# Water resources and water management in the Bahurutshe heartland

**Saroné Van Niekerk[1] and Kobus Du Pisani[2]***

[1] *Research Focus Area Sustainable Social Development, North-West University, Potchefstroom, South Africa*

[2] *Subject Group History, North-West University, Potchefstroom, South Africa*

## Abstract

With this study a brief descriptive survey, covering the period from 1972 to the present, of the water resources in the Lehurutshe district, formerly part of Bophuthatswana and now part of the Zeerust district of the North-West Province, is given. Both surface water bodies (rivers, catchments, drainage systems, wetlands, pans, dams and reservoirs) and groundwater resources (aquifers, dolomitic eyes, springs and boreholes) of Lehurutshe are discussed in terms of the quantity and quality of their water yields. Water provision and water use are assessed and observations made about water management in Lehurutshe in the context of shifting hydropolitical objectives in South Africa.

**Keywords:** Lehurutshe, surface water resources, groundwater resources, water management

## Introduction

In the north-western corner of South Africa, bordering Botswana, lies a piece of land that has been occupied for at least the past 300 years by the Bahurutshe, a section of the Tswana people. During the apartheid period this hilly terrain, covering just over 250 000 ha, formed a block of the Bophuthatswana homeland and was named Lehurutshe 1 District (Bophuthatswana Region Planning book, 1974b: Map 4.1). It is now part of the Zeerust district of the North-West Province and is situated on the western side of the semi-arid Bushveld and Bankenveld of the Marico region. Figure 1 indicates where Lehurutshe is located in relation to the Zeerust district, the Crocodile (West) Marico Catchment (one of 19 catchments identified in South Africa) and the rest of South Africa.

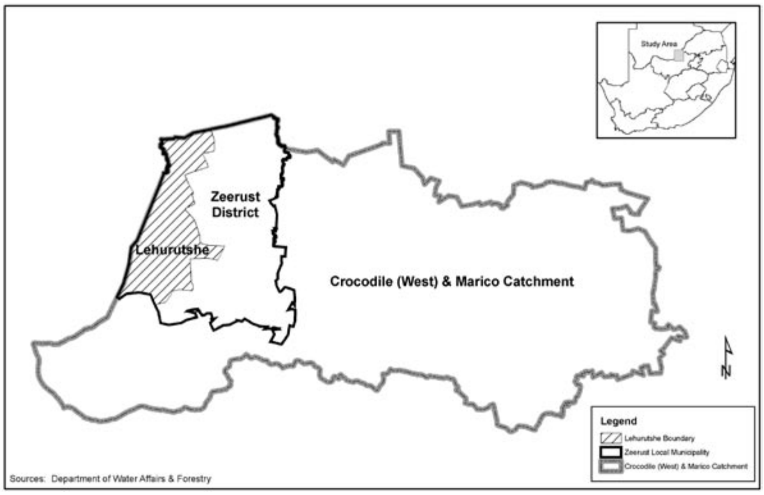


***Figure 1***
*Location of Lehurutshe*

The western part of South Africa, where Lehurutshe is located, is arid to semi-arid, receiving rainfall in the summer months when the evaporation rates are at their highest. Lehurutshe has a mean annual precipitation (MAP) of approximately 560 mm (Department of Water Affairs, 1986) and the evaporation rate of 1 600 to 1 800 mm/a (Barnard, 2000) exceeds rainfall by about 300%. Because of the high evaporation rate and the porous nature of the terrain the mean annual runoff (MAR) is very low, only about 3.1% of the precipitation (Department of Water Affairs, 1986), which is among the lowest conversion rates in the world (Turton et al., 2003). Drought statistics show that between 1920 and 1984 relatively severe droughts occurred for 22 years out of 65, i.e. about one year in every three on average, in the Lehurutshe area (Department of Water Affairs, 1986).

