquifers of the Omaruru and the Lower Kuiseb rivers.

The storage functional element is defined as a facility used for the storage of water normally at or near the source of supply (Linsley *et al.*, 1992). In the study area, there are two such storage facilities namely a 10,500 cubic metre reservoir at Mile 7 which supplies Walvis Bay. The town of Swakopmund is supplied by a 20,000 cubic metre reservoir situated on a site near the B2 national road. Rossing and Arandis are also supplied by this reservoir. However, Rossing also pumps saline water from the Khan River for its mining operations.

The transmission element in the water supply network is defined as the facility used to transport water from a storage plant to treatment facilities (*ibid.*). In the treatment facilities, the quality of the water is improved or altered to suit the needs of the consumer (*ibid.*). However, in the study area, these two functional elements are absent. This is mainly due to the good quality of the extracted groundwater. As such no treatment, besides the addition of chlorine, is required. (Lucks, Pers.Comm.).

The transmission and storage element is defined as the facilities used to transport treated water to intermediate storage facilities to one or more points for distribution (Linsley *et al.*, 1992). In the study area, the transmission network is operated by the South Operation division of the Water Supply directorate of the Department of Water Affairs. The pipelines in this network have a carrying capacity of between four million metric cube per annum to fourteen million metric cube per annum (EBS, 1996). The storage facilities utilised for this functional element are similar to those utilised by the storage functional element namely the reservoirs at Mile 7 and the one on the B2.

The distribution element is defined as the facilities used to distribute the water to the individual users connected to the system (Linsley *et al.*, 1992). In the study area, the distribution networks, especially in the towns of Walvis Bay and Swakopmund, consist of concrete pipes of between 100mm and 500mm in diameter. These distribution networks are maintained and operated by the individual municipalities (EBS, 1996).

3.2 CRITICAL ISSUES RELEVANT TO THE SOURCES OF SUPPLY FUNCTIONAL ELEMENT

This section will be subdivided into two parts namely underground water and desalination. Critical issues relevant to the use of underground water from the Lower Kuiseb and the

Omaruru will be analysed and assessed. A similar exercise will be carried out for desalination, the future source of water in the study area.

3.2.1 Over extraction of groundwater

According to Rammler (1995), the underground water aquifers of the Erongo region have been overutilised in the past. This is very relevant for the Lower Kuiseb aquifers which until recently have been overutilised. The major reason for the over-exploitation was the inadequacy and inaccuracy of the recharge data available on the aquifers. This lead to a false determination of the safe yield of the aquifers (DWA, 1993b).As a result the previous estimates for the safe yields were far higher than the actual values (*ibid.*). One of the major impacts of the overextraction has been the dramatic lowering of the water table levels in the aquifers especially for the Lower Kuiseb aquifers. Figure 2.2 illustrates the fall in water table levels in the boreholes of the Rooibank area in the Lower Kuiseb.

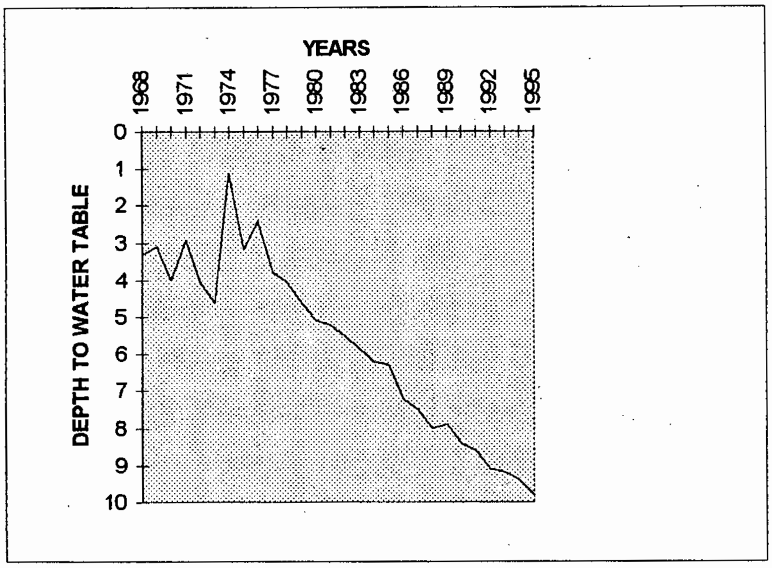


Figure 3.2: Depth of water table in Rooibank Borehole
(Walvis Bay Town Engineer, 1995)

From Figure 3.2, it is observed that the water levels have fallen consistently since 1974 from a depth of around 1.5m to a 9m depth in the early 1990's. This situation has somewhat stabilised at a level of about 9 m, especially after studies were carried out in 1992 to accurately determine the safe yield of the aquifers (DWA, 1993b).

3.2.1.1 Impacts of the overextraction of groundwater

One of the major impacts of falling groundwater near the coast is the salinisation of the groundwater. This has been identified as the single greatest threat to the groundwater aquifers especially those in the Lower Kuiseb (Brummer, Pers.Comm.).

Salinisation of the groundwater resources is defined as the process whereby sea water seeps into the underground aquifers thereby increasing the salinity of the water (Simons, 1967). This degrades the quality of the water and often makes it undrinkable. Figure 3.3 illustrates the way in which sea water contaminates inland underground aquifers.

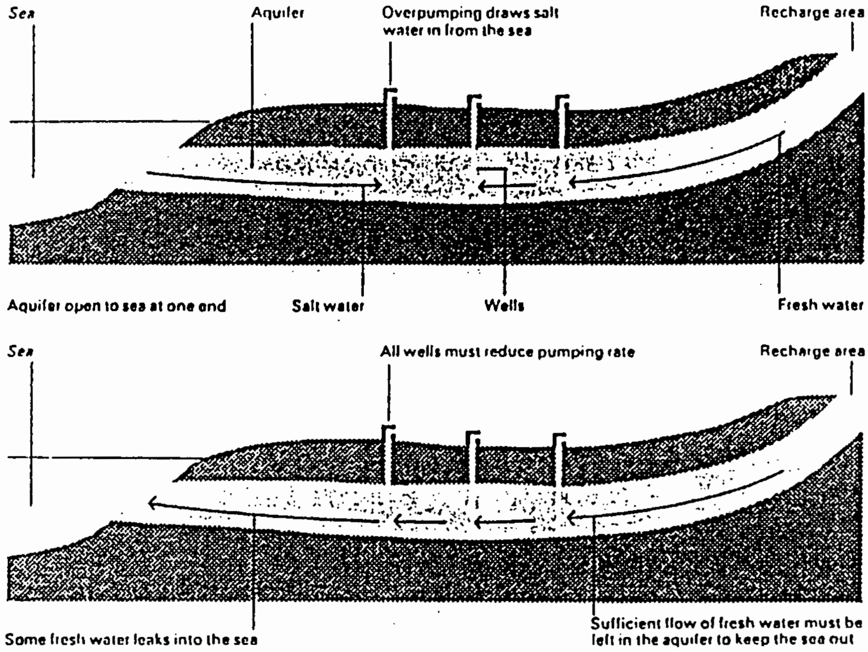


Figure 3.3 Salinisation of underground water

(Simons, 1967)

From the above figure, it is observed that whenever the rate at which water is pumped out of an aquifer exceeds the rate of which the aquifer is being replenished, the level of water falls. The water level continues to fall until it reaches seawater level. At this point, no further fall in water table level occurs. Instead, sea water will seep into the aquifer due to a pressure gradient. This process continues if the unsustainable extraction rates are maintained and it results in the groundwater being contaminated with brine. An example of such a case is the Santa Clara Valley in California where overextraction lead to salinisation rendering the aquifer permanently useless (Simons, 1967). Linsley *et al.* (1992) states that the only way to reduce or avoid such a scenario is to make a thorough survey of the groundwater resources and determine an accurate yield for the aquifers.

The drying up of vegetation is another direct impact of the dramatic lowering of the water table levels. This problem is especially severe in the flood plains of the Lower Kuiseb River. Endemic vegetation species such as the !nara and the ana are dying back because the roots of the plant no longer reach the water table levels (EBS, 1996). This has had a ripple effect on the Topnaar community which uses the !nara tree as a source of food, medicine, cosmetics and fodder for domestic animals (Seely, 1992).

3.1.2.2 Assessment of impacts of the overextraction of groundwater

The extraction of groundwater in the study area is not an efficient process. This is because the benefits derived from extracting the water are neutralised by the potential loss of a source of water as a result of salinisation due to a lowering of the water table.. Furthermore, the Topnaar community has been negatively impacted and is now worse off because of overextraction of groundwater. As such, the financial cost of extraction of groundwater is increasing over the years while the benefits derived remain unchanged. This results in a decrease in efficiency as time passes..

The abstraction of water from underground aquifers is an equitable one. This is so because the benefits and costs derived from the action are distributed evenly among a majority of the inhabitants of the study area. However, the Topnaar community has been negatively impacted while at the same time receiving none of the benefits such as receiving drinkable water. In fact, the Topnaar community had to request drought relief at the end of 1994 (Seely, 1992). Despite this fact, this does not make the water supply inequitable as the Topnaars account for less than one percent of the total population in the study area (EBS, 1996). However, it is essential that this issue should be addressed and drinking water should be made available to the Topnaars.

The current usage of the groundwater resources is not sustainable. This is because underground aquifers are under the threat of becoming unusable in the future as a result of salinisation. This would mean that the future generations would not benefit from the source. Instead they will have to pay a higher cost in order to receive the same water amenities. This does not satisfy the criteria for intergenerational equity as defined in Section 2.4, thus making the current usage of groundwater resources unsustainable.

3.2.2 Desalination plant

According to a feasibility study compiled by the Department of Water Affairs (DWA, 1993b), desalination was identified as the best solution to meet the water demands in the region. The study recommended that the desalinisation plant be located at Plaatjies, a site south of Walvis Bay harbour. This plant would use the mechanical vapour compression method (see Appendix 1 for greater detail) and would cost N$ 81.98 million.

