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THE ROLE OF WATER DEMAND MANAGEMENT IN INTEGRATED WATER RESOURCE MANAGEMENT: CONSTRAINTS AND OPPORTUNITIES IN SOUTHERN NAMIBIA

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The Role of Water Demand Management in Integrated Water Resource Management: Constraints and Opportunities in Southern Namibia

Anton Boonzaier

ABSTRACT

Namibia is the driest country in sub-Saharan Africa and has been projected to reach an overall water deficit by 2020. Southern Namibia is especially arid, and appropriate and holistic management of water resources is thus becoming increasingly essential. Water demand management (WDM) is a potential component of sustainable, integrated water resource management in southern Namibia. WDM is a multi-faceted concept that aims to reduce water consumption by directly influencing user demand for water, thereby providing an alternative to costly supply-side management. A contextual review of WDM, including its current application in Namibia, focuses on recent developments regarding policy formulation, legislation and institutional arrangements. WDM is an important component of the new National Water Policy of Namibia. Surface water in southern Namibia is very limited and the region is largely dependent on groundwater. However, large quantities of surface water are used for irrigation and mining. Current water management in the region is disparate and involves several different institutions, and the use of water varies greatly between different economic sectors. Southern Namibia presents a specific set of circumstances for the application of WDM. Each sector has different constraints and opportunities for WDM and the importance of a context-appropriate approach to the adoption and implementation of WDM is emphasised. The strategic objectives of water resource management can also significantly affect the application of WDM. The economic and water-institution sectors examined include NamWater, local authorities, rural water supply, commercial farmers, irrigated agriculture and mining. Irrigated agriculture has the greatest potential for the application of WDM,

but this is presently constrained by various historical and economic factors. Imposition of regulations may be necessary to ensure the implementation of WDM by NamWater, commercial farmers and the mining industry. A critical period currently exists in Namibia regarding policy formulation and the drafting of water-related legislation. If WDM is to become an effective tool within integrated water resource management, it is vital that it forms a central component of water resource policy and legislation. Furthermore, institutional arrangements and the allocation of resources must ensure that WDM measures are implemented and that regulations are enforced.

INTRODUCTION

Insufficient water to meet the growing needs of humans is rapidly becoming a global crisis. The United Nations has projected that, at present consumption patterns, two thirds of humanity will live in water stressed conditions within 25 years from now (UNEP, 2000). In addition, global distribution of freshwater resources is extremely uneven and stark differences exist regarding the regional availability of water. The southern African region as a whole is generally considered as water scarce, with Namibia being the driest country in sub-Saharan Africa (Heyns *et al*, 1998). Namibia has been projected to reach an overall water deficit, with demand for water exceeding available supply, by 2020 (Chenje and Johnson, 1994). Inadequate water management practices are among the reasons why water resources are under threat. Appropriate and holistic management of water resources is thus increasingly perceived as essential.

Water shortages throughout the world have been traditionally managed through supply-orientated approaches. Water supply schemes usually involve large and expensive engineering projects, often involving significant social and environmental costs. Partly as the result of a growing recognition of these problems, and partly due to increased and unsustainable pressures on scarce and shrinking water resources, new approaches to integrated and sustainable management of water resources have emerged over the last few decades. One of these approaches is water demand management (WDM). WDM is a multi-faceted approach that aims to reduce water consumption by directly influencing user demand for water, thereby providing an alternative to costly supply-management options. WDM has achieved worldwide recognition as an important strategy for water resource management and conservation at global, regional and local levels. It is also gaining acceptance as a future national strategy in Namibia.

This paper examines the application of WDM as a strategy for sustainable, integrated water resource management in southern Namibia. Firstly, current conceptual thinking and the international application of WDM are briefly reviewed. Thereafter, the context and application of WDM within southern Africa and Namibia is outlined, including a description of present dynamics regarding policy-making and institutional arrangements within the water sector of Namibia. This is followed by a review of the actual water resources of southern Namibia, especially regarding the current management of these resources. A number of potential obstacles or constraints to the effective implementation of WDM in southern Namibia are then discussed. Possible solutions to overcome these difficulties are suggested in the paper, and potential opportunities for the application of WDM at various levels are also indicated. The paper emphasises the importance of a context-appropriate approach to adoption and implementation of WDM. The strategic importance of the overall objectives of integrated water resource management is also illustrated. The paper focuses on current developments regarding policy formulation, legislation and institutional arrangements, as pertinent to WDM.

This paper largely draws on research conducted during a study on land degradation in the Orange and Fish River Catchment Area of southern Namibia, on behalf of the Namibian Ministry of Environment and Tourism (MET) and the Namibian Programme to Combat Desertification (NAPCOD) (Boonzaier *et al*, 2000). Research methods for the above study included literature reviews, extensive interviews and personal communication with various stakeholders and experts from all sectors, and participatory field visits and observations. Additional research for this paper included a review of international and regional literature pertaining to WDM, and further, detailed interviews with relevant stakeholders in the water sector of Namibia.

A CONCEPTUAL UNDERSTANDING OF WATER DEMAND MANAGEMENT

The philosophy underpinning WDM is clear. Instead of responding to water scarcity or shortage by increasing the supply of water, management efforts are directed at reducing the demand for water. Demand management can avoid or delay the need for supply augmentation projects and the economic, social and environmental costs associated with these. Because the demand for water includes both the actual use of water and potential demand for water, WDM encompasses manipulation of both of these aspects. Water conservation measures, including more efficient use of water, are thus part of WDM, as are measures designed to influence potential demand. WDM is therefore a broad concept consisting of a diverse set of policies, initiatives, investments and other measures in order to meet a wide range of objectives that often vary from context to context. Such objectives may include economic efficiency, social development and equity, environmental protection, sustainability of water resource use, and political acceptability (DWAF, 1999).

The various possible components of a WDM strategy are therefore numerous and can include: water conservation measures; re-use and recycling; water pricing and tariff adjustment; demand forecasting; sectoral water allocation; education, training and awareness; audits; incentives and disincentives; and, legislation, regulations and guidelines. Furthermore, the scope for application of WDM includes the entire water supply chain – from abstraction to end use. The principles of WDM can be incorporated and applied at any level – from formulation of national policy to the changing of household habits (DWAF, 1999).

WDM should therefore not be seen as a complete strategy in itself, but rather as a range of measures or tools that can be adapted and used within a particular strategy in order to achieve a certain objective. The actual measures used will depend greatly on the specific context or situation. It is also important to realise that, despite its multi-faceted nature, WDM is only one component of an integrated approach to water resource management. Other possible components of integrated water resource management include macro-economic considerations, resource economics, water information systems, and legal and institutional arrangements, as well as supply-side management (UNEP, 2000). The relative importance and actual role that each of these components plays within an integrated strategy will depend on the context and chosen objectives of that strategy. Conflict may arise between competing economic, social and environmental objectives regarding the use of water. The importance of context, and choice of management objectives, in the application of WDM will be illustrated later in this paper using specific examples from southern Namibia.