Water is the most fundamental and indispensable natural resource. As a result of the growing world population and the drop in the renewable freshwater supply per person (Turton et al., 2003) there has been an increasing awareness of the value of water resources, which has also led to a readjustment of priorities with regard to water supply. Since the 1970s, when the Mar del Plata Action Plan and UNESCO's first International Hydrological Programme were adopted (Department of Water Affairs, 1986), the global focus has been on the efficient, equitable and sustainable use of water. Wise management of water on a global, regional, national, local and individual basis is of the utmost importance.

When one looks at the water situation in South Africa, it becomes clear why the country's water resources are so precious. Located in the drought belt of the globe South Africa has very limited water resources and is ranked as one of the twenty most water deficient countries in the world (Ashton & Haasbroek, 2002). The country does not have sufficient freshwater nationally to meet current and future needs and is expected to reach the limit of its economically usable land-based water resources sometime between 2020 and 2030 (Allan, 2002; Ashton and Haasbroek, 2002). At the start of the new millennium

* To whom all correspondence should be addressed.
☎ +27 18 2991594; fax: +27 18 2994254;
e-mail: gskjadp@puknet.puk.ac.za
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projections were made that there would be a 51.7% increase in the demand for water in South Africa by 2030 and that at least 7 water basins would be in deficit and would not be able to meet their water budgets (Turton et al., 2003). Although water optimists argue that 'virtual water', as effective operational solution in the hydro-politics of semi-arid regions, can ameliorate strategic water deficits (Allan, 2002), it is self-evident that the use of the available water resources must be optimised, even more so in semi-arid and arid regions. Water is, according to the then South African Minister of Water Affairs and Forestry, Ronnie Kasrils, 'the very foundation upon which social, political and economic stability is based' and access to water resources is a strategically important issue for South Africa, because of its impact on economic growth potential, community health and ecosystems (Kasrils, 2002). Water scarcity is regarded as potentially the most limiting factor in national development in South Africa.

The Mar del Plata Action Plan states: 'To improve the management of water resources, greater knowledge about their quantity and quality is needed' (cited in Department of Water Affairs, 1986). Sami and Murray (1998) also emphasise that the accurate quantification of all the available water resources, including surface water, groundwater and springs, is a major factor in rural water management. This article provides a summary of the water resource and water demand data available for the Lehurutshe district, attempts to catalogue how the water status of the Lehurutshe district changed over the past 30 years, and discusses some water management issues flowing from this information.

## Water resources in Lehurutshe

Lehurutshe forms part of the Limpopo-Olifants drainage system and all its rivers and tributaries drain northward (Middleton et al., 1982). One of the two bigger rivers, the Marico River, of which the western tributaries stretch into Lehurutshe, drains into the Limpopo River (Primary Drainage Region A) and the other, the Notwane River, drains away into Botswana. This region is part of the recently demarcated Crocodile (West) Marico Catchment. The location of major water resources in Lehurutshe, including rivers, constructed dams, pans, aquifers and dolomitic eyes, is indicated in Fig. 2.

A summary of data on water resources in Lehurutshe is provided in Table 1, which gives an overview of the different types of water resources, the estimated quantity of available water, and water quality.

The following information and comments supplement the data contained in the table.

### *Surface water*

- None of the rivers in Lehurutshe are of major magnitude. The mean annual runoff (MAR) of the Marico and Notwane Rivers represents less than 5 $m^3/km^2$ of the district, but the runoff rate of the seasonal rivers in the district is not established, because none of the smaller rivers contain gauge stations (Fernandez, 2004).
- The three major constructed dams in Lehurutshe are not particularly large, are not unique in biodiversity and have a low ecological status. Their water is used mainly for agriculture and domestic purposes in the villages, and only to a very limited extent for industry and recreation (Fernandez, 2004; Mangold et al., 2002). A rough estimation based on current sedimentation rates indicates that complete sedimentation of the dams in the Lehurutshe district will be reached in approximately 250 years. No inter-basin transfer of water currently occurs within the district, but the Department of Water Affairs and Forestry (DWAF) has considered pumping water from the nearby Molatedi Dam.

