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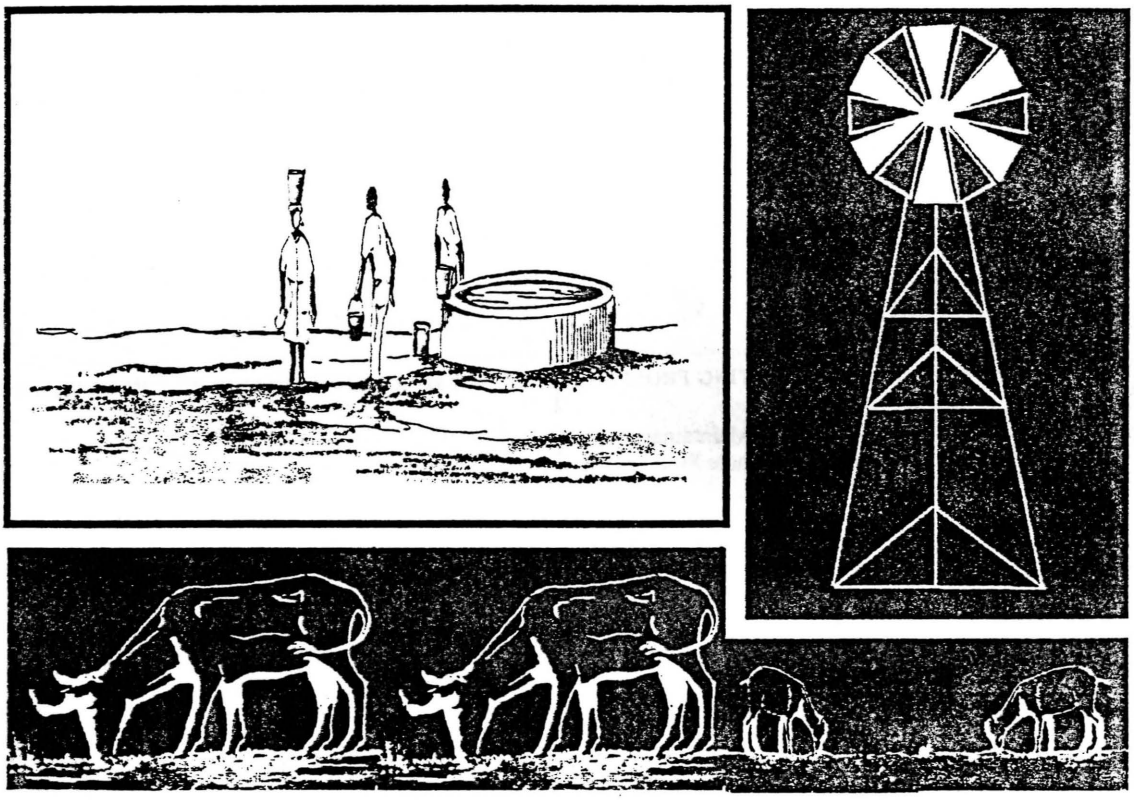
SUMMARY

A Retrospective Study of the Environmental Impacts of Emergency Borehole Supply in the Gam and Khorixas Areas of Namibia.

Conducted by the 1996/97 Masters group of the Department of Environmental and Geographical Science at the University of Cape Town, South Africa, under the supervision of the Environmental Evaluation Unit, UCT.



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PURPOSE OF STUDY AND TERMS OF REFERENCE

The 1992/93 drought period provided a flow of foreign aid to Namibia's rural water supply development programme, mainly through the construction and renovation of boreholes, pipelines and water canals. Borehole construction also occurred in the Gam district during 1993/94 as part of the repatriation of Herero people from Botswana. There is a deficiency of documented knowledge regarding the environmental impacts of borehole provision in arid and semi-arid areas and consequently little clarity on environmental criteria by which to assess and guide future borehole provision programmes in Namibia. This study was commissioned to begin to address this situation and its main terms of reference were:

- to briefly review, at the national and regional level, the relevant climatic, demographic, political and socio-economic characteristics of Namibia;
- to present an overview of Namibian water resources, water supply policy - in particular, rural water supply policy - and land use patterns;
- to present a review of emergency borehole supply policy;
- to identify and evaluate the ecological, social and economic impacts of emergency boreholes in the two case study areas; and
- to provide, on the basis of the above, recommendations and guidelines on borehole provision.