3.2.2.1 Impacts of the desalination plant

In order to identify all the critical impacts of the desalinisation plant, a comprehensive EIA needs to be carried out. This will require specialist input and a public participatory exercise. Such an exercise was not done in this case because of time and financial constraints. However, in this study, certain obvious and general impacts have been identified but these are not all encompassing.

The major impact of the desalinisation plant is that it will reduce the pressure on groundwater sources. This would enable the authorities to pump aquifers at below safe yield thus permitting an adequate recharge and increase in water table levels. This has been suggested as a measure to recharge the aquifers (Rammler, 1995).

The other major impact of the plant would be on the local fauna and flora. It is proposed that the desalination plant should be built at Plaatjies (Heyns, Pers.Comm) and this is an area that is environmentally sensitive and rich in biodiversity. The area is rich in aquatic plant communities making it an ideal venue for fauna especially migrating birds (EBS, 1996). In fact, this area has been identified as a prime site for protection under the RAMSAR treaty. It is believed that the major impact of the plant on its immediate surroundings would be during construction and through the release of brine, a by-product of the desalinisation process. The release of brine would increase the salinity levels of the sea water near Plaatjies. This will result in the destruction of the aquatic fauna which is sensitive to the salinity levels in the water (EBS, 1996). The migrating birds arriving to this location will thus be negatively impacted.

Another identified impact of the desalinisation plant is that it will lead to dramatic increase in the price of water due to the cost of desalinating sea water. It is estimated that the price, will increase 250% over the next ten years (Heyns, Pers.Comm.). This will negatively affect the poorer communities especially if water subsidies are completely removed.

3.2.2.2 Assessment

The desalination plant will provide the study area with an endless source of water, thereby removing the single largest obstacle to the regions development. The benefits obtained from the resulting development will far outweigh any negative impact associated with the construction of the desalination plant. However, the unit cost of producing water will go up and efficiency of water production is decreased in financial terms. This increase in the price of water will reduce the per capita consumption, which will result in an increase in the efficiency of water usage and reduce the overall water demand. Initially, this will make the desalination plant inefficient, but over the years as the financial savings made from the decrease in water consumption increase, they can be used to balance out the price increases of the unit cost of water. Hence, in the long run, the desalination process is efficient.

If measures are taken to reduce the impact of increasing water tariffs on poorer communities, desalination can be described as being equitable. Moreover, mitigating measures that will decrease the impacts of the construction and running of the desalination plant on the surrounding environment, need to be implemented. This will ensure that the cost of the development is shared equally between nature and human beings, thus making the process more equitable.

Desalination will provide the study area with a limitless source of water. Moreover, it will help improve the conditions of the underground aquifers of the region. This translates into a resource being passed on to the next generation in a similar or better condition by the previous generation. Furthermore, it is also necessary that mitigating measures be taken to reduce the long term impact of the desalination plant on its surroundings. If these conditions are satisfied, then, according to the definition in Section 2.4, this makes desalination sustainable.

3.3 CRITICAL ISSUES RELEVANT TO TRANSMISSION AND STORAGE FUNCTIONAL ELEMENT

3.3.1 Water loss in the pipeline network

According to Rammler (1995), during 1995 the DWA produced 9.562Mm^3 of water while the total water received in bulk by the municipalities was 7.512Mm^3. This translates into an average loss of 21.5% of the water produced. According to Petersen (1984), pipeline networks having water loss of up to five percent are considered to be efficient. Complete elimination of leakage is generally not a feasible option because it is economically unviable.

Currently the only method used for detecting the presence of leaks is the meter reading of meters placed at various points on the network (Rammler, 1995). This method has a severe limitation because it can detect the presence of leaks but cannot pinpoint the exact location of the leak. The absence of specific equipment to detect and seal off the leaks further aggravates the problem. Moreover, there is currently no plan that has been drawn up which details exactly what measures need to be taken in order to minimise water leaks, and to effectively deal with them if they do occur. Hence, the leak detection process is currently reactive rather than proactive.

3.3.2 Insufficient storage capacity

Currently the DWA operates two main reservoirs namely a 10,500 m^3 reservoir at Mile 2 and a 20,000 m^3 reservoir near Swakopmund. These reservoirs supply the town of Walvis Bay and Swakopmund respectively. According to the Swakopmund Town Engineer (Lester, Pers.Comm.), the current storage capacity of the reservoir supplying the town is inadequate. This is because the reservoir is unable to supply the town with a continuous flow of water during peak seasons when the average water demand is 20% above the normal value (Rammler, 1995).

Reservoirs are normally designed for a 95% reliability rate (Linsley *et al.*, 1992). This means that for 95% of their operational existence the reservoir can supply water without incurring a deficiency. The peak water demand in Swakopmund is during the tourist seasons from December to February. During that time, certain areas in town are not continuously supplied with water. Since the peak tourist season lasts for three months, the reservoir can be said to have a reliability of only 75% thus making it unsuitable. No concrete analysis could be made as regards of the reservoir at Mile 2 due to unavailability of information.

3.3.3 Administration of network

Currently, the Operation South division of the DWA is experiencing a severe shortage in terms of engineers and technicians (DWA, 1993(a)). According to the DWA, on a national level there is currently a shortage of staff of 52% in the professional and technical post categories (*ibid.*). This is mainly due to two reasons, firstly the lack of competent education facilities inside Namibia. The second reason is that the private sector offers a better pay package which results in most engineers and technicians working there. Petersen (1984) mentions that adequate technical staff and appropriately trained workers are one of the cornerstones of a successful water supply operation. In the study area, this is currently not the case and, as a result, the network is not maintained to its optimal level. This might be one of the reasons for the high incidence of leaks and the high leakage losses of the network.

3.3.4 Assessment of the transmission and storage functional element

According to the definition in Section 2.4, the transmission and storage functional element is not efficient. This is because the excessive losses due to leakage of the system lowers the benefits, which negatively affects the efficiency.

This functional element of the water supply network can be defined as being equitable. This is because it provides a reliable water supply to all the important bulk consumers of the region namely, Swakopmund, Walvis Bay, Henties Bay, Arandis and Rossing Uranium Mine. However, in order to make the water supply network more equitable, the Topnaar community should be supplied with potable water.

This functional element is not sustainable because it is not maintained effectively. As a result of lack of qualified personnel, the operational lifespan of the transmission and storage network is diminished. Pipelines are normally designed to last for sixty to eighty years (Petersen, 1984) and, if not properly maintained, their lifespan can be halved (*ibid.*). Hence, even if the lifespan of the transmission network is halved, it amounts thirty to forty years which is equal to, or greater than, the lifespan of a generation which is generally thirty years. As such, some generations will have to incur these additional capital costs while other generations will not. This results in intergenerational inequality as the capital costs of the network will be greater on certain generations.

3.4 CRITICAL ISSUES RELEVANT TO THE DISTRIBUTION NETWORK

This section will describe and assess critical issues relevant to the distribution network of the town of Walvis Bay and Swakopmund. this distribution network of Walvis Bay and Arandis could not be analysed due to the lack of available information on these networks.

3.4.1 Leakage in the distribution network.

Table 3.1 indicates the average percentage loss in the distribution networks of the Walvis Bay and Swakopmund municipalities.

	1988	1989	1990	1991	1992	1993	1994
W.Bay	12.1%	13.1%	11.8%	10.9%	13.2%	12.6%	12.4%
Swakopmund	10.8%	11.9%	10.5%	4.6%	14%	9.9%	9.2%

Table 3.1 Percentage water loss in the distribution networks of Walvis Bay and Swakopmund.

(Walvis Bay Town Engineer (1995) and Lester (Pers.Comm.))

From table 3.1, it is calculated that the average percentage of water lost in the pipeline network of Walvis Bay and Swakopmund is fairly constant at around 12.3% and 11.1% respectively. Rammler (1995) states that leakage in the pipeline network is the major cause for the loss of water. According to Petersen (1984), pipeline networks having water losses of up to five percent of the total volume transported by them are considered to be efficient. However, since the water losses of the distribution networks of both municipalities are more than twice the acceptable value, it can be deduced that the distribution networks are inefficient.

3.4.2 Administration of the network

According to Rammler (1995), there is a team of four people maintaining the distribution network of Walvis Bay. Currently there is only one qualified technician in the team. The situation in Swakopmund is worse because there is a crew of only two people responsible for maintaining the network, none of whom are qualified. Due to the absence of properly trained personnel, illegal connections as well as leakages, are not detected for long periods of time. Currently, both municipalities have no leakage prevention or monitoring system in place. The leakage control system is purely passive and the leakage can be detected only if they appear above the ground or if they create green patches (Rammler, 1995).

3.4.3 Assessment of the distribution network

According to the definition in Section 2.4, the distribution functional element is not efficient. This is because the excessive losses due to leakage of the system lowers the benefits, which negatively affects the efficiency.

This functional element of the water supply network can be defined as being equitable. This is because it provides a potable water supply to over 99% of all the consumers in Walvis Bay and Swakopmund (Rammler, 1995)

This functional element is not sustainable because it is not maintained effectively. As a result of lack of qualified personnel, the operational lifespan of the distribution network is diminished. Pipelines are normally designed to last for sixty to eighty years (Petersen, 1984) and, if not properly maintained, their lifespan can be halved (*ibid.*). Hence, even if the lifespan of the transmission network is halved, it amounts thirty to forty years which is equal to, or greater than, the lifespan of a generation which is generally thirty years. As such, some generations will have to incur these additional capital costs while other generations will not. This results in intergenerational inequality as the capital costs of the network will be greater on certain generations.

CHAPTER 4: WATER DEMAND

This section will analyse and assess the critical issues relevant to water demand in the study area. The water consumption pattern in the study area will be analysed through the following methods:

- consumption patterns according to various sectors
- per capita consumption in Walvis Bay and Swakopmund
- consumption patterns based on the earnings of the consumer.

Based on this analysis, an assessment of the water consumption patterns will be carried out. This section will also analyse the various measures taken to manage water demand and based on this analysis an assessment of the current water demand management program will be made.

4.1 WATER CONSUMPTION PATTERNS

4.1.1 Sectoral consumption

The three major consumers in the region are the towns of Walvis Bay and Swakopmund and the Rossing Uranium Mine. These three consumers account for 90% of the total water consumed in the study area (Rammler, 1995). Figure 4.1 indicates the percentage consumption of each of these consumers in 1994.