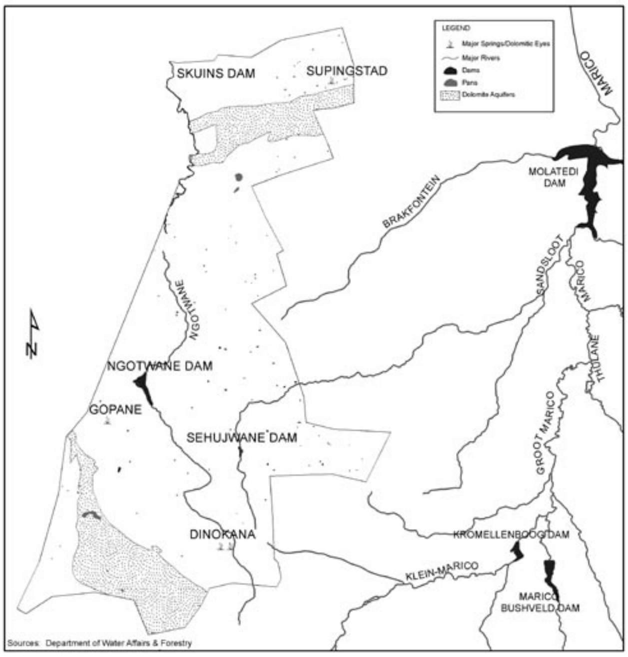


**Figure 2**
*Major water resources in Lehurutshe*

- A large number of earthen dams, constructed by mechanically creating an embankment of soil to concentrate runoff water in a dam, have been constructed to provide water supplies for the dry winter months (Propp, 2001). Available satellite images do not give an accurate indication of the number of earthen dams, because their resolution is too low to pick up all the smaller dams in dry periods, but they show that in wet periods some of these dams cover quite a large surface area.
- The pans in the district form part of the Plateau Wetland Group and most of them are closed pans with no outlet. When inundated, the temporary pans are ecologically significant, because they are inhabited by a variety of unique aquatic invertebrate species and birds (Mangold et al., 2002).

### *Groundwater*

- In Lehurutshe groundwater constitutes the most reliable and major water resource. A large reservoir of subterranean water, in the form of fractured aquifers and dolomitic compartments, occurs in the Lehurutshe district and parts of the district (e.g. Dinokana, Braklaagte and Serake in the south-west and Supingstad in the north) have hydrogeological potential. Since the aquifers are semi-confined, the pressure in the aquifer exceeds that of the general air pressure outside and causes groundwater to rise in a borehole or spring.
- Although the chemical composition of the groundwater may not be optimal for domestic use and successful livestock production (Water Research Commission, 2000), groundwater is of critical importance for rural communities in the drier regions and often the only available water resource (Ashton and Haasbroek, 2002; Middleton et al., 1982). Inhabitants of several villages (e.g. Dinokana, Lehurutshe, Mosweu, Ntsweletsoku, Gopane, Witkleigat, Serake and Supingstad) rely on either dolomitic eyes or borehole water for human


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consumption and stock-watering. Pumping more groundwater from the northern compartments of the Zeerust/Mafikeng/Lichtenburg dolomitic series into the Lehurutshe district has been considered by DWAF.

- There is difference of opinion about the recharge rate of groundwater in this district, but it seems to be generally rather low. The recharge rate of the Dinokana, Braklaagte and Serake aquifers is approximately 8.1 to 32.0 mm/a (Mangold et al., 2002: Map 14), but the recharge rates of the other Lehurutshe aquifers are uncertain (Fernandez, 2004). Currently, detailed studies that will reveal the available yields of the aquifers, ascertain the effects of tapping from groundwater resources on the physical and socio-economic environment of the region, as well as determine how to sustain the balance between linked aquifers, are under way (Tsolo, 2004).

### Water demand and stress on groundwater resources in Lehurutshe

During the 1970s and 1980s there was a sharp increase in the water demand of the Lehurutshe district. In terms of the former South African government's policy of separate development Bophuthatswana was demarcated as the ethnic homeland of the Tswana people and received self-government in 1972 and 'independence' (recognised by South Africa only) in 1977. It was the function of the homelands to accommodate 'surplus' Black people not needed for labour in the urban and rural areas of 'White' South Africa. A massive programme of relocation of Black people to the homelands caused the rapid increase in the size of the population of Lehurutshe.