METHODOLOGY

Methods used to gather information included the following:

- Literature review;
- Interviews with key stakeholders and informants, including relevant informants from government and non-government organisations, aid agencies and relevant researchers;
- Field work in the two study areas included observations, informal interviews with people from communities using boreholes, and the use of Participatory Rural Appraisal techniques (PRA).

BACKGROUND INFORMATION

Political History

Namibia was proclaimed a German protectorate in 1884. During the period 1884 to 1908 the German settlers fought a number of wars with the indigenous peoples, especially the Hereros and Namas. A great number of the Hereros who survived fled into Botswana. The descendants of these Hereros are now involved in the Namibian repatriation programme from Botswana to Gam. As a result of the recommendations of the Odendaal Commission in 1964, Namibia's agricultural sector is divided between a commercial, mainly "white" sub-sector of farming and animal husbandry, and a large "black" tradi-

Ephemeral Rivers flow only after strong rains have fallen over their catchment area. In contrast to the perennial rivers along its borders, rivers which originate within Namibia are all ephemeral. For most of the year these Namibian rivers are dry, sandy channels. Ephemeral surface water, in the form of large reservoirs which store seasonal flood waters, supply 20% of Namibia's total water demand. Although the utilisation of surface water close to the point of demand tends to be the cheapest way of providing water, a number of factors hamper effective planning and management of Namibia's surface water resources (DWA, 1993).

Groundwater resources provide approximately 57% of Namibia's water demand and it is estimated that the country has 32 000 boreholes. Nevertheless good groundwater sources in Namibia are the exception rather than the norm and nearly 80% of these boreholes are considered to produce a yield not suitable for the purpose for which they were drilled. The occurrence and recharge of groundwater depends on a combination of sufficient rainfall and favourable hydrological conditions. To avoid the "mining" of aquifers, water should not be removed at a rate faster than it is replaced by these natural processes, as this unsustainable use will result in the aquifer drying up (Jacobson, *et al.*, 1995).

As a developing country, Namibia's demand for water can be expected to increase rapidly in the next few years. Information from the Department of Water Affairs (DWA) shows an expected increase in the utilisation of perennial rivers of 170%, as compared to 78% for ephemeral rivers and 8% for groundwater in the next 15 years. The major water sources present in the interior of the country are virtually fully exploited and Namibia will clearly have to rely on long-distance water transfers from perennial rivers to meet future demand.

The increasing pressure to extend water to the rural areas presents a continuous challenge for Government (NPC, 1995). To meet this challenge, the rural supply policy was formulated within the framework of the WASP (Water and Sanitation Policy). The general objective of this policy is to accomplish user ownership and responsibility for operation and maintenance by the local communities. To achieve this, elected water committees are being established countrywide to take overall responsibility for their water points (Koch, pers. comm.). It is envisaged that in the long term, the DRWS should play the role of a facilitator rather than a provider of water. To date, rural water supply is still the full responsibility of the DRWS, and is largely subsidised.

The Water Act No. 54 1956, which is administered by the Department of Water Affairs is the principal legislative tool for all aspects of water management in Namibia including the regulation of borehole drilling. The drafting of a new Water Bill is underway to replace the 1956 Act. It is envisaged that this new Bill will take cognisance of the principles of WASP, and thus provide a broad framework for sustainable management of water resources in Namibia.

Land use in communal areas

In pre-colonial times, settlement was confined to areas of reliable water. Traditionally, in the southern and central areas, people followed scarce water and grazing resources. In the north, communities were more settled, but at the end of the wet season, as accessible

tional sub-sector that is subsistence orientated and operates at a low technological level. Independence from South Africa was formally declared on 21 March 1990 (NPC, 1995).