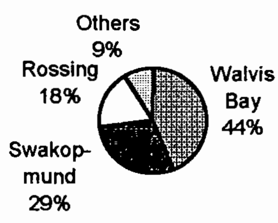


Figure 4.1: Major consumers of water in the study area (Rammler, 1995)

4.1.1.1 Walvis Bay

Figure 4.2 indicates the percentage consumption of the various sectors in the town of Walvis Bay.

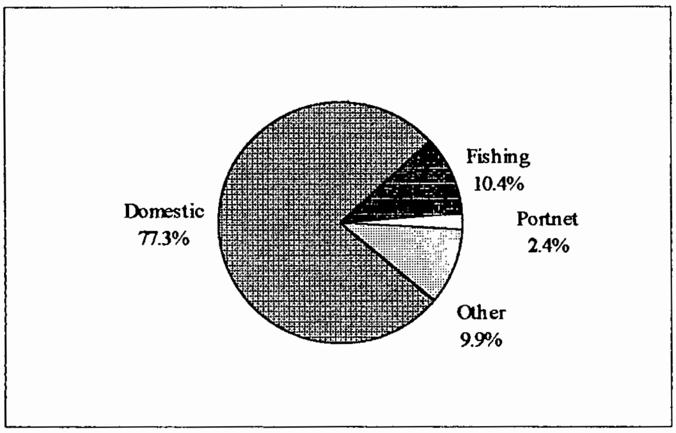


Figure 4.2 Water consumption in 1994 according to various sectors
(Walvis Bay Town Engineer, 1995)

From Figure 4.2, it is observed that the domestic sector is by far the largest water consumer. Rammler (1995) states that around fifty percent of all water used by the domestic sector is used to maintain private gardens containing alien species. This illustrates the wastage of a water because a garden with local species would be as beautiful but far less water demanding (Seely, 1992). The demand for water from the domestic sector is expected to increase by 5% (Walvis Bay Town Engineer, 1995). This is because of the expected increase in fish quotas which will create jobs in the industry and thus attract a greater number of migrant labour (*ibid.*).

From Figure 4.2, it is also observed that the fishing industry is the second largest water consumer. According to a study carried out by DANCED (1995), the fishing industry can make water savings of up to 30% if proper measures and technology are utilised to process the fish. This is one of the objectives of a program for cleaner fish technology currently being carried out by DANCED. A saving of 30% in the fishing industry translates in a overall water saving of

5% of the total water demand. Moreover, as this industry grows, the savings from this industry will have a greater impact on overall water savings.

With the opening of the Trans Kalahari and the Trans Caprivi, a doubling of activities in Walvis Bay harbour is expected over the next three years (Walvis Bay Town Engineer, 1995). As a result, Portnet is expecting an increase of about 5 to 6 % in the water demand over the same time period.

The remainder of the water in Walvis Bay is consumed mainly by local industries. The consumption of water in this sector is going to increase with the plans to introduce an Export Processing Zone (EPZ) in Walvis Bay. Currently the government has recognised the need to exclude water `heavy' industries because of the scarcity of water (de Leon, 1995). However no guidelines defining water intensive industries have been drawn up (*ibid.*). Considering the future importance of this sector this deficiency has to be addressed.

4.1.1.2 Swakopmund

Figure 4.3 below indicates the percentage consumption of the various sectors in Swakopmund.

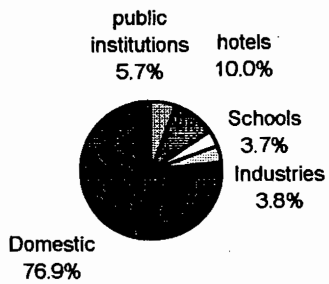


Figure 4.3: Water consumption in 1994 according to various sectors

(Swakopmund Town Engineer, 1995)

It is observed from Figure 4.3 that the largest user of water is the domestic sector About 40% water consumed by this sector is used to water gardens (Lester, Pers.Comm.). Another major reason for the high consumption of water is subsidised water. It is the policy of Rossing Uranium Mine and of Swakopmund Municipality to subsidise 110 cubic metre and 50 cubic metre of water per month per employee respectively (Lester, Pers.Comm.). This encourages water wastage, as the employees believe that if they do not utilise the quota to the limit, they lose their benefits.

The tourism sector in Namibia has grown by 166 % between 1993 and 1994 (EBS, 1996). Similar or higher rates of growth are expected for the year 1995. Since the study area is a prime area for the development of tourism, the consumption of water by hotels is expected to increase dramatically in the near future.

4.1.1.3 Rossing Uranium Mine

Rossing Uranium Mine consumed about 2.05Mm^3 in 1994 (EBS, 1994). The mine makes use of fresh water for domestic and plant use only whereas saline water, pumped from the Khan River, is used for activities not requiring fresh water. Rammler(1995) states that the mine has implemented extensive water saving mechanisms such as:

1) recycling and process modification;
2) operating of sailing dams; and
3) interception of seepage water.

These measures have decreased the quantity of water utilised to process a ton of Uranium from 0.55m^3/ton in 1988 to 0.35m^3/ton in 1994 (*ibid.*). According to Rossing Uranium Mine, further water demand management measures are not economically viable until the price of water is not increased to about N$10/kl (du Toit, Pers.Comm.).

4.1.2 Per capita consumption

Figure 4.4. illustrates the changes in per capita consumption of water for Walvis Bay and Swakopmund.

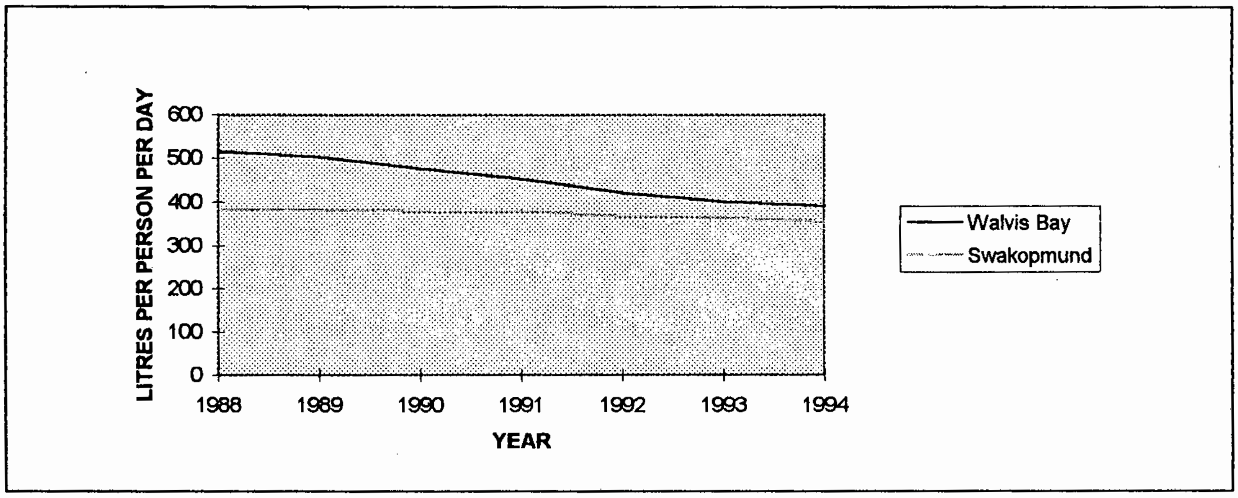


Figure 4.4: Per Capita consumption of water in Walvis Bay and Swakopmund

(Walvis Bay Town Engineer, 1995)

(Swakopmund Town Engineer, 1995)

According to the Central Area Master Plan (1993b), 100 l/per person per day is a reasonable water consumption value. Based on that, it is clearly seen that the inhabitants of Walvis Bay and Swakopmund consume about four times this rate in water. Moreover, from Figure 4.4, a drop of about 20 % is achieved in the per capita consumption of water in Walvis Bay from 1990 to 1994. This is mainly due to the migration of labour to Walvis Bay. The migrant labour normally tend to consume less water than 80l/per person per day, thereby decreasing the average water consumption values for the town..

4.1.3 Consumption patterns based on income

Figure 4.5 below illustrates the consumption patterns based on income for the towns of Walvis Bay and Swakopmund in 1993.

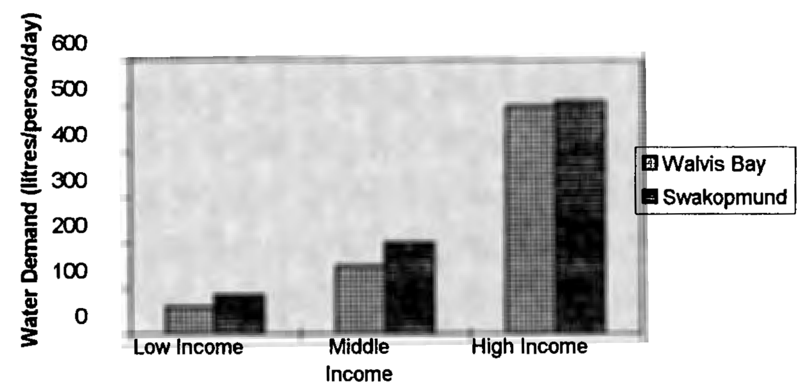


Figure 4.5: Water consumption Walvis Bay and Swakopmund based on income

(Seely, 1992)

It is observed that there is a close relation between income and water consumption. Water consumption tends to rise as the income of the consumer rises. From fig 4.5, it observed that high income consumers tend to use six times as much water as low income users. This situation is unacceptable as a small percentage of the community consumes most of the water. As a result, there is an urgent need to find ways to break the link between a high water demand and a luxurious lifestyle.

4.1.4 Assessment of water consumption patterns

The domestic consumption in the study area is not an efficient process. This is mainly because the per capita consumption of the inhabitants of the area is about four times the accepted value of 100l/per person/per day. Hence, the benefits derived by gaining drinking water is negated by the abuse of the resource through overconsumption.

The non-domestic consumption can be defined as being efficient. The two major non-domestic consumers in the study area the Rossing Uranium Mine and the fishing industry have respectively implemented or are to implement plans to improve the efficiency of water usage.