**TABLE 1**
**Water resources in Lehurutshe**

| Type of resource | Number in Lehurutshe district | Major examples | Estimated quantity of potential water yield | Water quality |
|---|---|---|---|---|
| | | | **Surface water resources** | |
| Rivers | 227 waterways | Marico River tributaries<br>Notwane River | 9.5 x $10^6 m^3$ (MAR of the two biggest rivers). MAR of smaller rivers not gauged. All the smaller rivers are non-perennial, irregular and strongly seasonal. | Good. No industrial pollution. Some nitrogen pollution from cattle kraals. |
| Wetlands | None | N.A. | N.A. | N.A. |
| Pans | 6 | -- | Average size 8 ha. All pans are non-perennial, not reliable water sources. | -- |
| Dams<br>- constructed | 3 | Notwane Dam (Skuinsdam)<br>Lehurutshe Dam (Ngotwane Dam)<br>Sehujwane Dam (Lehujwane Dam) | Area: 67.10 ha. Capacity: 1272 x $10^6 m^3$ (1986)<br>Area: 401.28 ha. Catchment size: 495 km². Capacity: 19530 x $10^6 m^3$ (1996). Assured yield: 2 x $10^6 m^3$/yr (2004).<br>Area: 70.28 ha. Capacity: 4101 x $10^6 m^3$ (1982). Assured yield: 0.9 x $10^6 m^3$/yr (2004). | Variable. Mud a problem when water levels are low. |
| - earthen | 225 (1968) → 117 (1984) | -- | Area: 567.9 ha (2001). Capacity unknown. | |
| Reservoirs | 18 (1968) → 16 (1988) | -- | Unknown. | -- |
| | | | **Groundwater resources** | |
| Dolomitic eyes and springs | Unknown | Eye of Dinokana<br>Gopane<br>Rietgat<br>Supingstad | All springs: 4227 x $10^6 m^3$/yr (1973 estimation). Flow of springs ranges from 7 ℓ/s to 146 ℓ/s (2002 statistics). | Variable. Typically alkaline (pH 7.5-9.3) containing magnesium and calcium carbonates. |
| Boreholes | 135 (1973) | -- | Average depth: 52.12 m. Average yield: 0.9 ℓ/s. Potential capacity: 1127 x $10^6 m^3$/yr. Recharge rates: 9-95 mm/yr.<br>Most of the boreholes have been reliable in their yield | From very pure in quartzite aquifers to variable in shale aquifers. Often high concentrations of dissolved salts and minerals. |
| Wind pumps | 100 (1968) → 84 (1988) | -- | Unknown. | Same as for boreholes. |
| TOTAL | -- | -- | 25255 x $10^6 m^3$ water available in Lehurutshe district (1980 calculation). | |

*Sources: Anon., 2004; Barnard, 2000: 37; Bophuthatswana Region Planning Book, 1974a: 5; Bophuthatswana Region Planning Book, 1974b: Map 4.3; Department of Water Affairs, 1986: 3; Fernandez, 2004; Mangold et al., 2002: 10, 11; Midgley et al., 1994: Map 0.1.*