Internationally, WDM has become well established in developed countries over the last two or three decades, especially at local authority and project levels. A high-profile example was the successful adoption of new policies and laws promoting WDM over supply-management in Boston, Massachusetts during the 1980's which led to significant reductions in Boston's water requirements (Davies and Day, 1998). Other international experience indicates that long–term savings of between 20% to 30% can be achieved through the adoption of WDM principles (Water Transfer Consultants, 1997). In the United Kingdom, WDM is seen as a key factor for a sustainable society and a National WDM Centre was set by the Environment Agency in 1993 in order to raise awareness and co-ordinate implementation of WDM (U.K.E.A, 2000).

In the developing world, WDM is a newer concept and has only been applied as such relatively recently – frequently as part of developmental or aid projects and often only at a research level. However, the large costs associated with supply-side projects make WDM increasingly appropriate for the developing world. In 1998, the Canadian-based International Development Research Centre (IDRC) set up a WDM Research Network for North Africa and the Middle East in Cairo. This network promotes and co-ordinates research of WDM in that water-scarce region, and its realm of interest has recently been extended to southern Africa (IDRC, 1997).

WDM in Southern Africa

In southern Africa, supply management has traditionally been the focus of water resource management. WDM has received increasing attention over the last decade or so, although its true value and importance has only recently been recognised. WDM was not mentioned in the 1994 State of the Environment in Southern Africa report (Chenje and Johnson, 1994), but by 1996, it had become identified as a component of water management in southern Africa (Chenje and Johnson, 1996). Such recognition is linked to the growing realisation of the vulnerability of the water resource in a water-scarce region that is experiencing population and economic growth. The World Conservation Union (IUCN) has instituted a regional programme to investigate WDM in southern Africa. A number of studies and reports on WDM within the Southern African Development Community (SADC) have been undertaken under the auspices of the IUCN, and the programme is generally orientated towards development as well as good environmental practice (Fakir, 2000, pers. comm).

A survey of WDM in southern Africa, published by the IDRC in 1997, contained a number of pertinent findings (Forster, 1997). Amongst these was that an overly strong emphasis has been placed on water pricing and tariffs, with only Namibia and South Africa having developed multi-faceted WDM strategies. Consumer education, especially regarding tariff reform, has generally been weak. An important finding of the survey was that, because supporting economic growth within the limitations of existing water supply is a challenge facing many countries of the region, governments still tend to give priority to the development of new water supplies if opportunities and finance are available. This illustrates how the overall objective of a water management strategy can define its nature. If economic growth is the main objective, supply-side projects may gain relative importance over considerations of sustainability or environmental concerns. As will be seen later, this is an important factor in southern Namibia.

Other obstacles to the effective implementation of WDM identified in the IDRC survey include: governments wanting to stake claims for untapped water resources; the needs of civil engineering consultants for construction projects; and, a failure to encompass new skills into the water industry such as economics, social anthropology and education. Interestingly, the survey found that WDM is generally seen as a more inclusive and participatory approach to water management, as opposed to the 'top-down' approach of traditional supply-side management.

In South Africa, water conservation measures and WDM are seen as essential to meet national goals of a basic water supply to all people and the sustainable use of water resources (DWAF, 1999). It is the stated policy of the South African Department of Water Affairs and Forestry (DWAF) to respond to water scarcity by reducing demand, rather than by implementing further expensive supply projects (DWAF, 1997). WDM is provided for in the South African National Water Act of 1998 as part of a National Water Resource Strategy, and provision is made in the Water Services Act of 1997 for the use of tariffs to achieve water conservation. WDM is also central to the National Water Conservation Campaign (Davies and Day, 1998).

THE APPLICATION OF WATER DEMAND MANAGEMENT IN NAMIBIA

Namibia is especially suited to the application of WDM because its water resources are notably limited, inherently vulnerable, and involve extreme hydrological risk (MAWRD, 2000). The country is largely dependent on groundwater and the few perennial rivers are confined to its northern and southern borders. Water scarcity is widely seen as a major constraint to economic development of the country but overall demand for water is increasing, especially in the urban centers, placing further pressure on water resources (NWRMR a, 2000). The growth in demand for water, variously estimated at between 2.2% and 6% per annum, is a combined result of population growth of around 3%, rapid urbanisation, economic development and social upliftment (Barnard, 1998; MET, 1999; van der Merwe, 1999). At a growth rate of 2.2%, full utilisation of Namibia's domestic water resources would occur by 2016 (MET, 1999). In addition, considerable uncertainty exists regarding future water availability in the face of global climate change (Boonzaier *et al*, 2000).

As a result of all these factors, new strategies to ensure effective management of the water resource are of crucial importance to Namibia's future, and a considerable degree of attention is currently being given to the water sector. Such attention includes:

- The recent release of a new National Water Policy White Paper, which will be the precursor of a new National Water Resources Bill;
- Various recent institutional arrangements concerning both water supply and the policy-making process;
- Initiatives such as community-based management of rural water supply; and,
- Investigations into the feasibility of large and expensive supply-augmentation projects such as water transfer from the Okavango River and a proposed dam on the Cunene River.

The concept of WDM has been variously accepted and implemented within Namibia – mainly by local authorities in the larger urban centers. The Windhoek Municipality in particular has implemented a very successful WDM programme since 1994, and water consumption has markedly decreased as a result. Various non-governmental organizations are also involved in the promotion of WDM, with the National Water Awareness Campaign, established in 1992, actively encouraging WDM. However, no national WDM strategy exists in Namibia as yet. WDM has largely been applied in an *ad hoc* and localised or non-contextual manner. Most research suggests that under-pricing and continued subsidisation of water are the main factors behind overuse of water throughout Namibia (van der Merwe, 1999). Other significant constraints include high levels of unaccounted for water, poor maintenance of infrastructure and non-payment of water bills (MET, 1999).

Current legislation pertaining to the water sector, especially the Water Act of 1956, is seriously out-dated. Considerable attention has therefore been given to policy reform and drafting of new legislation. This is briefly described below.

The Water Supply and Sanitation Sector Policy (WASP), approved by Cabinet in 1993, does not explicitly refer to WDM but does contain important provisions relevant to WDM. The WASP contains guiding principles for equitable and efficient water use, and has resulted in significant changes in water management. These are mainly at policy and institutional levels and include: recognition of water as a rare and valuable commodity; the principle of full cost recovery for the provision of water; community responsibility and management of rural water supply; and, the creation of the parastatal Nambia Water Corporation (NamWater) in 1997, responsible for bulk water supply.

The Model Water Supply Regulations of 1996 apply to water supply by local authorities who may implement the model regulations or proclaim their own regulations. The model regulations also contain WDM principles without specific reference to WDM. Most municipalities have not as yet promulgated Model Supply Regulations.

The Namibia Water Resources Management Review (NWRMR) is a multi-disciplinary team created by the Government in 1997, with facilitation and funding by a number of international organisations. Its purpose is to make recommendations in order to "achieve equitable access to, and the sustainable development of, freshwater resources, by all sections of the population..., in order to promote long-term social and economic development" (NWRMR b, 2000). The NWRMR's activities have included an examination of current water management practices, technical reviews on various themes, and participatory discussions with various stakeholders.