The domestic consumption pattern is not an equitable one. This is mainly because high income earners consume up to five times the accepted consumption value of 100l/per person/per day while low income earners consume less than 80l/per person/per day. Hence, the benefits are not equally spread making the consumption patterns inequitable.

The non-domestic consumption can be defined as equitable because the two major non-domestic areas are implementing cost saving measures, and are thus sharing the responsibility to save on water. However, if this measure is to remain equitable, any future industrial development especially in the EPZ sector should make provisions for effective water usage.

Current consumer patterns are not sustainable both for the domestic and non-domestic sectors. This is because the current levels of water consumption cannot be maintained as they are excessive. Hence, the current benefits derived from actual water usage will not be passed on to the next generation.

4.2 WATER DEMAND MANAGEMENT

Previously, water demand management was not considered as a essential process in water resources management. When planning for water resources, the supply aspect of planning was considered, whereby the analysis that was carried out evaluated various means of meeting current and future demands through supply augmentation. However, some form of demand management was introduced, when studies in 1992 revealed, that the underground aquifers were being overutilised and effects of the 1992/1993 drought was being felt.

Currently, water demand in the region is managed through water tariffs, public awareness campaigns and recycling of water.

4.2.1 Water tariffs

Before 1993 the Department of Water Affairs priced bulk water on a recovery of operational cost basis. This means that the bulk water consumers were only charged for the operational costs of the network. Moreover, the municipalities in the study area charged water according to a fixed unit rate.

As from 1994, the Department of Water Affairs is gradually charging bulk water on a full cost recovery basis. This implies that the cost of water includes not only the operating cost of the water, but the capital cost of the water supply network. Moreover, the various municipalities in the area have introduced a new scaled rate of tariffs.

This change, in pricing of tariffs, will have the effect of tripling the price of water in the study area by 1994. In order to avoid a sudden jump in prices, the full cost recovery tariffs are being introduced on a five year basis (Brummer, Pers.Comm.). Tariffs as applied by the Walvis Bay and Swakopmund municipalities are illustrated in Table 4.1 below.

Swakopmund		Walvis Bay	
Range (kl)	Tariff (N$)	Range (kl)	Tariff (N$)
0 - 15	1.79	0 - 15	1.11
16 - 30	1.87	16 - 25	1.50
31 - 60	2.30	26 - 85	1.99
61+	3.20	85+	3.85
small holdings	1.28	business	2.38

Table 4.1: Water tariffs applicable in Swakopmund and Walvis Bay

4.2.2 Public awareness

Education through the media and public meetings have been carried out in order to raise the awareness of the public as regards to water usage. During these awareness campaigns, issues dealing with the scarcity of water, the true cost of water and ways to save water have been discussed (Lester, Pers.Comm.). However, these campaigns have not been effective because the consumption per capita in the region has been the same. The decrease in per capita consumption at Walvis Bay was not the result of the public awareness campaign, but rather due to mass migration (Section 4.1.2). Since most of the people who have migrated to Walvis Bay are poor and looking for work, they tend to be low users of water. This in turn has reduced the per capita water consumption figures of the town. The major reason for the failures has been that the awareness campaigns have been more informative than participative.

4.2.3 Recycling of water

Currently both Swakopmund and Walvis Bay utilise recycled water from sewage effluent to irrigate municipal areas. This measure helps reduce the water consumed by the municipality. However this measure can only be truly effective if large quantities of water are reused. Currently both municipalities recycle only about one percent of the total volume of water consumed. As a result, recycling does not have a great bearing on reducing the quantity of freshwater utilised. However, it is a step in the right direction.

4.2.4 Assessment of water demand management in the study area

Water demand management in the study area is inefficient. This can be deduced from Figure 4.4, which indicates that the per capita consumption of water is still very high. This illustrates the failure of the various measures aimed to reduce water demand. However, with the introduction of new water tariff policies, water consumption is expected to decrease, thus improving the efficiency of water demand management.

Water demand management in the study area is equitable. This is because it aims to reduce water consumption through methods that ensure that if any savings are made they are shared equitably.

Water demand management in the study area is currently not sustainable. This is because it has failed to reduce the current rate of use of water, which cannot be maintained for a long period of time. This will result in the future generations not having the same benefits as the previous one, thus resulting in intergenerational inequality.

5 LEGISLATION AND POLICY

This chapter will analyse and assess key legislation and policies affecting the water sector. Though these laws and policies are implemented on a national level, it is important that they be analysed. This is because they have a direct impact on the water sector in the study area. The key legislation and policies that will be analysed and assessed are:

- Water Act 54 of 1956
- Water and Sanitation Policy (WASP)
- Privatisation of Bulk Water Supply.

5.1 WATER ACT 54 OF 1956

This Act is the single most important legislation regulating the water sector. The main objectives of this Act are to yield the highest possible quantity and quality of water on a dependable basis (Seely, 1992). The foundation of this Act is the distinction between private and public water. Section 5 of the Act states that the exclusive use and enjoyment of private water belong to the owner of the land in which the water is found. However, a qualification is incorporated such that the owner may not give, sell or transport the water beyond the boundary of his land. Public water is defined by Section 7 of the Act as "water flowing or found in or derived from the bed of a public stream visible or not". Since groundwater is the only source of water in the study area, emphasis is placed on the various aspects of the Act impacting on groundwater.

5.1.1 Abstraction of groundwater

Although the Water Act allows private and public extraction of water, it states that the Department of Water Affairs must be notified before any borehole is drilled. Moreover, according to Regulation 1278 of 23 July 1971, a journal detailing information on the borehole needs to be submitted to the Department of Water Affairs upon completion of the drilling work. The benefit of this regulation is that it enables the creation of a database on underground water resources. This provides valuable information when the water resources of a region are evaluated.

Another mechanism to control groundwater abstraction is through the declaration of Subterranean Water Control Areas (Section 28). This prevents the usage of groundwater for private purposes unless a permit is issued by the Department of Water Affairs. This theoretically enables an effective control over groundwater abstraction in these areas of critical importance. However, no such areas have been declared in the study area. This clause, though theoretically effective, is not preventing illegal drilling of boreholes. This is due to a lack of adequate enforcement mechanism. This issue will be discussed in greater detail under section 5.1.5.

5.1.2 Controls over quantity of water used

Under the Act, the responsibility of determining and controlling the quantity of water extracted is vested with the Department of Water Affairs. Section 9 A of the Act states that the Minister may " in his discretion ... control, regulate, limit as he may deem expedient .... the impounding, storage, abstractions and use of water". This Section gives the Minister far reaching powers over the control and use of water. If this power is utilised properly, overextraction of water can theoretically be stopped. However, the weakness of this Section is that the Department of Water Affairs is required to regulate itself so as to prevent abuses in the quantity of water extracted. This is an ineffective measure as there are no checks and balances to prevent the authorities from overextracting water from these sources. An example is the Lower Kuiseb aquifer where, during the eighties, the Department of Water Affairs extracted groundwater at a rate above the recharge rate of the aquifers without any legal problems.

Another major weakness of the Act is that if fails to recognise the downstream environment as a "user" of water (Seely, 1992). According to Seely (1992), 90% of Namibians depend on the environment for their livelihood. Therefore, failure to recognise the environment's need for water may have catastrophic consequences for the country.

Another limitation of the Act is the lack of any definition regarding sustainability (DWA, 1993a). Currently the Department of Water Affairs extracts water at a "dependable" rate which is not a sustainable rate. The term 'dependable' is loosely used by the Department of Water Affairs and it has never been properly defined (*ibid.*). This "dependable" rate of pumping water from the aquifers has resulted in overextraction of groundwater resources in the study area. Therefore, there is a need to define sustainability, with respect to quantity, as pumping not exceeding rate of recharge resulting, in no net change in groundwater table level. This definition has to be adopted by the Department of Water Affairs instead of the term "dependable".

5.1.3 Controls over quality of water

Under Section 21 of the Act, the Minister is empowered to prescribe requirements in connection with the purification and disposal of industrial wastes and effluent. Local authorities also require permission of the Minister to dispose of effluent (Section21(1)). Currently the Department of Water Affairs uses a uniform effluent standard approach to determine the quality of water. This method has a major drawback because it fails to protect water quality in cases where there are multiple point sources of pollution (Fuggle and Rabie, 1992). Moreover, it provides no incentive for industries to locate at an environmentally advantageous location (*ibid.*) .

A major failure of this Act is its inability to enforce standards on drinking water. Currently, there are no provisions that control the quality of drinking water. These are generally maintained through guidelines from the Department of Water Affairs. These guidelines do not carry the force of law.

Another major failure of the Act is that it does not require that the Minister be consulted over proposals for land development or change in the use of land. As a result, development or land uses that might have a negative impact on an aquifer's water quality, can take place without the knowledge of the Minister.

5.1.4 Powers of the Minister

Currently under the Water Act the Minister has extensive power to deal with any situation affecting the water sector. This power is absolute and is not subject to appeals. This can lead to abuses because of lack of a system of check and balances. Section 34 of the Act provides for the establishment of Water Courts. Section 40 empowers them to "enquire into, investigate and determine any right or obligation with respect to the use of public water". However, the power of the Water Courts is heavily restricted by Section 55 of the Act, which empowers the Minister to make regulations on any matter "which he considers necessary or expedient to prescribe in water related issues." The Water Courts are bound to abide by these regulations under Section 55 of the Act. This absence of a system of checks and balances in the legislation may lead to unaccountability as regards to decisions taken especially at a ministerial level.

5.1.5 Enforcement of the Act

According to Sections 1 and 3 of the Water Act, the Department of Water Affairs is responsible for enforcing the Act. However, this enforcement is ineffective mainly because of two reasons. The first one is insufficient funding and manpower available to enforce the rules. In 1993, there was an overall shortage of about twenty three percent in terms of manpower (DWA, 1993a). The lack of reasonable penalties is also another major factor limiting enforcement. For example, under Section 170 of the Water Act, a penalty of N$ 300 or a three month prison sentence will be imposed for the drilling of an illegal borehole. This is not a very effective deterrent as it does not reflect the value of water in Namibia. As such, there is a need to stiffen up penalties so that it can reflect the scarcity and corresponding value of water.