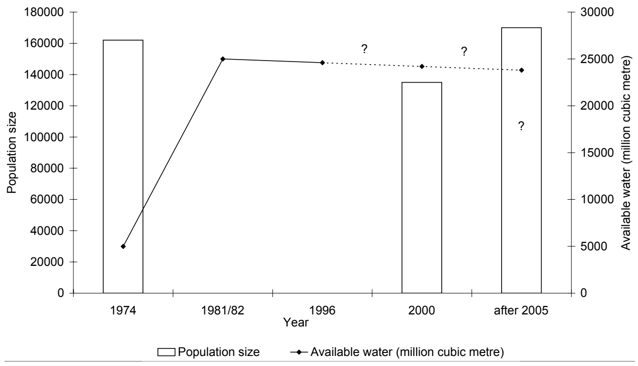


***Figure 3***
*Size of population in relation to available water*

Because of the increase in the population density a high demand was placed on the available natural resources, including water (Van Brakel, 1981). In the early 1980s it was predicted that the demand for water in the Marico catchment would rise from about 50 x $10^6$ $m^3$/a in 1985 to about 97 x $10^6$ $m^3$/a in 2000 (Van Brakel, 1981), in other words it would almost double. It was, however, calculated that water supply did not constitute a crisis, because there was 25 255 x $10^6$ $m^3$ water available in the Lehurutshe district, which would last for about 250 years. Water supply for Bophuthatswana, which was the responsibility of Bophuthatswana's own Department of Water Affairs between 1977 and 1994, nevertheless received special attention and relatively large waterworks were undertaken in the Marico River catchment to provide water services to an increasing population (Van Brakel, 1981).

After the political transition of 1994 Bophuthatswana was reincorporated into a united South Africa. Because apartheid influx control measures were lifted a net outflow of people from Lehurutshe occurred during the 1990s, but the slight decrease in population has not significantly relieved the pressure on water resources. Figure 3 shows the size of the population in Lehurutshe in relation to the available water.

Water shortages are a reality with which the local people have lived for some time. Especially in the dry winter months, when the rivers have run dry, the inhabitants of the district find it hard to provide water for themselves and their animals (Propp, 2001). Although the human population of the Lehurutshe district has now stabilised, it is expected to increase again due to the construction of the new N4 Platinum Highway, regarded as the gateway to Botswana and Namibia, running through the southern part of the district. Should there be a significant increase in the human population, water provision will become a serious problem.

The level of water demand has put stress on particularly the groundwater resources of Lehurutshe. In the 1980s the estimated mean annual groundwater extraction in the district in relation to mean annual total available water was regarded as low (Department of Water Affairs, 1986: 3.39 Figs. 3.8.2, 3.43 and Fig. 3.8.4). It was estimated that water yield from underground resources could be increased considerably without any damage to the resource if increased abstraction was done with the necessary caution (Van Brakel, 1981). However, the situation has deteriorated over the past 25 years. It has been speculated that because of groundwater abstraction the level of the aquifers has dropped by as much as 12 m in the last 15 years and that the total yield of all the dolomitic eyes and boreholes has decreased by up to 60 000 ℓ/s. Some smaller springs have ceased flowing in recent times (Fernandez, 2004; De Beer, 2006).

There is another danger associated with excessive groundwater abstraction. Because of dewatering of the fracture zones, they may collapse due to the high pressure, which may close off access to the groundwater resource. Therefore, the yield of springs and boreholes may decrease if it is pumped above its sustainable yield (Barnard, 2000). Many rural water supply schemes have failed as a result of the over-abstraction of groundwater from single springs or boreholes (Sami and Murray, 1998).

There will be a continued emphasis on the exploitation of groundwater resources to cater for the increasing water demand of the rural population of Lehurutshe, because owing to low population density, high cost and lack of surface water resources it is unlikely that water reticulation schemes distributing surface water from large impoundments will be installed in remote areas (Meyer, 2002).

## Major water management challenges

South Africa's Department of Water Affairs and Forestry (DWAF) and the local councils face serious constraints in providing water to the Lehurutshe district. Because water is used primarily for domestic and agricultural (stock-watering) purposes in Lehurutshe, water management challenges linked to these two types of water use are analysed below.

### *Domestic use*

Two of the principles of the current South African water policy, which relate to water supply for domestic use, are that:

- There should be an equitable distribution of water resources and every person should have access to sufficient clean water
- Human and ecological flows are prioritised over flows to industry and agriculture. These principles are in line with one of the UN's Millennium Development Goals (MDGs), which is aimed at reducing by half the number of people in the world without access to safe drinking water by 2015.