The most significant policy in terms of future implementation of WDM is the new National Water Policy White Paper, which was drafted by the NWRMR and approved by Cabinet in August 2000. The National Water Policy (NWP) will form the basis for the new National Water Resources Bill, which is currently being drafted by the NWRMR. WDM is an important component of the NWP. The Namibian Government advocates a new emphasis on the management of water demand and water conservation. WDM is seen as a range of regulatory, economic and technical measures to achieve an objective of more efficient water utilisation (MAWRD, 2000). Although WDM is not actually listed as one of the overarching guiding principles in the NWP, it is a recurring theme amongst the numerous strategies set out for policy implementation. Furthermore, principles of WDM are often included in discussion of water conservation measures, which also receive prominence in the NWP. Importantly, implementation of WDM is seen to require institutional adaptation and re-arrangement as well as legal reform. Important aspects of the NWP in relation to WDM in southern Namibia are discussed later in this paper.

Amidst this background, a comprehensive report on WDM in Namibia was commissioned in 1999 by the IUCN. This report, entitled 'IUCN Water Demand Management Country Study – Namibia' (van der Merwe, 1999), aimed to assess the extent of WDM practices in Namibia as part of the regional IUCN programme. The IUCN study looked at WDM in Namibia at a national scale, with particular emphasis on the urban water sector as well as economic considerations of WDM. Among the objectives of the report were to:

- "evaluate the effectiveness of WDM as a policy instrument within resource management, and
- identify regional WDM constraints and ways to resolve these".

In this paper, the above two objectives of the IUCN study are taken further with specific regard to southern Namibia, which is not covered in great detail by the IUCN report. Southern Namibia is defined in this paper as the Karas and Hardap Regions (see Figure 1). These two regions constitute the most arid part of Namibia, and present a set of specific factors and circumstances somewhat different to the rest of the country – posing unique constraints, challenges and opportunities for the effective implementation of WDM. Before these can be discussed, it is necessary to briefly describe the water resource of southern Namibia, and its current use and management.

THE WATER RESOURCE OF SOUTHERN NAMIBIA

Southern Namibia has an arid to hyper-arid climate and water is generally very scarce. Mean annual rainfall is low, ranging from below 50 mm per year in the extreme southwest, to 250 mm per year in the northeastern parts of the Hardap Region. Extreme variability is the most important feature of rainfall and large deviations from the mean are characteristic. Temporal and spatial fragmentation of rainfall renders it highly unreliable. Evaporation rates are extremely high and potential evaporation is in the order of 10 to 20 times greater than rainfall for most of southern Namibia (DWA, 1988). Two categories of water resources are generally available for use by humans – surface water and groundwater. Although these are distinct from one another in terms of how they are used, they are functionally and ecologically connected.

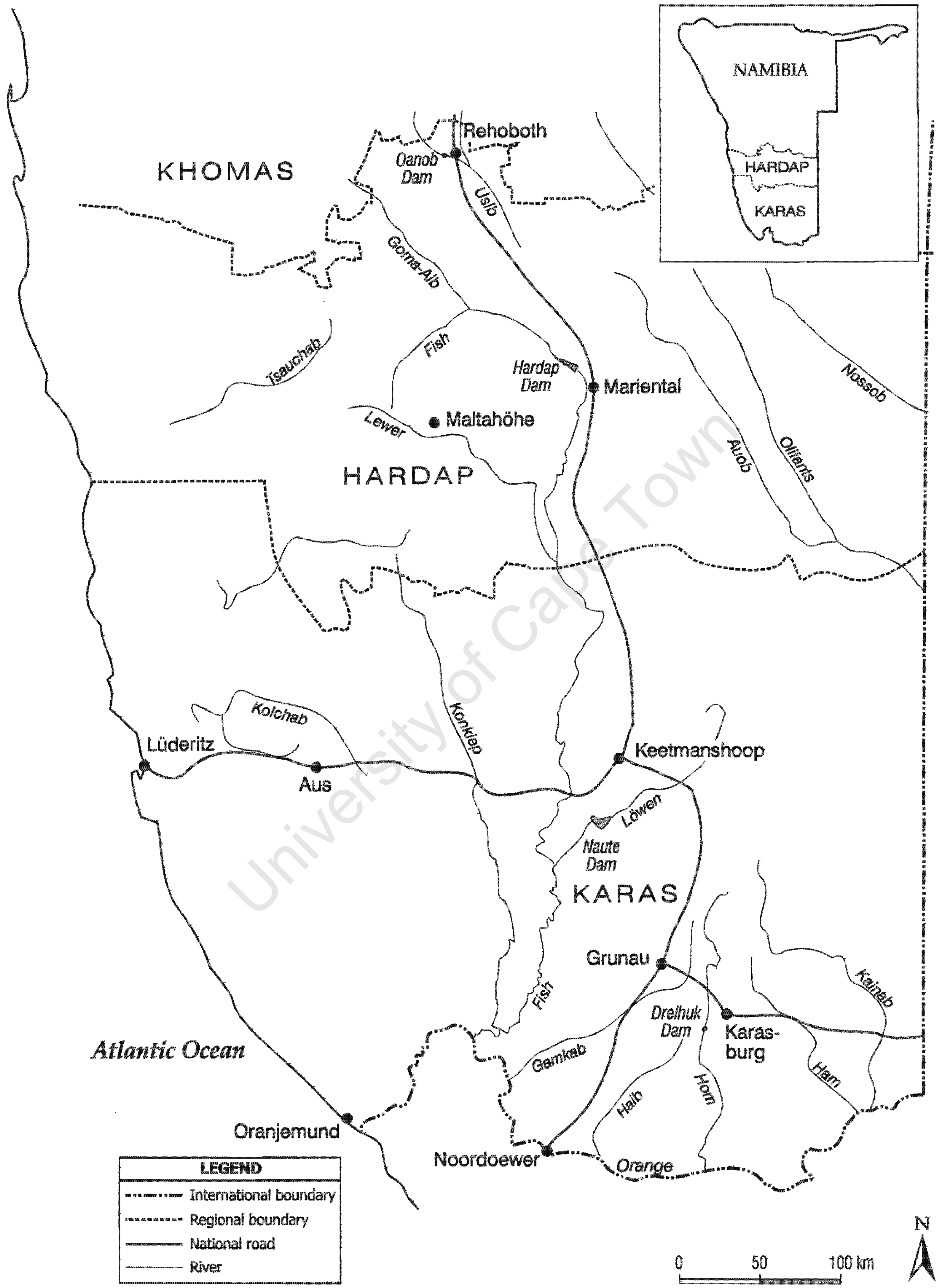

FIGURE 1: Water Resources in Southern Namibia

Surface water in southern Namibia is very limited and the only significant surface water resources are the perennial Orange River and the man-made impoundments to ephemeral rivers (see Fig. 1). The Orange River is potentially the largest available source of water in the region. However, it is situated far from the sources of highest demand, is already heavily regulated and utilised upstream in South Africa, and is subject to international agreements over the allocation of its water. The Fish River has by far the highest runoff of all Namibia's ephemeral rivers, and regularly flows into the Orange River. Two large dams (Hardap and Naute) in the Fish River catchment are very important for water supply in the region.

There are four major storage dams in southern Namibia – the Hardap, Naute, Dreihuk and Oanob Dams (see Table 1). All of these are on ephemeral rivers, which is significant because flow in ephemeral rivers is erratic and unreliable, and there are significant downstream implications. Floods in ephemeral rivers are very important for ecosystem integrity. Dams inhibit the recharge of alluvial aquifers, which sustain the riverine vegetation that acts as vital linear oases in the vulnerable, arid ecosystems.