5.1.6 Assessment of the Water Act

Theoretically the Act is efficient in achieving its objectives of maintaining a highest possible quantity and quality of water. This is because it provides rules such as catchment control area that enables proper legal protection to the sources of water. However, due to a deficient enforcing mechanism, this Act is ineffective on the field.

The Act is not an equitable one. This is because it does not recognise the demand on water made by the environment.. Moreover, the Act gives too much power to the minister and the absence of checks and balances in the Act results in a lack of accountability. This results in one sided decisions that are inequitable as all stakeholders do not have a say.

The Act is unsustainable. This is because it is not properly enforced and it fails to recognise the downstream environment as a user of water.

5.2 WATER AND SANITATION POLICY (WASP)

The Water and Sanitation Policy was adopted by the cabinet in 1993. This policy states the long term policy objective for the Water and Sanitation sector and ways to implement it.

5.2.1 Long term objectives of the Water and Sanitation Policy

The long term objectives of the Water and Sanitation Policy are

1. Accessibility of water to all Namibians at a reasonable cost.
2. Equitable improvement of water resources based on community involvement, participation and acceptance of mutual responsibility.
3. The right of the community, with due regard to environmental needs and available resources, to determine solutions and service levels acceptable to them. The beneficiaries shall contribute towards the cost of services at increased rates for standards exceeding those determined by basic needs.
4. The environmentally sustainable development, harnessing and utilisation of water resources of the countries is to be pursued to accommodate various needs.

According to Dalal Clayton *et al.*(1994), all policies should have sustainability as their overall goal. The Water and Sanitation Policy satisfies this requirement as it mentions sustainability of water resources as one of its long term objectives.

Moreover, the other benefit from the Water and Sanitation Policy is that it mentions only a few objectives that are all encompassing. This has the dual benefit of ensuring the support of the participants and the absence of any fragmentation and coherence in the policy (Dalal Clayton *et al.*, 1994).

The active involvement of communities in the determination of solutions and service levels is another great asset. This is because communities participating in designing and deciding of actions are more likely to understand the purpose of the actions and thus implement them completely (World Bank, 1993). This results in the corresponding development being suited to the needs of the community and as such being more efficient.

The Water and Sanitation Policy has determined a ranking of priorities as regards to the allocation of water. The ranking is as follows:

1. water for domestic purposes including livestock watering for subsistence and economic farming. In this section, rural communal areas are given higher priorities over urban areas as regards to domestic water supply.
2. water for economic activity such as mining industry and irrigation.

The advantage of the ranking of priorities is that it provides a clear guideline as to how the development of the water resources takes place. This is critical because allocation of water to competing demands will become difficult in future with the pressure exerted by a larger population on water resources. However, a major flaw of this ranking is that it fails to identify and rank the need of the environment as regards to water. This is critical since 90% of Namibian population depend directly on the environment for their livelihood (Seely, 1992).

5.2.2 Implementation of Water and Sanitation Policy

In order to implement the long term objectives of this policy, the WASP document calls for a forum for co-ordination to make recommendations to

- provide solutions for water sector policy issues and
- resolve practical water sector related problems such as overall planning, co-ordination and determination of priorities.

The forum is called the Water Supply and Sanitation Co-ordinating Committee (WASCO). This committee will be made up of representatives from concerned governmental and other involved agencies. Moreover, this forum contains subcommittees and a Secretariat made up of professionals from the technical, economic and social fields.

The implementation mechanism is very effective because it enables the co-operation between the government and the shareholders into finding solutions for the various problems arising in the water sector. This makes decision making more accountable as all affected parties can provide an input. Moreover, through the Secretariat, professionals from various fields can be consulted and this ensures a multidisciplinary approach in finding a solution.

Currently the Water and Sanitation Policy does not carry the force of the law and as such WASCO has not yet been institutionalised. This measure should be carried out in the new Water Act that is currently being drafted.

5.2.3 Assessment of the Water and Sanitation Policy

The Water and Sanitation Policy is efficient because, through WASCO, all shareholders can participate in identifying problems and finding solutions. This participating process enables the identification of all the relevant problems regarding the water sector. Moreover, because the shareholders understand and are aware of the issues, implementation of the solution is facilitated. Furthermore the multidisciplinary approach of the WASCO secretariat ensures that all aspects relating to developmental problems are analysed and understood.

The Water and Sanitation Policy is equitable because it calls for the equitable improvement of water services. Moreover, by involving all shareholders in the decision making process it ensures the accountability of decisions and thus ensures that assets and benefits are shared equally.

One of the long term policy goals of the Water and Sanitation Policy is that it calls for the sustainable development of water resources. As such, the Water and Sanitation Policy can be defined as being sustainable. The sustainability is somehow limited by the low ranking accorded to the needs of water of the environment. This might result in a neglect towards needs of the environment resulting in its subsequent degradation.

5.3 PRIVATISATION OF THE BULK WATER SUPPLY

A feasibility study investigating the possible privatisation of the water sector has recommended that the bulk water supply operations of the DWA be privatised (Ernst and Young, 1994). This study has recommended that the control of the company be taken over by a limited liability company. This company will be formed by the Minister of Agriculture, Water and Rural Development and will be incorporated under the provisions of the Companies Act of 1973. This company would be wholly owned by the government.

One of the major advantages of the company is that it can set long range strategic plans and set goals and objectives to achieve them (*ibid.*). This was not possible under the DWA because the budgetary process restricted the DWA to plan for one year cycles except for infrastructural planning (Fry, Pers.Comm.). Moreover the department is currently unable to invest and keep abreast of new water technologies due to lack of funding (*ibid.*). As such, privatisation will help improve the long term planning procedure for water development.

The saving incurred by the government through privatisation is also a major asset. This is because the government will no longer have to subsidise bulk water supply. Instead, the government can earn dividends from the company in the long run. This saving could result in better services for other sections of DWA especially in the rural water supply section. However, it should be noted that the water tariffs will be set up so that heavy water users will subsidise low water users, and as such, the price of water will be affordable to poor people.

Currently the Department of Water Affairs has a great shortage of manpower especially in the technical and engineering fields (DWA, 1993a). This is mainly because it cannot remunerate its staff properly (*ibid.*). However with privatisation, the staff can be properly remunerated based on market related salaries. This will attract and retain the best skill in the market. This will contribute to the improvements of bulk water supply.

However, because the company will be operating on a profit driven basis, social and environmental consideration might be ignored. The probability of such a scenario is highly increased by the fact the company will operate as a monopoly. In order to address these issues, a Public Utilities Commission is proposed. The role of such a commission would be to act as an economic regulator (Ernst & Young, 1994).

5.3.1 Assessment of the privatisation of Bulk Water Supply

Privatisation of the Bulk Water Supply is an efficient process as it will be able to provide a better service as compared to the DWA. This is because as a private entity, the planning of long term objectives is easier and this ensures a proper planning process resulting in greater efficiency. Moreover, as a private entity, it can pay for and obtain the best skills in the business and ensure a better and more efficient service.

Privatisation can be an equitable process only if the Public Utilities Commission regulates it properly. This is because a private company will primarily operate on a profit driven basis. Generally, in a market economy, the aim of a company will be to make as much money for its shareholders as possible. In order to achieve this, it can either raise the price of its product, or decrease its operating costs. Both of these methods when used to increase profits, will result in actions that will negatively impact a large majority of people for the sake of a few. Hence, the principle by which the market economy operates, is often inequitable.

Because privatisation enables long term planning and investment, it ensures that water resources are utilised sustainably. Moreover, due to the presence of proper staff as a result of privatisation, the water supply network can be effectively maintained and passed on in good condition to future generations. This ensures intergenerational equity that results in sustainability.

CHAPTER 6 MANAGEMENT OF THE WATER SECTOR

The analysis and assessment carried out on the water supply, water demand and policy and legislative sections of the water sector, revealed serious deficiencies in all three sections. These deficiencies are mainly the result of the poor management of the water sector in the study area and on a national level. Various diverse and interlinked factors occurring at a national, regional and local level are responsible for this situation. In order to improve the management of the water sector, these factors, as well as their linkages have to be identified. Sectoral Environmental Assessment (SEA) can provide a mechanism to identify these issues and also to address them. Sectoral Environmental Assessment is defined as:

"the formalised, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan or program and its alternatives of a sector, the preparation of a written report on its findings and the use of the findings in publicly accountable decision making." (Therivel,1993)

This chapter will begin by justifying the needs of an SEA. It will then describe the procedure to implement the SEA and illustrate how this procedure can be applied in a Namibian context. Finally the method in which the SEAs can be implemented effectively is then discussed.

6.1 NEED FOR A SEA

According to the World Bank (1993), a SEA is highly recommended if the answers to the next three questions are positive.

Are there major existing environmental problems associated with the water sector?

There are major existing environmental problem affecting the sector. An example of such a problem is the overextraction of groundwater resources resulting in the drying up of vegetation and possible contamination by seawater. Another major problem is the inability of the DWA to set long term strategies as regards to the management and usage of water resources. These are but a few of the environmental problems facing the water sector.

Is there a clear potential for significant improvement or avoidance of major problems in the sector?

From the analysis carried out in the chapters three four and five, it is deduced that the problems facing the water sector especially in those in the study area are not irreversible. These can be solved if proper measures are taken and as such there is a clear potential for improvement in the sector.

Are there clear policy, regulatory and or institutional weaknesses relative to environmental management in the sector?

Yes, because the Water Act 54 of 1956 is very ineffective as regards to managing the environment. Moreover, the Department of Water Affairs is unable to enforce the Act due to lack of manpower and financial constraints. Furthermore, due to the same reasons, the Department of Water Affairs is severely restricted from performing its functions which is to provide water of the highest quality and quality on a dependable basis (Seely, 1992).

As such, according to the criteria set by the World Bank, a SEA is highly recommended.

6.2 STEPS OF A SEA

Figure 6.1 illustrates the steps for carrying out a SEA. This figure and the accompanying definitions of the various steps in the figure have been developed from Therivel (1994), Saddler (1992) and Wood and Dejeddour (1992).