In terms of the quantity of water supply for domestic use the situation in Lehurutshe seems to be satisfactory. The mean domestic water consumption in Lehurutshe is currently calculated at 100 ℓ/cap·d for house connections, 50 ℓ/cap·d for yard connections, and 15 ℓ/cap·d for standpipes (Fernandez, 2004). In view of the fact that the majority of village inhabitants still rely on standpipes, average water consumption is probably not far out of line compared to the government's guideline of 25 ℓ/cap·d (DWAF, 2003). Thus, the available quantity of water in Lehurutshe does not seem to be a major problem. To deliver proper water services, i.e. to take the water to the people, is currently a bigger challenge.

Water authorities face the following challenges linked to domestic water supply:

- **Distance from water**: Currently the ideal is that water should be supplied at a distance of no more than 200 m from its users, but boreholes are sometimes as far as 1.5 km and even further away from the furthest points which they serve in villages. The daily trek to fetch water is a cumbersome fact of the lives of many of Lehurutshe's people (Propp, 2001).
- **Water quality**: The majority of the rural inhabitants of Lehurutshe are among the 6 to 7 million South Africans who still rely for domestic water on open streams, boreholes or stagnant sources and who are exposed to the dangers of pollution and water-borne diseases (Schreiner et al., 2002).


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- **Geographical constraints:** The rocky soil necessitates expensive blasting operations to lay water pipes and the undulating landscape often requires water to be pumped uphill.
- **Demographics**: The balance of water provision between the densely populated east and the sparsely populated west is problematic (Anon, 2004).
- **Maintenance of infrastructure**: During the Bophuthatswana period a lot of money was invested in infrastructure (dams, pipelines, boreholes, water tanks, etc.) to try and make the homeland viable. Although the water supply infrastructure in the district is still generally in a reasonable state, it is deteriorating. Local communities do not always have the knowledge, tools and other resources to repair damaged water pumps and breached earthen dams (Propp, 2001; Anon, 2004; Fernandez, 2004).
- **Cost-recovery**: In terms of current government policy, users are expected to pay for the service of water provision, but in reality rural households are often unable or unwilling to pay high tariffs for water. Expensive gravity-fed water schemes may therefore not be viable. A pre-paid dispensing system is in place in some villages, but proper water consumption monitoring systems are not yet in operation in the remote parts of the Lehurutshe district. Illegal connections to the water supply network are a problem in villages such as Dinokana (Anon, 2004).

If service delivery is improved, which in itself constitutes progress, it would create new water supply challenges, because water consumption will rise. Where house connections are installed water consumption per capita is about seven times higher than when people have to fetch water from standpipe connections. Better service delivery thus will have implications for water provision, which must be taken into account in the water management planning process.

### *Stock-watering*

The most vexing issue in terms of water management in rural Lehurutshe is stock-watering. For centuries the culture of the Bahurutshe has centred on the ownership of cattle. Today the main economic activity in Lehurutshe still is extensive livestock farming. In environmental terms the centrality of cattle has unfortunately resulted in massive over-stocking, which has caused serious and in some cases irreversible land degradation. Warnings that the balance between the carrying capacity of the land, the availability of water, and stock numbers should be maintained, have been sounded for many years (see e.g. Republiek van Suid-Afrika, 1970). These warnings have often not been heeded and stock numbers have steadily increased, putting enormous stress on the limited natural resources of this semi-arid region. From the side of the authorities it is not always easy to control the situation, because of the age-old system of communal land tenure and communal grazing rights. It may also be that the political will to control stock numbers is absent, because the government do not wish to alienate the traditional leaders and their supporters (Allan, 2002).

It is the policy of DWAF that emerging farmers should receive sufficient water supplies. The question is whether the type of extensive non-commercial livestock ‘farming’ (many of the cattle owners can hardly be called farmers) that is predominant on the communal lands controlled by tribal authorities is really viable in the long run. Water use for stock-watering on the communal lands may be equitable in the sense that water is supplied for the livelihood needs of the rural poor. Allan (2002) rightly points out that water for livelihood is a major issue for communities living in poverty and is as emotionally significant to them as drinking water.