Short-term dam operation is based on an evaluation of available reserves at the end of each rainy season, and an assumption of no further inflow for two years. This implies that two consecutive dry years may result in a potential supply crisis. This is considered acceptable for Namibian conditions, and a longer safety period would be overly inefficient due to high evaporation (DWA, 1995). Dams in southern Namibia are inherently inefficient as they all have very high evaporative losses, and low assured yields. Evaporation losses range between 30% and 50% in one season. In addition, the high variability of runoff means that the dams have excessive capacity in most years, but are not large enough for those years with very high inflows. The Hardap Dam has a capacity 3.5 times the median annual runoff, Naute Dam's is 9 times, and Dreihuk Dam's is a massive 600 times (DWA, 1995). The typical efficiency of the dams (sustainable yield over average river flow) is only around 20%.

TABLE 1: Characteristics of the Major Supply Dams in Southern Namibia

Name of dam	Hardap	Naute	Dreihuk	Oanob
River	Fish	Lowen (Fish)	Hom	Oanob (Auob)
Year completed	1962	1971	1978	1990
Nearest town	Mariental	Keetmanshoop	Karasburg	Rehoboth
Max. storage capacity (Mm^3)	295	83.5	15.5	34.5
Surface area (Mm^2)	29	12	3	4
Annual potential evaporation (m)	2.4	2.5	2.5	2.3
Normal annual evaporation (%)	29.4	35.9	54.1	24
Mean Annual Runoff (Mm^3)	186	67	0.6	9.5
Median annual runoff (Mm^3)	83	9.5	0.024	5
95% Sustainable Yield (Mm^3)	55.5	12	0	4.5
Main supply use/s	Irrigation, Mariental	Irrigation, Keetmanshoop	Karasburg	Rehoboth

(DWA, 1995; NWRMR a, 2000)

The vast majority of the total water resource available in southern Namibia is in the form of groundwater, and human habitation in the area is largely dependent on groundwater. Enormous uncertainty surrounds the issue of sustainable utilisation of groundwater reserves. Only partial knowledge exists as to the extent of groundwater reserves, aquifer recharge rates, total abstraction rates, and the renewability of the resource. It would seem likely that groundwater is being progressively depleted – and especially so during drought years.

There are two designated Groundwater Control Areas in southern Namibia – the Stampriet and Maltahöhe Artesian Aquifers – within which permits are required to abstract groundwater. Both aquifers are currently being abstracted by commercial farmers. Enforcement of permit requirements is limited and illegal abstraction and irrigation is probably occurring. It is likely that uncontrolled abstraction has a negative influence on borehole yields, with possible negative economic and environmental effects (Christelis; Wessels, 2000, pers.comms.).

Having described the available resources, the present use and management of water in southern Namibia will now be reviewed. It is important to realise that use of water in the region is very disparate – there is no single authority or institution responsible for water supply or management and the particulars of water use vary widely in different circumstances.

WATER SUPPLY INFRASTRUCTURE AND SERVICES IN SOUTHERN NAMIBIA

Water supply in southern Namibia is managed by several different institutions, namely:

- NamWater, which is responsible for bulk water supply to larger towns and settlements, large irrigation projects and some mines;
- The Directorate of Rural Water Supply (DRWS) within the Ministry of Agriculture, Water and Rural Development (MAWRD); and,
- Independent or private users of water, which include commercial farmers, mines and some irrigation projects.

Each of these water supply sectors is described separately below and the differences in infrastructure, management practices and relative quantities of water used by each sector are discussed. The implications for WDM in each sector will be discussed later in this paper.

Bulk Water Supply by Namwater

NamWater operates relatively independently and on a cost-recovery basis, which is an attempt to increase the economic efficiency of water supply services. Water supply infrastructure operated by NamWater in southern Namibia includes: the four dams described earlier, and the pipelines and purification works associated with these; Orange River water abstraction infrastructure at Noordoewer and Rosh Pinah; and 28 groundwater schemes. NamWater has no master plan for water supply in the south and planning is done on a project and/or scheme basis (Drews, 2000, pers.comm.). NamWater receives payment for bulk water from a large number of various clients in the region. Although some municipalities and other local authorities pay NamWater directly, the Ministry of Regional and Local Government (MRLGH) and the Regional Councils pay NamWater on behalf of many local authorities. Other major clients include Rosh Pinah Mine and the Hardap and Naute Irrigation Schemes. There are widespread problems with wastage of water and non-payment, especially within those local authorities whose water bills are paid for by the MRLGH or Regional Councils (van der Merwe, 1999). In addition, some local authorities sell water for less than what they pay NamWater (Kok, 2000, pers.comm.).

There are only six NamWater surface water schemes in southern Namibia. Significant uses of surface water are briefly described below. Current and projected water demand figures for the major users of surface water in southern Namibia are presented in Table

2. Quantities of surface water used by tourism, stock farming and other industry are relatively insignificant and are not considered.

TABLE 2: Current and Projected Surface Water Demand (m^3 x 1000/year)

Source	Sector	1999	2005	2015
Orange River	Irrigation	41 042[1]	59 532	78 023
	Mining	7547	22 368 (Includes Skorpion[2] and Haib[3])	32 368
	Noordoewer	37	Not available	Not available
Hardap Dam	Mariental	658	Not available	Not available
	Irrigation	34 933	46 5699 (Includes Naute and Hardap combined)	51 617
Naute Dam	Irrigation	3 469		
	Keetmanshoop	1 947	2121	2461

(Source: NamWater Production Figures, 2000; NWRMR, 2000)

[1]Not supplied by NamWater
[2]The new Skorpion Zinc Mine will use over 4 Mm^3 /year when in operation
[3]The proposed Haib Copper Mine was projected to need up to 20 Mm^3 /year

The main uses of water from the Hardap Dam are the Hardap Irrigation Scheme and domestic water for Mariental. The irrigation scheme is by far the largest consumer of water from the dam – using about 95% of the total. NamWater sells bulk irrigation water to the Department of Agriculture, which is then distributed to the farms in the irrigation scheme. The irrigation scheme infrastructure has deteriorated markedly, and damaged pipelines, blocked drainage canals and excessive reed growth present significant problems (du Plessis, 2000, pers.comm.).

The Naute Dam supplies Keetmanshoop and the Naute Irrigation Scheme. The Naute Irrigation Scheme is newer and smaller than the Hardap Scheme, and utilises far more efficient irrigation systems. Of all the dams in southern Namibia, the Naute Dam has consistently maintained the highest water levels as a percentage of total capacity. These factors combined give the dam considerable reserve capacity to support the present irrigation projects, plus further limited development (de Wet, 2000, pers.comm.).

The Dreihuk Dam is chronically empty. It has never been more than 19% full and was completely dry in 1985 (Louw, 2000, pers.comm.). This reflects an apparent situation where the design of the dam far exceeds the run-off potential of the river it impounds. Apart from the waste of capital expenditure this implies, the excessive engineering has had significant environmental effects. The presence of the dam has resulted in a lack of recharge of downstream alluvial aquifers, leading to the death of trees in the river bed that depend on these aquifers (Steyn, 2000, pers.comm.). The Dreihuk Dam presents a very good example of the shortcomings of an exclusive supply-side approach to water resource management.