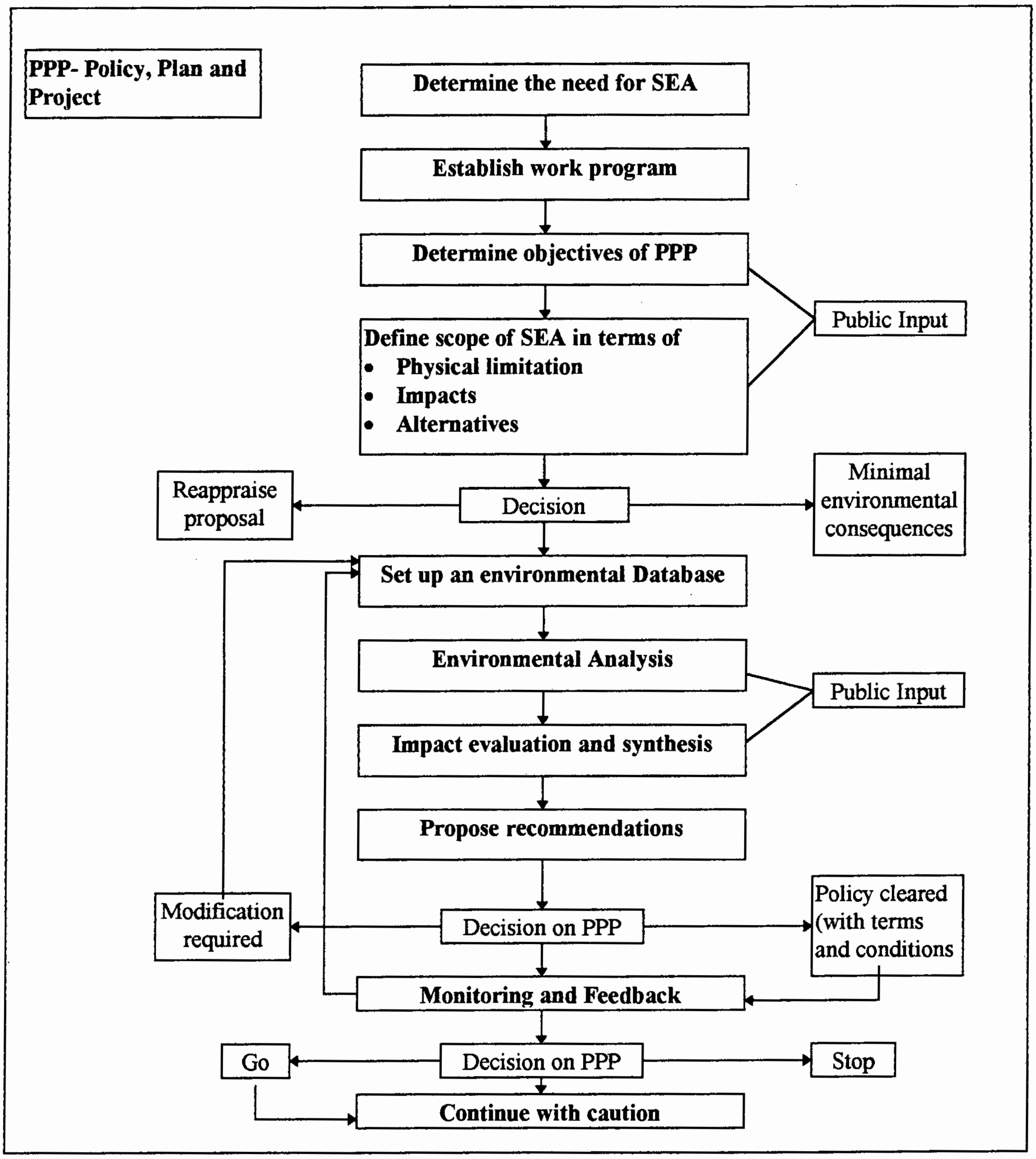


Figure 6.1 Flow chart for application of SEA

Need for an SEA

The start of this process is initiated by the lead agency which determines whether the SEA is required and then determines the feasibility of doing one. The establishment of a lead authority is essential as it clearly defines the decision making hierarchy. The lead authority in the study to evaluate the water sector should be the DWA, because under the Water Act 54 of 1956, it is responsible for managing the water sector in Namibia.

Establish a work programme

The lead agency establishes the goals and targets to be achieved. Furthermore, issues relating to internal administration, inter-agency corporation, scheduling and staffing of the operation need to be considered. The goals and objectives for the SEA of the water sector can be determined from the Water and Sanitation Policy (WASP).

Determining the objectives of Policies, Plan and Project (PPP)

These objectives have to be clearly defined so as to provide a clear understanding of issues. Moreover, the ultimate objective of any PPP should be that of sustainability (Dalal Clayton *et al.*, 1994). In that regard, the goals and objectives as stated by the Water and Sanitation Policy (WASP) document could be included as the part of the objectives of the SEA, because they are simple and satisfy the sustainability criteria (Section 4.2.3). During this stage interagency co-operation and public participation are essential in order to ensure that the objectives of the SEA are all encompassing. Hence, it is essential that all the affected governmental organisations and non governmental organisations take part in this exercise. For example, if a plan is drawn up to supply water to the mines in the Erongo region, it is essential that officials from the Department of Water Affairs, Ministry of Mines and Energy, Ministry of Regional and Local Government and the relevant NGO's consult each other.

Defining the Scope of the SEA

The scope of the SEA can be defined through the identification of the physical regional limits of the assessment, by the impacts to be addressed and the list of possible alternatives considered. These physical limits are influenced by man made or natural features or by the administrative boundaries. It is suggested that for the water sector, the boundaries be biophysical i.e. hydrological, rather than administrative, as is currently the case. This is important because, often, there are projects in the water sector which affect numerous regional administrative regions. As a result, approval has to be sought from all of these authorities in order for the project to move ahead. This often creates unnecessary red tape which ends up delaying the project. Therefore, it is essential that the PPP take into account the biophysical boundaries when dealing with the water sector.

The impacts to be addressed when defining the scope of an SEA can be determined by using checklists and through existing databases, when considering alternatives and during public input. The alternatives considered should be from likely development outcomes, including the "no go" option. Public participation is essential in this stage and the input from this exercise should be recorded and the scope of the SEA be amended accordingly. In the proposed future legislation concerning the water sector, it is hoped that public consultation exercises will be conducted at policy level through the Water and Sanitation Committee (WASCO). Though this is a step in the right direction, it is essential the involvement of I&AP'S be carried out at plan and project level also and not only at policy level as WASCO proposes.

Establishing an environmental database

An effective database is required in order to deal with the large, yet relevant amount of information obtained during impact analysis, synthesis, evaluation and monitoring. This database should generally be subdivided to contain four types of data namely:

- Biophysical data: This category should include all biophysical information pertaining to the water sector for example borehole water levels and extraction rates, rainfall data in the various catchment areas etc.
- Social data: This category should include social information such water consumption per capita, water consumption based on income, major consumers of water etc.
- Financial data: This category should include financial information such as the cost of extracting water in the various regions, capital costs of future projects, financial estimates of the environmental costs of a capital project etc.
- Policy and legislative data: This category should contain information pertaining to the various laws and policies of the water sector that are currently being applied.

This information has to be easily accessible in order to maintain the efficiency of the database. This database should be kept by the DWA because it is required by the department to make correct decisions regarding the water sector. It should be noted that an efficient scoping exercise will help reduce the quantity of redundant data.

Environmental Analysis

During analysis the likely impacts for each alternative Policy, Plan or Programme are predicted. The significance of the impacts is the evaluated and appropriate mitigating measures are proposed. It is suggested that the Water and Sanitation Committee be involved in this exercise. Since this committee has a multidisciplinary approach, the analysis is likely to be more encompassing. Moreover, this will further contribute towards public participation because WASCO consists of governmental as well as non governmental organisation (NGOs)

Impact Evaluation and Synthesis

In this section, the impacts of various alternatives of PPP are evaluated against each other. This evaluation is not only based on the data collected, but also on other factors that help the interpretation and evaluation of alternatives. These are: regulatory standards, governmental guidance, preferences of the residents and the effectiveness of planning and management in mitigating potential impacts through prevention, reduction and compensation.

Proposing recommendations

Recommendations made should include the preferred alternative, the mitigatiory measures and the monitoring measures. According to the World Bank (1993), the output of an SEA should contain a mitigation plan, an environmental management and training plan and an environmental monitoring plan.

The mitigation plan should include broad options to eliminate or reduce to acceptable levels or mitigating environmental impact (*ibid.*). The plan should not only draw on the analysis of impacts and alternatives but on policy, legal and institutional issues as well. Since the water sector contains programmes that involve multiple investments the mitigation plan is effective. This is because it can consider sector wide mitigation solutions that require economies of scale to be effective.

The environmental management plan makes recommendations on ways to improve environmental management on a sector wide basis (*ibid.*). These recommendations might include training of existing staff, hiring of new staff and a redefinition of roles and responsibilities. Moreover, it will also recommend policy and regulatory changes to improve environmental management and enforcement in the sector. Such a plan is ideal for the water sector because it lacks manpower resources and has an ineffective legislation regulating it.

The monitoring plan provides guidelines for long term monitoring sector wide monitoring (*ibid.*). This enables the collection of baseline data which is utilised to measure environmental progress.

Monitoring and feedback

In this section the effects of policy are evaluated and issues requiring further attention are identified and fed back in the system.

6.3 IMPLEMENTATION OF SEA

The efficiency of a SEA also depends upon the way it is implemented at a policy, plan and project level (PPP). Wood and Djeddour (1992) suggested a tiering system to implement SEA. The tiering system is defined as " a sequential process of addressing issues and impacts at the appropriate level and with a degree of effort required for decision making." (Saddler, 1994). Figure 6.2 illustrates this system as applied to the transport sector.