Climate

Namibia's climate is arid to semi-arid, with low, variable rainfall, high evaporation rates and frequent drought periods. These climatic extremes contribute to a unique and extreme hydrological cycle. It is estimated that on average 83% of the total rainfall evaporates shortly after precipitation, 17% is available as surface runoff, of which 1% recharges groundwater sources and 14% is lost through evapotranspiration. Only 2% remains available for surface storage (DWA, 1991).
Namibia needs to take cognisance of the fragility and limitations of her environment. This is especially relevant in the planning, management and implementation of development in the rural areas. It is in these areas where people are particularly vulnerable to the effects of environmental degradation.

Demography

Namibia's estimated population for 1995 was 1.61 million, growing at a rate of approximately 3% per year (Central Statistics Office, 1994). Population densities within the country vary enormously with 60% of the population living in the northern districts where population densities may exceed 100 people per km^2. Only 7% of the population live in the southern areas where population densities can be as low as 0.5 per km^2. At present the estimated 68% of the population living in rural areas are experiencing rapid urbanisation.

Economy and Reliance on Agriculture

Namibians are largely dependent on the environment for their livelihoods. In addition, a significant proportion of both formal and informal economic activity depends on the ecological production and integrity of the environment (NPC, 1995). The overall contribution of the agriculture sector to the GDP is 10.5%, of which less than 3% is derived from subsistence agriculture (UNDP, 1996). The main environmental constraints confronting the development of agriculture in Namibia are the threat of drought, overgrazing, bush encroachment, soil erosion, and desertification.

Agriculture can be seen to play an essential role in the livelihoods of rural households, particularly for the poorest, who have least access to off-farm incomes (*ibid.*).
Agriculture's contribution to rural livelihoods, particularly in the communal-tenure areas, is much more significant than the GDP suggests. As much as 70% of the population is directly or indirectly dependent on agriculture, with the agricultural sector accounting for 27% of private sector employment.

Water Resources and Demand

Namibian water resources can be divided into three major categories: -
Perennial rivers supply 23% of Namibia's water demand, however, this is mainly to villages and towns close to these sources. The water utilised by Namibia from the perennial rivers which flow past the country is less than 0.1% of their combined annual runoff (DWA, 1991).

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surface water and grass diminished, livestock were herded to more distant grazing areas (Ashley, 1994).
With the dispossession of land and the creation of native reserves by the Odendaal Commision, these traditional land use practises came under increasing pressure and changed. In the northern higher rainfall areas, mixed dryland farming on a subsistence level is the predominant system, whilst in the remainder of the communal areas grazing systems still predominate (Seely *et al.*, 1995). In many areas, forms of migratory pastoralism are still practised, though much restricted compared to pre-colonial systems. Forced relocation due to colonialism and the erection of fences since independence have reduced people's ability to respond flexibly to a semi-arid environment.

Land Tenure

Land tenure and control over resources are important issues for people's ability to effectively manage their environment. As boreholes are resources that provide benefits such as access to grazing, communities need to be able to effectively manage them.

The legal status of land allocation and management in Namibia's communal areas is problematic. There are no regulating laws and traditional authorities no longer have the power or ability to effectively administer land tenure and administration. As a result, rural communities do not have secure, exclusive tenure over land and resources (Dewdney, 1996). This lack of clear tenure arrangements is a disincentive to long term planning and the sustainable use and management of resources (Jones, 1993). Lack of secure communal tenure is a major contributing factor to land degradation as people seek to maximise, individually their own benefit. This is at the cost of the long term sustainability of resource use and leads to competition amongst users (Dewdney, 1996).

Recent initiatives by the Ministry of Environment and Tourism will result in communities in communal areas being given rights to utilise and manage wildlife once they have formed a conservancy. This is a step toward community ownership of natural resources. However, for natural resource management to be effective, the nature of tenure over natural resources has to become more holistic (Shumba, pers. comm.; Dewdney, 1996).