Almost all the smaller towns and settlements in southern Namibia depend on borehole abstraction of groundwater. There are 15 NamWater groundwater schemes in the NamWater-Karas Area and 13 in the NamWater-Hardap Area, with a total of about 90 production boreholes. The total potential yield of these boreholes far exceeds the total current demand. However, yields are highly variable, and localised water supply problems do occur. NamWater is able to meet demand relatively easily at most of the schemes. The exceptions are at Aus and Grünau (see Fig. 1), where there are ongoing problems with water quantity – especially at Aus where NamWater is unable to meet demand. Supply augmentation projects – drilling more boreholes or a pipeline from Karasburg – are possible solutions at Grünau (Grobbelaar, 2000, pers.comm.). Supply augmentation is not feasible at Aus however, as there is simply insufficient groundwater in the area. Importation of water by train has been proposed, but demand management remains the most feasible management option. Water levels of a number of other boreholes fluctuate seasonally, and some dropped significantly during the last drought (especially at Kalkrand, Maltahöhe and Tses). These generally recover after rain (Bonthuys; van Heerden, 2000, pers.comms.). NamWater controls all aspects of borehole abstraction in-house and their geohydrologists regularly monitor groundwater levels, abstraction rates and water quality.

Rural Water Supply by the Directorate of Rural Water Supply

The DRWS is responsible for water supply, for both human and livestock consumption, to small rural communities in the communal areas. Rural water supply in southern Namibia is almost entirely from groundwater, and essentially consists of over 900 individual boreholes scattered throughout the communal areas. These boreholes serve as communal water-points, and are often used all year round. The total combined quantity of water used in the rural water supply sector is only a small fraction of the bulk water supplied by NamWater. Water supply to this sector in the past has been free or greatly subsidised and thus entails a significant cost to the government. A number of difficulties have been encountered with rural water-points, including over-extraction, inefficient use of water and inequitable access. Such problems are often related to the perceptions of water as 'free', lack of 'ownership' of the resource, and to inadequate institutional arrangements at a local level (Boonzaier *et al*, 2000; Sekhesa, 1997).

In an attempt to address these problems, the DRWS began a community-based, cost-recovery management programme in 1997. The objective is to transfer management and payment of water services from the DRWS to communities themselves. A phased approach to community based management (CBM) will initially see communities responsible for operation and maintenance of water-points, followed by full decentralisation and cost recovery at a community level by 2007. The importance of legal measures, institutional arrangements and other enabling mechanisms necessary to ensure the success of the CBM programme have been pointed out by Sekhesa (1997). Several role-players have also suggested that full cost recovery may be beyond the economic capacities of many communities (Boonzaier *et al*, 2000).

Independent/Private Water Users

A number of private water users in southern Namibia provide and manage their own water supply at their own costs. They are independent of both NamWater and Government (except for applicable licensing requirements). The combined quantity of water used by all these users is unknown but forms a very significant proportion of the total. This group includes commercial farmers, the Orange River irrigation schemes at Noordoewer and Aussenkehr, and the Namdeb Diamond Mining Corporation and the town of Oranjemund. Water use by tourism enterprises, small-scale mining enterprises and independent settlements are minimal in comparison and are not considered further.

Commercial Farming

Collectively, commercial farmers probably constitute the largest independent water user and, spatially, have the most significant impact on the total water resource of southern Namibia. Although commercial farmers depend on rainfall for grazing of their livestock, they are largely dependant on groundwater. The combined impact of groundwater abstraction by commercial farmers represents the major uncertainty pertaining to the water resources of southern Namibia. Most farmers do not monitor groundwater levels or borehole extraction rates, and if they do, these records are not reported. There is therefore no or little regulation or control over groundwater extraction by commercial farmers. Even within the two proclaimed Groundwater Control Areas in southern Namibia there is little enforcement of permit conditions (Christelis, 2000, pers.comm.). The fact that commercial farmers usually practice rotational grazing between fenced camps implies that some boreholes are only used for part of the year. This differs from the general situation in communal areas, and may, in part, explain why most farmers interviewed reported no real problems with their water supply (Boonzaier *et al* , 2000). Most farmers provide their own water at their own capital and operating costs. This implies full cost recovery, but only for actual financial costs. Environmental costs and future opportunity costs are clearly not considered.

Orange River Irrigation Schemes

The irrigation schemes at Noordoewer and Aussenkehr use large amounts of water from the Orange River under license from the DWA. Nominal tariffs are paid to the DWA per hectare under irrigation. The Noordoewer Irrigation Scheme is the oldest irrigation scheme in the region. A variety of crops are grown on about 300 ha, mainly using flood irrigation from a gravity-fed canal. The Aussenkehr Irrigation Scheme is a new project growing mainly table grapes for export on about 1300 ha of land. The current water abstraction permit is for 13.2 Mm^3/year (van der Merwe, 1999) and modern, efficient irrigation techniques are employed.

Namdeb Diamond Mining Corporation and Oranjemund

Namdeb extracts water directly from the lower Orange River for its diamond mining operations alongside the river. At the Orange River mouth, Namdeb extracts water from boreholes to supply the town of Oranjemund, and uses about 6 Mm^3/year from this source – a considerable quantity. Namdeb provides water to Oranjemund at no charge for the users and is responsible for operation and maintenance of the required infrastructure.

CONSTRAINTS AND OPPORTUNITIES FOR THE EFFECTIVE IMPLEMENTATION OF WATER DEMAND MANAGEMENT IN SOUTHERN NAMIBIA

A number of specific features and circumstances distinguish use of the water resource in southern Namibia from the rest of the country. These have significant bearing on the application or implementation of WDM in the region. As described above, southern Namibia has less water resources than the rest of the country. However, the region is also much less populated than the rest of the country and has by far the lowest population densities. Mainly as a result of population scarcity, water supply can easily cope with current demand – with only a few localised exceptions. Furthermore, population growth in southern Namibia is zero, or even negative overall (mainly due to out-migration). This is in stark contrast to a country-wide growth of around 3% (Boonzaier *et al*, 2000). The absence of population growth implies that domestic water demand in southern Namibia is unlikely to increase in the foreseeable future. It would seem that significant increases in overall water demand can only be fuelled by further development of irrigation projects, tourism, mining or industry. Of these, growth of water-dependent industry seems improbable in the economic context of the region. The tourism industry has important localised opportunities for application of WDM, which are generally small-scale (Schachtschneider, 2000). The total quantity of water used by tourist enterprises in southern Namibia is minimal however in relation to the major users of water. This leaves irrigation and mining as the main foreseeable sources of overall increased demand for water in southern Namibia. These sectors are discussed in more detail below.

Another distinguishing feature of water use in southern Namibia is the relatively high proportion of private management of water supply. This can largely be ascribed to the rural nature of the region – with the main land-use being rangeland livestock farming – and a relative lack of large urban centers where local authorities are responsible for water supply. The geographical isolation of the diamond mining industry also contributes to this situation. Private users will tend to use as much water as is economically efficient to supply – akin to a supply management approach. Independent control of water use will thus tend to minimise the implementation of WDM, especially in the absence of appropriate and enforceable legislation or regulations. The NWP emphasises state ownership and control over water resources. To this end, a new regulatory regime, which includes the payment of abstraction fees, will be established (MAWRD, 2000). The effectiveness of these changes over current independent control of water use will depend on how the NWP is translated into new legislation, and on the allocation of resources and institutional arrangements necessary to enforce such legislation.