However, water use for stock-watering on the communal lands is not efficient, because the meagre outputs do not justify the stress put on water resources. Quite a large amount of water, about 45 ℓ of water per day per large stock unit and 4.5 ℓ/d per small stock unit, is needed for stock-watering (Van Brakel, 1981. See also the water demand maps in Department of Water Affairs, 1986). Very little economic value in the form of income generation is added in this type of agricultural activity. Even in commercial farming, which ought to be much more cost-efficient than farming on communal lands, 16 times more water is required to produce 1 kg of meat than 1 kg of wheat. Livelihood water in areas such as Lehurutshe can require up to a thousand times the volume needed for drinking water. It has been suggested that one of the solutions to the water shortage would be to change patterns of food consumption by decreasing the consumption of animal products. The ideal situation would be that the productive capacity of farmers in better endowed regions should provide the food security of water deficit regions (Allan, 2002).

Water use for stock-watering on the communal lands is also not sustainable. The dangers of over-abstraction at boreholes were mentioned before. But water is not the only natural resource that is affected by livestock farming which is not efficiently managed. Overstocking and overgrazing are putting tremendous strain on the soil and plant resources and cause land degradation, which in some areas of the Lehurutshe district has reached a point of no return where rehabilitation cannot restore the land.

Against this background water shortages may, in some cases, be a blessing in disguise for sustainable natural resource management. If water supplies were more abundant, cattle numbers would further increase, which would put even more stress on other natural resources, such as soils and grasses. Thus water shortages may act as a control measure to keep stock numbers in check. In fact, during fieldwork in Lehurutshe, we have often seen instances where shortage of water has restricted stock numbers and protected the natural grasslands from overgrazing.

National hydro-politics should mediate between the needs of society, the economy and the environment. Allan (2002) states that the health of society, the economy and the environment require that water is used in ways that reflect its value in the economy and the environment. In Lehurutshe considerations of economic viability and environmental sustainability seem to have been dominated by considerations of social acceptability related to cultural traditions. Because the possession of cattle has for so long been central to the social organisation of the Bahurutshe, it may require a lot of time to increase the social acceptability of the reduction of the number of cattle owned by people not involved in commercial farming.

## Towards solutions for water management problems in Lehurutshe

How should the current pattern of water use and water provision in the Lehurutshe area be assessed in terms of the broader objectives of South African water policy? If this pattern does not conform to the international and national criteria with regard to the efficient, equitable and sustainable use of water, what should and could be done? Possible solutions are suggested below, taking into account South African water policy, as reflected in the Water Services Act (Act No. 108 of 1997), the National Water

Act (Act No. 36 of 1998) and policy documents of the Department of Water Affairs and Forestry (see DWAF, 2003).

In terms of groundwater management two water policy principles are relevant, i.e.:

- That water should be used carefully, sustainably and productively
- Better management and monitoring of groundwater resources will be carried out in the framework of catchment management plans.

In Lehurutshe, which is so dependent on groundwater resources, the prevention of the long-term deterioration of the groundwater system is crucial. Groundwater, as a strategic resource in drier regions where its use is a cost-effective method of meeting essential water needs, is vulnerable to poor management and in South Africa the control over the use of groundwater resources is not yet what it ought to be. The key criteria for the management of groundwater are beneficial use, economic efficiency, equity and the protection of the resource base (Lazarus, 1998). Not only for the protection of the available groundwater resources, but also for the protection of other natural resources, the sinking of more boreholes in Lehurutshe should be approached with great caution. In terms of DWAF policy all new boreholes must be registered and groundwater resources must be used in the context of a catchment management plan overseen by a catchment management agency (CMA). Proper monitoring and management of existing boreholes are required to optimise borehole pumping rates, prevent over-utilisation and prevent groundwater contamination from surface sources (Kundhlande et al., 2004).