Borehole Provision in Namibia

On unproclaimed State land boreholes in Namibia are provided as part of :-

- **Ongoing rural water supply development.**
- **Resettlement schemes.** The repatriation of Herero people, from Botswana to Namibia in 1994 required the urgent provision of boreholes to meet the water needs of returnees and their livestock in an area where there was no permanent surface water.
- **Drought relief programmes under the label of "emergency boreholes".** In 1992 and 1993 approximately 300 emergency boreholes were drilled and installed and another 50 non-functioning boreholes were rehabilitated (National Drought Task Force, 1993).

The provision of boreholes allows continued occupation of areas where water was previously absent. This can have definite ecological and socio-economic impacts.

Potential Positive Impacts of Boreholes

- Provided that certain criteria regarding the quantity, quality and manner of provision are met, access to a safe and adequate water supply in rural communities can have significant positive effects on the health of that community (see Table 1).

- The provision of water points can allow for the population of previously unoccupied areas (Jacobson *et al.*, 1995).

Table 1.Potential Positive Effects of a Safe and Adequate Water Supply

Primary Health Benefits	**Improved hygiene and sanitation leading to a decrease in water washed diseases.** **Safe water leading to a decrease in morbidity and mortality from waterborne diseases.**
Primary Effects and Opportunities	**Possibility of maintaining crops or a productive garden for commercial and/or subsistence benefit.** **Possibility of increasing livestock numbers.**
Consequent Secondary Health Benefits	**Better nutrition due to better food supply in terms of quantity, reliability and variety.**
Secondary Effects	**Increased income and financial independence leading to improved standard of living.**
Tertiary and Cumulative Benefits	**Socio-economic upliftment. Means to access education. Food security. Financial and social security. All these have a significant positive impact on community health status.**

Potential Negative Impacts of Boreholes

The provision of waterpoints in arid areas allows livestock numbers to increase, resulting in additional pressure on pastures and an increase in the potential for degradation of rangeland .

- People and livestock often settle permanently at water points regardless of current rains (sedentarisation) (Jacobson *et al.*, 1995). Farmers no longer respond flexibly to uncertain events and do not follow the natural seasonal variations in pasture and water availability.

- Loss of vegetation cover can lead to soil loss or degradation. Trampling by livestock renders soils more susceptible to wind and water erosion and to desiccation and oxidation. Persistent overtrampling and wind erosion will lead to the reduction and ultimate eradication of the seed bank that sustains the grasses (Seely *et al.*, 1994).

- Borehole provision can enhance susceptibility to future droughts, with stock maintained on land which should be rested to avoid degradation, and land users developing an expectation of the arid land which exceeds the realities of its naturally low and highly variable productivity.

- In communities where control over resources is weak or absent sedentary settlement may lead to competition and conflicts over resources.

- Furthermore, pasture degradation surrounding borehole settlements results in livelihood and subsistence losses to the communities. This places increased pressure on other sectors and on working relatives (Quan *et al.*, 1994).

- Possible increased urban migration would result in a further absence of able-bodied adults, particularly men, which would lead to a further decline in agricultural labour and affect management decisions, thus further undermining farm production and negatively affecting livelihoods and subsistence.

These issues relating to water provision and its positive and negative impacts were elaborated and illustrated in the two case studies of emergency borehole provision in the Gam and Khorixas areas.

THE ECOLOGICAL, ECONOMIC AND SOCIAL IMPACTS OF BOREHOLES IN TWO STUDY AREAS OF NAMIBIA

Two case study areas formed the focus for this research into the environmental impacts of boreholes and directed the investigation towards the relevant policies and processes which inform and guide borehole implementation in Namibia. In the first case study area, boreholes were installed as part of the emergency drought relief programme in 1992/1993. In the second case study area borehole installation was an essential part of the Herero resettlement programme at Gam.