The scope for WDM is arguably highest in specific, localised situations and, within the context of southern Namibia, especially so in the urban centers and irrigation projects. However, two of the main urban centers, Keetmanshoop and Mariental, receive their water supply from the nearby, relatively large dams. The nature of these dams pose interesting caveats to WDM in these towns. As shown earlier, the dams are inherently inefficient and are unnecessarily large except for exceptionally high rainfall seasons. They have capacities way in excess of the requirements of the towns. The result is enormous wastage of water to evaporation, as well as significant downstream environmental costs. Given the presence of these dams, it could therefore be argued that this water may as well be used, including for irrigation, instead of being conserved only to then evaporate. As the amount of water used for domestic purposes is much less than that used for irrigation, it would seem there is little point in instituting WDM in the towns when any water saved would either be lost to evaporation or used for inefficient irrigation. This is especially applicable to Mariental, which uses only a fraction of the water used by the irrigation scheme and the irrigation scheme employs particularly wasteful techniques. Even if very successful, implementation of WDM in Mariental would largely be insignificant when placed in the local context.

This situation raises more questions about the sustainability of the dams than it does about WDM. These dams were designed and built in an era when supply management dominated the thinking regarding provision of water, subsidisation of irrigation projects was considered an economic imperative, and environmental concerns were barely considered. There is now increasing recognition of the environment as an important water user in its own right; for instance, the recharge of downstream aquifers and maintaining the integrity of dependant ecosystems. This use of water must be adequately considered for future management of the existing dams. The concept of an 'environmental reserve' of water for maintaining ecological integrity is discussed in the NWP. If this concept is built into forthcoming legislation it will become a mandatory allocation of water and will thus impact on other allocations, effectively making increased efficiency of current uses more important. For example, water saved by improving the efficiency of irrigation could then be allocated for downstream ecological requirements. Furthermore, adequate consideration of the environment, especially the fragile ephemeral river ecosystems, would count against any consideration of new dams on the scale of the existing ones. Smaller, more efficient dams, and especially sand-storage techniques, would seem more appropriate. However, the first priorities of new capital expenditure should be to upgrade the infrastructure of existing schemes to improve efficiency, or expansion of the existing schemes where reserve dam capacity is available.

To further understand the constraints and opportunities for the application of WDM in southern Namibia it is necessary to consider these within similar sectors as used earlier to describe water supply. The sectoral approach adopted below allows for more detailed consideration of WDM within the specific context of each sector.

NamWater

The shift to increased water tariffs is primarily aimed at recovering costs, and decreased demand is only considered as secondary to this (Drews, 2000, pers.comm). However, due to the economies of scale in the sparsely populated region, NamWater would actually prefer to sell more water in southern Namibia as this would improve regional income, marginal cost recovery and economic efficiency (Bonthuys, 2000, pers.comm). There is thus no economic incentive for NamWater to supply less water or to reduce demand. NamWater has the capacity, and access to sufficient water resources, to supply more water, and only the lack of demand prevents them from doing so. In fact, a potential situation arises where a reduction in demand due to increased water tariffs may result in NamWater not being able to reach full cost recovery. It is feasible that lower water prices and increased demand would actually be preferable to NamWater in terms of cost-recovery and economic efficiency. In this instance, there is potential conflict between regional economic efficiency and the aims of WDM.

This region-specific situation could be remedied by the adoption of a country-wide WDM policy by NamWater, with cross-subsidisation within the corporation to alleviate regional constraints. For instance, a more co-ordinated approach to regional financial planning in southern Namibia could allow for future income from supplying the new Skorpion Zinc Mine to offset losses that may be incurred elsewhere through water savings. As yet, there is no apparent move by NamWater to adopt a specific WDM policy. Such a policy would clearly require co-ordination with local authorities and other clients within a set policy, legislative and institutional framework.

The imposition of regulations to enforce the adoption of WDM by NamWater is also a possibility. The NWP contains a clear intention to set up an 'Independent Regulator'. This body will regulate all state utilities, parastatals and private service providers involved in water supply, with specific emphasis on water price setting. In addition, the establishment of a 'pricing review group' is envisaged to "provide independent advice on the water pricing proposals of NamWater and from local authorities" and to "set the maximum price for water services" until the independent regulator is created (MAWRD, 2000). Although appropriate pricing will be set according to social, environmental and economic considerations, no specific reference to WDM is made in the discussion of independent regulation. Furthermore, the reference to a maximum price for water, but not to any minimum price, would seem to abrogate against the consideration of WDM as an important part of the envisaged price regulation. It would seem clear that a careful and strategic approach is necessary to ensure the integration of WDM into pricing regulation mechanisms.

Local Authorities

Indirect payment to NamWater by the MRLGH and Regional Councils on behalf of many local authorities in southern Namibia implies that these local authorities are unaccountable for the costs of water supply. Such unaccountability is a clear constraint for effective WDM. The situation whereby some local authorities do not pass on NamWater's tariff increases to end consumers but absorb the costs themselves, or are subsidised by higher tiers of government, also clearly negates any effect on demand reduction that increased tariffs may have. Reasons for this practice are generally related to lack of necessity, capacity or will to enforce or collect increased tariffs. These aspects are covered in detail at a countrywide scale by van der Merwe (1999).

In terms of local authorities in southern Namibia, a blanket approach to the application of WDM is inappropriate. Each local authority has its own particular context and circumstances in terms of capacity, institutional arrangements and payment structure, size and complexity of its reticulation network, and type and extent of its water source. These will all influence the application of WDM measures. For instance, the importance of WDM in Mariental can not be equally compared to the situation in the town of Lüderitz. Mariental has an enormous and renewable (barring severe drought) source of water and any savings incurred through WDM would be an order of magnitude less than that which could be achieved by more efficient irrigation. Lüderitz, on the other hand, relies on the abstraction of 'fossil' groundwater, which is essentially non-renewable, and water conservation is thus central to the life-span of this source. In the case of Grünau, and even more so in Aus, WDM is of vital necessity as there are few other options available. In addition, the nature of the most appropriate WDM measures will vary according to different local circumstances. Pricing mechanisms, for example, may be more important in a relatively large municipality like Keetmanshoop, but less so in a poor, rural settlement where the per-capita use of water is far lower. The larger municipalities also provide more scope for application of a wider range of measures, including water recycling, whereas the scope is more restricted in the smaller centers.

Water restrictions and detailed attention to leakages, pressure and metering would seem most appropriate in Aus, whilst public awareness may be the best option in Noordoewer. This re-illustrates the context-specific nature of WDM and that the choice of appropriate measures is of primary importance to the eventual success of a WDM strategy.