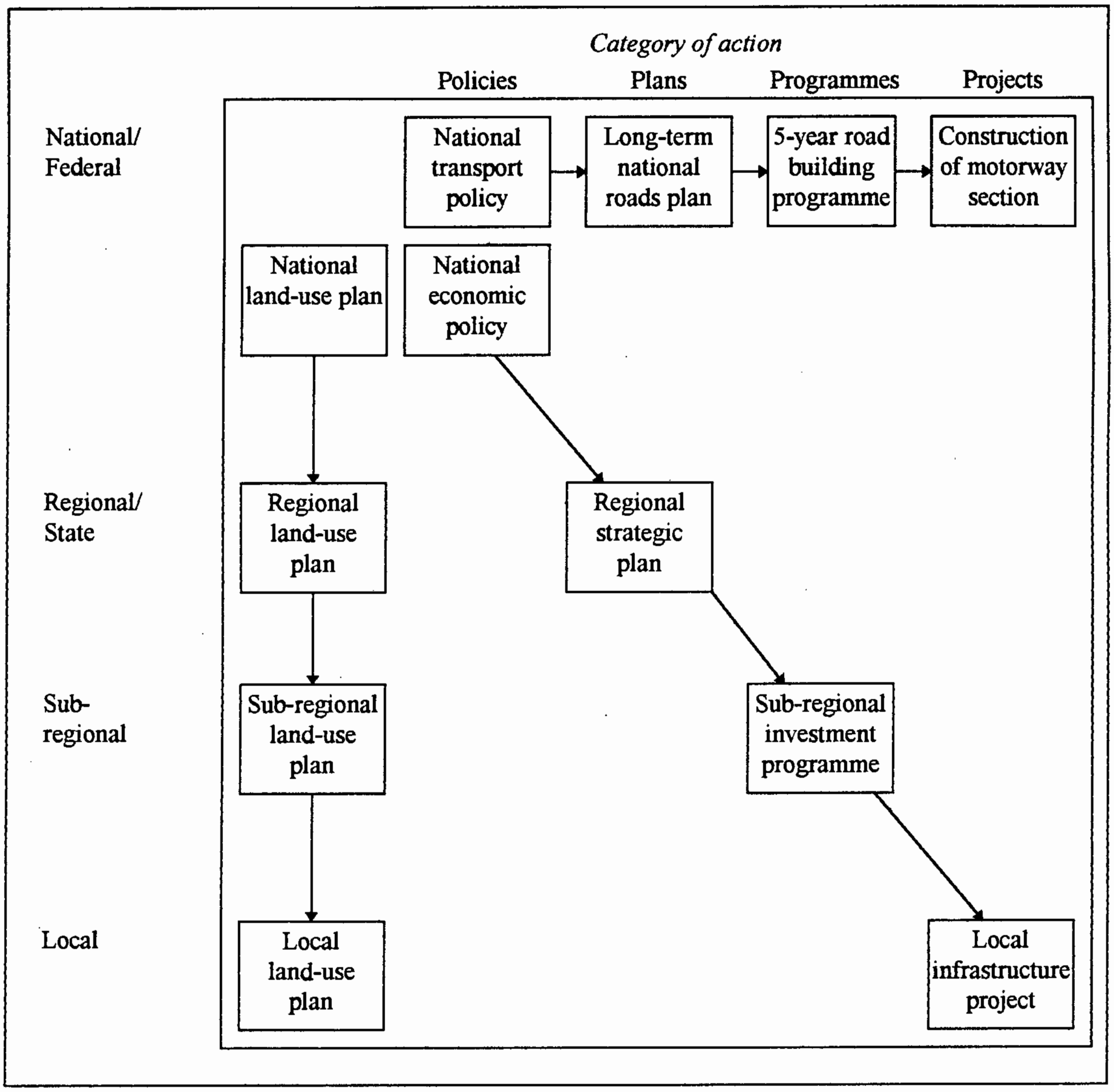


Figure 6.2 The Tiering System of the transport sector

(Wood and Djeddour, 1992)

From figure 6.2, it is observed that a decision making "stair-case" is formed by PPPs. These not only provide a benchmark for conducting reviews, but also indicate at what level related issues can be raised and addressed. Hence, this system enables a disciplined and adaptive approach and permits a certain degree of substitution of effort between different levels (Saddler, 1996).

In the context of the water sector of Namibia, the word “roads“ can be replaced by “water” in figure 6.2. It is then observed that, if the tiering system is adopted to suit the Namibian context, then any Policy Plan or Projects (PPP) can be implemented with great efficiency. In this context, National or Federal level in figure 6.2 would be replaced by the grouping of the various countries in the region, the regional/state can be replaced by the country itself, the sub regional level will be the various districts of Namibia and the local level can be substituted to the various local authorities in the district.

7 CONCLUSION AND RECOMMENDATIONS

7.1 PURPOSE OF STUDY

Water in the study area is a scarce resource and the lack of it is believed to be a single most important obstacle to the development of the region. The study aims to identify the critical environmental impacts of the water sector in the study area. These impacts are then assessed but not evaluated. This is mainly due to a lack of specialist input and proper public participatory exercise without which evaluation is futile.

It is hoped that the study will act as an initial base or guide that can be used along with other studies to the development of an integrated coastal zone management plan. Moreover, it raises issues for attention that should help in the establishment of a plan to enable the sustainable utilisation of scarce water resources in the study area.

7.2 APPROACH TO STUDY AND METHODOLOGY

The study was guided by the principles of Integrated Water Resources Management and needs to be used in the planning process for water resource utilisation in the study area. To achieve this, the Integrated Environment Management theory is used together with the principles of Integrated Water Resource Management. This will ensure that the study

- Uses a broad definition of the environment so as to identify all key opportunities and constraints of the water sector.
- Would help towards the creation of a plan to manage the water sector in order to optimise the benefits of the sector while at the same time minimising or mitigating the costs.

To achieve these aims, the systems approach, as suggested by the Integrated Water Resource Management theory, was utilised. In order to facilitate the analysis the water sector was broken down into three categories namely water supply, water demand and legislation and policy. The critical factors relevant to each sector were then identified and were assessed according to the concept of efficiency, equity and sustainability.

7.3 ENVIRONMENTAL PROFILE OF THE WATER SECTOR IN THE STUDY AREA

7.3.1 Water Supply

The water supply section was subdivided into three functional elements namely source of water element, transmission and storage element and the distribution element. The critical impacts relevant to each element were enumerated, analysed and assessed.

Table 7.3.1 summarises these results for each element.

CRITICAL COMPONENT	IS IT EFFICIENT ?	IS IT EQUITABLE ?	IS IT SUSTAINABLE ?
SOURCE OF WATER SUPPLY ELEMENT			
UNDERGROUND AQUIFERS	Not efficient. Because of the potential loss of this source of water to salinisation. Moreover, the financial cost of extracting water increasing while benefits remain the same.	Equitable because the costs and the benefits are distributed equally among a majority of inhabitants. Topnaars are an exception as they have no potable source of water. This issue needs to be addressed.	Unsustainable because aquifers will become useless due to salinisation This threat will increase with the lowering of the water table.
DESALINATION	Initially inefficient because of 250 % price increases. More efficient in the long term as savings made from reduced water consumption neutralise the effects of the price hikes.	Equitable, if the big water users subsidise the low water users who are generally poor. Moreover, mitigating measures during the construction and operation of the desalination plant need to be implemented.	Sustainable because it is a limitless source of water and it will help improve the conditions of the underground aquifers in the region
TRANSMISSION AND STORAGE ELEMENT	Inefficient because of excessive water losses due to leakage.	Equitable as a majority of the inhabitants of the region have a reliable water supply. However, the Topnaar community needs to be supplied with potable water.	Unsustainable because of a lack of qualified personnel, the operational lifespan of the network is reduced.
DISTRIBUTION ELEMENT (Walvis Bay and Swakopmund)	Inefficient because of excessive water losses due to leakage.	Equitable as a majority of the inhabitants of the region have a reliable water supply. However, the Topnaar community needs to be supplied with potable water.	Unsustainable because of a lack of qualified personnel, the operational lifespan of the network is reduced

TABLE 7.1 SUMMARY OF ASSESSMENT RESULTS FOR THE WATER SUPPLY SECTION

7.3.2 Water Demand

In this section, two critical factors affecting water demand were identified, analysed and assessed.

These two factors are the water consumption patterns of the region and the water demand management strategies.

Water consumption patterns were analysed using

1. Consumption patterns according to sector
2. Per capita consumption in Walvis Bay and Swakopmund
3. Consumption patterns based on earnings of the consumers

The water demand management is analysed and assessed by investigating the methods used to implement it.

Table 7.2 summarises the results of the assessment

CRITICAL COMPONENTS	IS IT EFFICIENT ?	IS IT EQUITABLE ?	IS IT SUSTAINAIBLE ?
CURRENT WATER CONSUMPTION			
DOMESTIC	Inefficient because per capita consumption is four times the accepted average of 100 litres per person per day.	Not equitable because high income earners consume more than five times more water than low income earners.	Unsustainable because the current levels of water consumption cannot be maintained as it exceeds the rate of recharge of the aquifers.
NON DOMESTIC	Efficient because the two largest non domestic users of water have implemented or will implement ways to increase efficiency of water usage.	Equitable because the two largest consumers i.e. Rossing and the fishing industry are sharing the responsibility of water saving measures. For the long term, it is essential that any new non domestic heavy water user implement similar measures.	Unsustainable because the current levels of water consumption cannot be maintained as it exceeds the rate of recharge of the aquifers.
WATER DEMAND MANAGEMENT	Inefficient because per capita rate of water consumption still high. Will improve with the introduction of higher tariffs for big water users.	Equitable because methods aimed at reducing water consumption ensure that the savings will be shared equitably by everyone.	Unsustainable because of the failure to reduce the actual rate of water consumption which is unsustainable.

TABLE 7.2 SUMMARY OF ASSESSMENT RESULTS FOR THE WATER DEMAND SECTION

7.3.3 Legislation and policy

In this section, three key uses affecting the legislation and policy of the water sector are analysed and assessed. These are the Water Act 54 of 1956, the Water and Sanitation Policy (WASP) and privatisation of Bulk Water Supply.

Table 7.3 summarises the results of the assessment.