KHORIXAS CASE STUDY

Background Information

The Khorixas area falls within the Kunene region in north western Namibia. This is an arid to semi-arid region which experiences localised, highly variable rainfall patterns and frequent dry periods. Groundwater supply is almost the exclusive source of water in the area and consequently, is highly sensitive to exploitation.

Human settlement and the kraaling of livestock in this area are determined largely by the location of functioning boreholes. Historically, borehole sites were restricted to areas of better grazing and easy access, rather than to areas of greater groundwater potential. This has resulted in low rates of successful borehole drilling, with the successful boreholes generally producing low yields (DWA, 1994).

Soils in the Khorixas area are thin and poorly developed. Livestock farming is the major economic activity of the area. Although traditionally hunter-gatherers, virtually all rural communities residing in this area now practice livestock farming, particularly with goats and cattle, as a form of subsistence and livelihood. Wildlife and veld-food sources have become inadequate to sustain a living (Malan, 1993). Due to limited employment opportunities, the majoriy of rural communities in the Khorixas area depend on the physical environment for their livelihoods. With an annual growth rate of 3.34%, the population of the southern Kunene Region is expected to double within the next 25 years. This is an important issue to bear in mind when considering future development and demand for water.

Two emergency water resource development programmes functioned in this area during the 1992/93 Drought Relief Programme. The Nigerian Government funded one and the other was funded by the United States Agency for International Development (USAID) and implemented by the International Medical Corps (IMC).

The Issues and Impacts Resulting from the 1992/1993 Drought Relief Programme in Khorixas

Environmental considerations were generally not taken into account during the emergency borehole provision programme. Little consideration seems to have been given to the economic sustainability of boreholes in terms of cost effectiveness, efficiency, reliability, and appropriateness of technology.

Water Supply and Maintenance Issues

- The Nigerian programme had exceptionally low success rates in providing useful boreholes. Of the 23 boreholes drilled, only 14 were installed. Of these 14, only four are delivering water, two of which are unfit for human consumption. The programme was poorly supervised and there appears to have been minimal accountability by either donors or geotechnical consultants, for the quality of work. Cost control does not appear to have been implemented. It is estimated that the programme cost approximately N$600 000 out of the total N$1.5 million provided. The balance does not seem to have been accounted for (Hoffman, 1993).

- During the IMC programme Environmental Certificate clearances were to be issued by the Ministry of Environment and Tourism (MET) before drilling of new boreholes. However, a general lack of capacity within the MET regarding relevant environmental criteria for siting of boreholes, hampered the effectiveness of this method of environmental control. The MET were only able to provide advice where obvious environmental damage could occur at specific sites. The first time an environmental assessment report (including an environmental baseline study) was prepared for a borehole installation project was in phase 3 of the IMC programme. Under the Nigerian programme, environmental implications of borehole siting were not considered.

- Prior to drilling in the Khorixas area, there appears to have been little or no consultation with the relevant stakeholders such as Government officers, local chiefs and headmen. It seems boreholes were sited arbitrarily and with a lack of participatory-procedures.

- A trend existed between what was observed in this study and what was reported by the IMC regarding borehole yields and numbers of people served. Generally the IMC report states that both yields and numbers were higher than what was observed on the ground. Correlating these observations to depleted groundwater reserves was not possible as no monitoring has occurred since installation. However, stepped pump testing of the boreholes drilled by the IMC did not seem to have take place (van der Merwe, pers. comm.), and hence the recommended installations and pumping rates could not have been based on accurately measured sustainable yields.

- Although the IMC had a good success rate of supplying emergency drought relief boreholes, some of these boreholes seem to have been installed in communities which already had a steady source of water. This raises a query on the procedures which were used to classify a drought relief borehole. The issue, however, could not be

clarified by either the IMC, Khorixas DRWS Regional office, or the communities involved.