There are certain approaches, however, that may be applied more generally. Decentralisation of the responsibility for collection of payment and cost recovery, as well as the removal of subsidisation, would promote accountability and improve efficiency at a local authority level. A carefully monitored, phased approach, within the limits set by local capacity, would be necessary to ensure successful decentralisation. Consumer education and awareness raising are important responsibilities of all local authorities, as is the adoption of the Model Water Supply Regulations, or at least the principles contained therein. Improved co-operation between NamWater and local authorities would enhance a co-ordinated approach to efficient water management. It would also seem apparent that regulatory mechanisms, in conjunction with a clear policy commitment to WDM, would also be necessary to ensure the effective implementation of WDM by local authorities. As is the case with NamWater, the regulation of local authorities is envisaged in the NWP, but the extent to which WDM will be part of such regulation is not made clear.

Rural Water Supply

The CBM programme currently being implemented by the DRWS will, in principle, reduce demand and increase efficiency of water use as the previous free supply led to inefficient use and waste. Other advantages include: enhanced incentives to manage water; community development; more equitable use of water within communities; greater sustainability of water points; and, a reduced need for new boreholes. However, a number of potential problems may negate the success of the programme. Adequate training, education, capacity building and the use of appropriate technologies will all be necessary to avoid failure. It has also been argued that security of tenure, including the right to make long-term decisions over access and use of water, is very important for success of the CBM programme (Sekhesa, 1997). In terms of both the Communal Land Bill and the NWP, natural resources, including water, remain under state control and security of tenure is therefore not guaranteed. An adequate solution to this apparent contradiction would seem far more important than WDM in terms of achieving sustainable water management in this sector.

Interfaces between the DRWS programme and WDM are comprehensively explored at a national level in the IUCN WDM study (van der Merwe, 1999). In this report it is pointed out that WDM policy has limited application in this sector due to the fact that mean per-capita water consumption in rural areas is less than the national average, and in fact is far less than minimum acceptable guidelines required for good health. Equity considerations would therefore seem to be more of an issue in this sector than WDM. This again illustrates the contextual nature of WDM and the importance of the overall objective of a water management strategy. In this instance, the achievement of social equity takes precedence over conservation of water or improved efficiency of water use.

The IUCN report does not specifically look at the application of the DRWS programme in southern Namibia and it is worth noting some issues that are somewhat different to those of the communal areas elsewhere. Firstly, the southern communal areas are far more arid and dependent on groundwater and the groundwater resource is thus more vulnerable to drought and over-exploitation. This makes the sustainability of water points that much more of an issue. On the other hand, negligible population growth in the southern communal areas contrasts markedly with the growth in population of communal areas elsewhere. The communal areas of southern Namibia are populated by the Nama ethnic group, and are culturally and politically distinct from other communal areas. Concern has been raised that the DRWS programme may cause further sedentarisation and loss of traditional Nama nomadic pastoralism, leading to an increased tendency of over-concentration of stock around water points and subsequent land degradation (Boonzaier *et al*, 2000).

The NWP indicates that significant changes will be made to the DRWS. According to the NWP, the DRWS will be transformed into a "RWS Project Team" or "Task Force" and its role will change from "service designer and deliverer" to "facilitator, enabler and advisor for the delivery of services" (MAWRD, 2000). There is no reference in the NWP to WDM for this sector.

Commercial Farmers

WDM is a difficult concept to apply to this sector under current circumstances. Commercial farmers supply water at their own costs and for their own use, thus managing both supply and demand themselves. Farmers will use as much water as necessary for their needs, and will want to recover the capital costs of infrastructure and maintenance at least. Beyond this there is generally no cost for the water they use and, outside of Groundwater Control Areas, no regulation. As long as farmers perceive that their supply is not threatened, there is little incentive or disincentive to reduce abstraction rates or inefficient water use. Almost all the commercial farmers interviewed by Boonzaier *et al* (2000) reported a sufficient supply of groundwater for their needs. The general perception seemed to be that borehole depth is the most important factor regarding groundwater supply, and that the main limitations are only the costs associated with drilling ever-deeper boreholes. There was a general lack of awareness regarding the nature of secondary aquifers, the long-term sustainability of groundwater abstraction or any environmental considerations related to groundwater. Commercial farmers generally do not take the existence of considerable scientific uncertainty regarding the extent of groundwater reserves, aquifer recharge and linkages between groundwater and the environment into account.

Under the existing Water Act, farmers have an entrenched right to the water on or under their land. It is clear that this right will be removed when the existing legislation is replaced. It is stated in the Namibian Constitution that the Government will be the custodian of water resources and will have the authority to regulate water abstraction and use. The NWP provides some indication of the mechanisms that will be adopted to enable these Constitutional principles. It is apparent that regulatory measures, water abstraction fees and enforcement mechanisms are all envisaged in this regard (MAWRD, 2000). Although the commercial farming sector is not specifically identified, these measures will apply to all water users. A phased approach to implementation, the recognition of existing rights and equity considerations are also envisaged, although few specific details are provided as to how these will be applied.

The application of the above principles to the commercial farming sector will have far reaching consequences. Regulation of, and payment for, water abstraction will enable the application of WDM principles to this sector. This will be significant as WDM can then provide a mechanism to ensure that the issues of equity, efficiency and environmental sustainability are applied to future management of the groundwater resource. However, practical implementation and enforcement of these principles will be very difficult. For instance, metering of groundwater abstraction, monitoring of water use and collection of tariffs will require enormous capital expenditure and institutional capacity. These may simply not be forthcoming in the geographical and economic context of southern Namibia, as illustrated by current widespread non-compliance and poor enforcement of existing regulations within Groundwater Control Areas. Meaningful application of the principles outlined in the NWP will require very careful and detailed drafting of new water legislation and regulations, with close attention to the institutional arrangements and capacity necessary for enforcement of these.

Irrigated Agriculture

This sector is by far the biggest user of water in southern Namibia in terms of overall quantity, and has large scope for application of WDM principles. Indeed, more water could be saved through effective WDM and water conservation measures in this sector than in all the other sectors combined. The economic and environmental implications of the construction of the dams necessary to support the irrigation schemes have been discussed earlier. The irrigation schemes themselves also have significant environmental implications. The older schemes use highly inefficient irrigation methods that result in massive wastage of water. Flood irrigation is especially wasteful and can use up to 10 times more water than is actually needed to irrigate the crops grown (Bethune, 2000, pers.comm.). Flood irrigation and agricultural runoff at the Hardap Irrigation Scheme have caused soil salinification and have had various effects on the aquatic ecosystems of the Fish River. Amongst these is a progressive increase in growth of *Phragmites australis* reeds alongside the scheme which has raised the level of the river bed and was a major contributor to the flooding of Mariental experienced in 2000 (du Plessis, 2000, pers.comm.).

The irrigation sector illustrates the crucial importance of the strategic objectives of a water management strategy. The irrigation schemes were conceived in terms of their potential for economic growth, diversification and employment, and water management is secondary to these objectives. The application of WDM to this sector is complex and must be viewed within the context of the economic importance of the sector as well as national economic and agricultural policies. The needs of other water users, such as the environment, have to be balanced against the needs of the regional and national economies. A management strategy that adequately balances economic value and efficiency with environmental sustainability would require sophisticated resource economics analysis to ascertain the comparative values of the different uses of water. This would be complicated by the need to define specific time frames, and such a strategy would need to be consistent with overriding agricultural policy. For instance, the debate around a national agricultural policy of food self-sufficiency versus food security has vital implications for the type of crops grown by the irrigation schemes, and hence the quantities of water necessary. An objective of food self-sufficiency through irrigation, as adopted in the First National Development Plan 1995-2000, necessitates both trade protection measures and water subsidies (Lange, 1998). A goal of food security, however, is a far more efficient approach to water use as food can be imported using capital generated elsewhere through more water-efficient means (Heyns *et al*, 1998). The concept of 'virtual water' has significance in this regard. Virtual water is that water which is effectively 'imported' by importing crops that have been grown using water resources elsewhere. Thus, if high value crops are grown locally in place of crops that need larger quantities of water, the proceeds from the sale of the high value crops can be used to purchase more water-intensive crops such as staple cereals. In this way the 'virtual water' is conserved (Heyns, 1999). National agricultural policy may therefore have a greater influence on the efficiency of water use than the application of WDM.