Various types of solutions to safeguard groundwater resources in Lehurutshe ought to be considered:

- The 1st type of solution would involve the reduction of water consumption for agricultural purposes, and specifically stock-watering. This can only be done sustainably by reducing the number of people directly relying on the land for a livelihood. Laker (2004: vii) correctly assesses the situation: 'Efficient resource use and alleviation of rural poverty is not possible in over-crowded rural areas. Thus, creation of the maximum job opportunities in other economic sectors, to draw as many people as possible away from being dependent on the land for survival, is imperative.' But what should happen to these people and their livelihoods? They cannot simply be relocated to urban areas in order to try and reverse the effect of the homeland policy. That would simply mean the relocation of poverty to urban areas that can no more than the rural areas provide job opportunities and livelihoods to these people. The fundamental problem is not really that the human population density in Lehurutshe is too high for such a semi-arid region to support sustainably, but that a too high proportion of the population possess cattle. This places a double burden on the natural resources to sustain both the people and their cattle. Urgent consideration of other livelihood options in Lehurutshe must now receive attention. This will be difficult, because it will induce cultural changes, and it will require firm political will from the leadership, but without tackling it with resolve the chances of successfully addressing the emerging water crisis will remain slender.
- A 2nd type of solution would be for those sections of communities that remain involved in farming to implement best agricultural practices to facilitate improved water management. Soil conservation, including combating soil erosion, is an important element in a district such as Lehurutshe, where overgrazing and cultivation have caused land degradation. Extension and soil conservation officers should make the farming communities aware that the pastures and even the yards of homes in the villages should be covered with vegetation. They should also be taught that, where soil erosion has denuded the land, the amount of runoff can be decreased and slowed down by using a variety of methods, e.g. using branches and stones to obstruct the free downhill flow of water, ripping the soil, or re-establishing grass cover. These methods would also improve water infiltration into the soil and ultimately to the aquifers. Soil cover also lowers the evaporation rate of an area.
- A 3rd type of solution would be to investigate the feasibility of different water- saving and water-harvesting techniques in the particular conditions that prevail in Lehurutshe. There are several methods to save or harvest water, e.g. recycling water by using bath/grey water to irrigate the garden, collecting rain-water from the roof of structures into a container, and collecting dew with plastic bags spread open over a hollow and collecting the resulting condensed water in a container. Infield rain-water harvesting systems hold exciting possibilities as a possible method to supplement the water supply (see Kundhlande et al., 2004), but research on its viability has not yet been done for this region.

The process to implement the government's water policies has been set in motion in this region. The establishment of the Crocodile (West) Marico CMA has been approved and the appointment of the advisory committee to assist the Minister of Water Affairs and Forestry with the identification of stakeholders to serve in the governing board of this CMA is imminent (DWAF, 2006).

## Environmental awareness and individual responsibility

In the final analysis provision of water is a local affair. A principle of South African water policy, which brings water management closer to the people, is that the responsibility for water services is vested in local government. Even if the state showed the political will to implement its water policies, it would still be difficult to effect change without the cooperation of local communities. Progress is being made towards the enhancement of the social adaptive capacity to improve water demand management in South Africa (Ashton and Haasbroek, 2002). DWAF set out to establish village level local water committees. Some of these are becoming well established, but in many villages the local bodies that should carry out the water provision task are non-existent (Anon, 2004). In the end the effective implementation of measures to ensure the optimal management of water resources is a matter of self-management by communities.

One of the major challenges is to change the attitude of the inhabitants. It may be true that the responsible authorities endeavour to devise plans to relieve the water scarcity in the district, but unless each person takes responsibility to save, and not just use less water, government will be hard-pressed for answers. Effective local water management can only be realized if individuals take personal responsibility for sustainable water use. Ways in which to conserve and optimally use the amount of water available to each person must in the final analysis become individual responsibility.

Personal responsibility is linked to awareness. Therefore the importance of education as a tool towards improved water management cannot be overemphasised. Through the available



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channels of communication (the schools, TV, local radio stations such as Motsweding, local magazines, etc.) people should be taught all about the water cycle, how groundwater sources are recharged, and how they individually can save water. In order to know the extent to which one must save water, one must know what is available per person, and how the whole water cycle is influenced by the use of water. Because government officials do not have the capacity to keep all the communities in the remote areas informed representatives of the village level water committees ought to be trained in aspects such as the provision and maintenance of water supply structures. If local knowledge of water issues is enhanced and local participation in water management is increased a solid foundation for the sustainable management of the scarce water resources in Lehurutshe, outlined in this article, will have been laid.

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