CRITICAL COMPONENTS	IS IT EFFICIENT ?	IS IT EQUITABLE ?	IS IT SUSTAINABLE ?
WATER ACT	Inefficient due to a deficient enforcement mechanism due to a lack of qualified manpower.	Inequitable because it fails to recognise the water demand of the environment and gives too much power to the minister.	Unsustainable because it fails recognise the environment as the downstream user of water and the act is not properly enforced.
WATER AND SANITATION POLICY (WASP)	Efficient because of its participatory and multidisciplinary approach.	Equitable because through the participatory approach it ensures accountability of decisions and the equal sharing of assets and benefits.	Sustainable but low priority given to the needs of the environment counters the sustainability objective.
PRIVATISATION	Efficient because of the ability to pay for the best skills in the business and because of long term planning.	Equitable only if the Public Utilities Commission is established to monitor the private water company.	Sustainable because of long term planning and qualified personnel.

TABLE 7.3 SUMMARY OF ASSESSMENT RESULTS FOR THE LEGISLATION AND POLICY SECTION

From the assessment results of the various components of the water sector the following observations are made.

1. All the critical components that will be implemented in the near future are efficient, sustainable and equitable. These components are desalination, the Water and Sanitation Policy and the privatisation of bulk water supply.

2. All the components of water supply currently in use do not satisfy the efficiency and sustainability criteria.

3. The water demand section is unsustainable.

During the analysis into the need for an SEA, its procedure and the method to implement it, the following observations were also made:

1. The objectives of any policy, plan or programme needs to be concise and yet all encompassing in order to ensure the success of the PPP.
2. An adaptive and circular process procedure to implement PPP is the most effective as it is adaptable and is effective in dealing with changing scenarios.
3. The strategy should be as participatory as possible.
4. PPP need to be integrated into the decision making systems of society and an integrated approach is then developed.

Based on these observation the following conclusions can be made

- the water sector in the study area is inefficient because of the combined effect of an inefficient water supply section coupled with a demand for water that is unsustainable. This imposes a severe threat to the continued sustainable utilisation of the aquifers supplying water to the study area.

- there will be an improvement in the water sector in the region with the privatisation of the bulk water supply, the adoption of the WASP principles and the use of desalinisation to supplement the regional water supply.
- from the analysis of the SEA procedure, it is observed that if the suggestions mentioned in chapter 6 were adopted, the efficiency of the water sector in the country and in the study area would improve dramatically.

Based on the findings and conclusions of this report the following recommendations are made

- In the short term, it is essential that the desalination plant be built to ensure that the underground aquifers do not become permanently damaged. This measure needs to be applied in conjunction with an aggressive water demand management campaign based on increased tariffs and a more proactive awareness campaign.
- the study has helped to identify critical issues concerning the water sector in the study area and should be useful when a water resources management plan is drawn up for the Erongo and Namibia.
- A relatively simple analysis based on principles of Sectoral Environmental Assessment revealed the numerous flaws in the water sector of the Erongo and Namibia. As such, it is recommended that a more detailed SEA be carried out, so that all the strengths and weakness of the water sector can be identified, and a proper management plan drawn up as a long term solution.

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Appendix 1

WALVIS BAY WATER SUPPLY
DESALINATION OF SEA WATER

BRIEF DESCRIPTION OF MECHANICAL VAPOUR COMPRESSION

1 DISTILLATION PROCESSES

1.1 Development of Distillation

Distillation is the oldest known process for producing virtually pure water from sea water.

Few changes occurred in process technology until 1930, when the idea of using up to four stages in the evaporation design was adopted as a method of improving heat utilisation and increasing capacity.

Although flash evaporators were introduced during the 1950's, the first large 4 000 m^3/d sea water distillation plant was not installed until 1960 in Kuwait. Since 1960, many different types of distillation designs have been developed. The major differences among these designs are the type and arrangement of the heat exchange surfaces and the operating temperatures. The three major classifications of distillation systems in use today are flash type evaporators, boiling type evaporators and vapour compression systems. Examples of these processes are discussed in Section 2.3.

1.2 Principles of Operation

When water boils it changes to a vapour, leaving behind the non-volatile impurities. When water vapour (steam) is cooled, it changes back to water which is free of the non-volatile impurities. Two phase changes occur at the boiling point that require or liberate energy. First, water is changed from liquid to vapour requiring energy (in addition to the energy needed to heat the water to its boiling point) called the heat of vaporisation. Second, the vapour is changed back to liquid, resulting in liberation of energy. All modern distillation process designs involve techniques to use the heat released by the vapour as it condenses to heat the feedwater. The most common method for recovering the heat of vaporisation is to heat the incoming feedwater with the vapour in a heat exchanger. As the vapour condenses the feedwater is heated. Relatively efficient modern processes utilise most of the energy originally required to turn the sea water into steam. A substantial proportion of any volatile non-condensable components are vented to atmosphere by means of ejector systems.

1.3 Process Descriptions

Mechanical Vapour Compression (MVC)

Multiple-effect distillation uses the heat from the vapour in the first effect to heat sea water in the second stage, producing vapour at lower pressure and therefore lower temperature. Vapour compression reverses this effect. The vapour from the first effect is compressed which increases its temperature and reduces its volume. When exposed to a heat transfer surface, the vapour condenses.

The most common system design is the ambient temperature vapour compression cycle (ATVC) shown in Figure A1. Incoming feedwater passes through a heat exchanger, mixes with recirculated brine and is then sprayed on the outside of horizontal heat transfer tubes to form a thin film. The vapour within the tubes transfers its heat, as it condenses, to the water on the outside causing vapour to form. Vapour is then compressed and passes to the inside of the tubes where it condenses. The condensate and rejected brine exchange heat with the feed and are pumped out.

Vapour compression requires minimal continual heat supply and uses energy only to run the compressor. It is one of the more efficient thermal processes. Equipment capacities, however are currently limited to 3 000m^3/day increments. Each increment is a separate piece of equipment, which must be installed and operated independently.

Note: Mechanical (electricity powered) Vapour Compression is a well-favoured process and is used extensively for plants of up to 4 000m^3/day capacity. The steam ejector version of vapour compression which is known as Thermal Vapour Compression (TVC) is also in common use. This type of plant has been recommended for use in Walvis Bay by some of the firms that have been approached for their opinions.

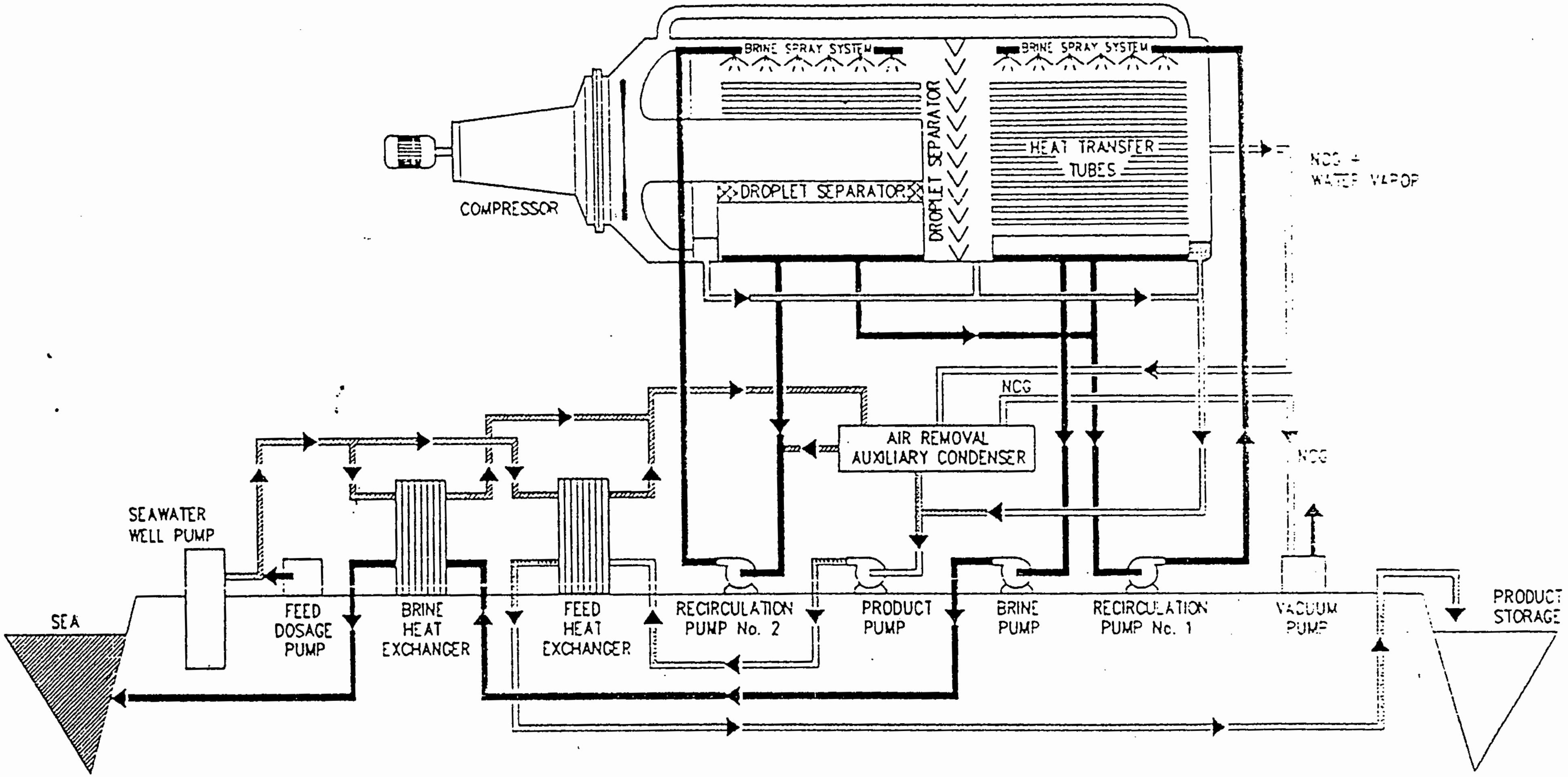

FIG. 3 FLOW DIAGRAM FOR TWO EFFECT
MECHANICAL VAPOUR COMPRESSION (MVC) UNIT