Lange (1998) has examined the use of natural resource accounting to achieve sustainable water management within the contexts of water policy and the tradeoffs between competing economic activities. Some pertinent issues are illustrated by examining the example of the Hardap Irrigation Scheme. This scheme has provided considerable economic benefits in terms of the economic objectives mentioned above, and remains highly important for the regional economy (Klein, 2000, pers.comm). Economic success has, however, depended on massive subsidisation of water, which entails financial costs as well as the environmental and social costs of inefficient water use as described previously. In addition, because the value-added per unit of water used for irrigation is very low in comparison to other uses, the opportunity costs of this water use are very high.

The move towards full cost recovery of water supply through tariff increases would seemingly encourage more efficient use of water at Hardap. Indeed, the threat of future tariff increases may partly explain the shift to more water-efficient crops. The Department of Agriculture nevertheless continues to subsidise water to the order of 70% of the full cost, and farmers simply refuse to pay the full cost (Rothauge and Moono, 2000). Under current irrigation practices farmers could not remain profitable if they had to pay the full cost of water, so continued subsidisation is necessary for the economic viability of the scheme (Lange, 1998). In addition, there are currently no means to meter the use of water anyway, so volumetric tariffs are largely meaningless (Klein, 2000, pers.comm.). All these factors clearly make effective application of WDM difficult and economic concerns seem to dictate that highly inefficient water use continues. What role can WDM then play within an integrated management strategy at Hardap? The best way forward would seem to be major new capital expenditure on infrastructure. The replacement of the poorly maintained flood irrigation infrastructure with efficient micro-irrigation systems, including mechanisms for metering water use, would entail large cost. However, this cost needs to be compared against the financial cost of continued subsidisation, as well as the long-term social, environmental and opportunity costs of inefficient water use. If a combination of more efficient irrigation and higher-value crops allow farming to remain profitable with full cost recovery for water, WDM can be successful. Not only can the water saved then be allocated for other users, including downstream ecological requirements, but the irrigation scheme could conceivably expand within the constraints imposed by the variable capacity of the dam.

The newer irrigation schemes (Naute and Aussenkehr) both use much more water-efficient micro-irrigation systems, and grow high-value export crops. However, both schemes still do not pay the full costs of water supply. The Naute scheme remains partially subsidised, and the water tariffs paid by the Aussenkehr scheme are nominal. Considerations regarding sustainability are somewhat different at Aussenkehr due to the differences between abstraction from the perennial Orange River and dam-dependant irrigation. Aussenkehr is a near end-user of a heavily used and regulated river basin, which has been comprehensively reviewed in a pilot study undertaken for the World Commission on Dams (W.C.D, 1998). Similar considerations apply to the downstream mining industry and the mining towns of Oranjemund and Rosh Pinah.

Mining

Water use by mines is often relatively efficient and there is high value added per unit of water used (MET, 1999). There is, however, no attempt to practice WDM in Oranjemund or Rosh Pinah. Residents of Oranjemund are supplied free water by Namdeb as part of an employment package that includes free housing, and there are generally no restrictions on water use. Namdeb regularly monitors the aquifer from which it abstracts water as part of an early warning system. Water restrictions are only occasionally applied on an *ad hoc* basis during periods of very low flows in the Orange River, and then mainly to maintain pressure in the reticulation system. There is no water-restriction policy and no penalties for non-adherence. There is a strong perception amongst the residents of Oranjemund that water use is not an issue because water can usually be seen flowing past them into the sea (Parkins, 2000, pers.comm). Although Namdeb is currently implementing the International Standards Organisation (ISO) 14001 environmental management system in Oranjemund, water will continue to be supplied free of charge. This is in part due to the fact that houses are not equipped with water meters, and meter installation would require major capital expenditure. When Oranjemund becomes proclaimed as a municipality sometime in the future it may have to introduce water tariffs (Parkins, 2000, pers.comm).

There are thus no incentives or disincentives for the application of WDM in Oranjemund, and very few mechanisms if there were. Education and raising of awareness would seem currently most important. The provisions of the NWP, as discussed above, may have significant bearing on this situation in the future, and it seems that the imposition of regulations through legislation would be the only way to achieve WDM in Oranjemund at present.

CONCLUSION

Despite the fact that water supply in southern Namibia is generally able to meet current demand, conservation and efficient management of water in the region will remain highly important for several reasons. These include: frequent droughts; future climate change scenarios which may further limit available water resources; dependence on largely unknown groundwater reserves; the often poor quality of groundwater; and, environmental considerations of water use. Effective and sustainable management of water resources requires a holistic, integrated approach that goes well beyond traditional supply-side management. WDM will become an increasingly important component of an integrated approach to water management in southern Namibia. WDM is not a panacea however, and its effectiveness is largely contingent on the context and manner in which it is applied.

As has been illustrated in this paper, the objectives of resource management will greatly influence management strategies. Even if we assume that the overall objective of integrated water resource management is to achieve economically efficient, socially equitable and environmentally sustainable provision of water, the specific context and the relative importance given to each of these objectives will determine the nature of the management strategy. A holistic view is therefore necessary in order to establish the role of WDM in a particular management strategy. Thus, in southern Namibia, economic considerations and agricultural policy will largely dictate how WDM is applied to the irrigation sector. Similarly, social equity is arguably more important than efficiency of water use in the rural water supply sector.

A sector-based examination of the constraints and opportunities for application of WDM in Southern Namibia reveals the crucial importance of context in determining the application and value of WDM within each sector. The range of appropriate WDM measures, and their relative effectiveness, will also vary greatly depending on the context in which they are applied. The circumstances surrounding the water resources of southern Namibia pose distinct challenges for WDM. A blanket approach to WDM in the region is not feasible however, and each sector presents a different set of constraints and opportunities for WDM. Furthermore, the application of WDM measures within each sector will vary widely according to specific local factors and circumstances.

A critical period currently exists in Namibia regarding national policy formulation and the drafting of appropriate legislation. If WDM is to become an effective tool within integrated water resource management, it is vital that it forms a central but flexible component of water resource policy and legislation. The creation of a National WDM Policy has been advocated in this regard (van der Merwe, 1999). Such policy would have clear countrywide benefits, but regional constraints, as described in this paper, necessitate an adaptable approach. A National WDM Policy would also have to conform to the WDM provisions contained in the NWP. These provisions need to be translated into explicit and detailed stipulations in forthcoming legislation, preferably on a per-sector basis. Furthermore, institutional arrangements and the allocation of resources should ensure that WDM measures are mainstreamed and implemented, and that legislation and regulations are adequately enforced.

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