- Maintenance conditions of boreholes varied widely. Although the responsibility for maintenance of boreholes falls under the Khorixas Regional DRWS office, the condition of many water points was often directly related to the attitudes of the community concerned. Attitudes to water conservation also varied considerably, with some villages making a concerted effort to stop leakage, while others seemed unconcerned over water wasted through leakage.

Biophysical Impacts

Boreholes drilled as temporary relief measures in the 1992/93 drought period are now being used on a permanent basis. This has, arguably, resulted in inappropriate farming and land use strategies in an arid area, and has increased stress on natural resources.

- Evidence of soil degradation was observed around boreholes. This could be as a result of heavy grazing, constant animal traffic and reduced vegetative cover. Perennial grass was absent around boreholes and trees and bushes showed signs of heavy browsing. The vegetation in the area is as much influenced by rainfall as by grazing pressure and therefore determining whether irreversible vegetation degradation has taken place, was not possible.

- Establishment of new stock posts through water supply provision has resulted in an increase in livestock numbers in some parts of the region which has increased pressure on the rangeland. Poor planning and siting of boreholes during emergency provision has exacerbated this.

- The Kunene region has a low groundwater potential, with groundwater reserves being restricted to secondary aquifers. As groundwater is the exclusive source of water in the region, unmonitored exploitation could increase the risk of water shortages.

- Most boreholes have been sited along drainage lines. Overuse of these boreholes could have negative impacts downstream as aquifers associated with these drainage lines are depleted. Furthermore, overuse of vegetation near boreholes combined with compaction of the soil by livestock may further contribute to decreasing water infiltration and ground water recharge rates. Requests for new boreholes are generally restricted to areas of good grazing potential, and to sites close to the communities, rather than to areas where a greater ground water potential may exist.

- It did not appear as if boreholes had affected adaptive farming strategies to a large extent, as farmers still moved in response to dry times. Thus, drought relief boreholes appear to be misdirected relief, as grazing problems are more pressing in the Khorixas area during droughts than water problems.

Socio-Economic Impacts

The installation of poorly planned water points in the Khorixas area, without proper consideration of their spacing, the availability of grazing on surrounding land and the changing patterns of grazing demand, has had both positive and negative socio - economic impacts.

- Provision of permanent water points has enabled settlements to develop where previously such areas were not habitable due to a lack of permanent water.

- Influxes of newcomers and their livestock into areas was found to cause problems which need to be addressed. This is especially the case in areas where there are conflicting land use practices, inequality of wealth and weak leadership structures. This results in competition over and increased pressure on limited resources, and provides a disincentive to manage these resources sustainably.

- In the Kunene region, the mobility, interconnection and composition of a community at a settlement varies over time due to their flexible livelihood. Thus, households and communities may not be clearly defined. Any systems (such as establishment of water point committees) imposed from outside without taking these factors into consideration are likely to fail.

- Borehole provision has led to an improved quality of life in some respects. Where infrastructure is adequate, health impacts of boreholes are generally positive. In the Khorixas area most of the IMC installations used closed plastic domestic tanks and provided separate facilities for people and livestock. None of these had significant bacterial contamination and hence, maximised the positive health impacts of providing water. Furthermore, the IMC's educational programme on rural health focusing on hygiene, sanitation, water use patterns, efficiency and sustainable borehole yields, has to some extent raised peoples awareness of these issues (Murowoa, pers. comm.)

- The Namibian Government is planning to implement a new cost-recovery policy for the maintenance of boreholes. However, it seems that little consideration has been given to the economic sustainability of boreholes in terms of cost effectiveness, efficiency, reliability, and appropriateness of technology.

Policy and Decision Making Issues

- The inability of farmers to have control over their land due to the lack of a clear land tenure policy that gives them exclusive and secure tenure to the communal lands can result in a disincentive to manage resources sustainably. Communities cannot control individuals or other communities who infringe on their traditional rights.

- Although the communities have benefited from provision of water supply through the 1992/3 borehole drilling programme, a full environmental impact assessment was not done. Consequently, this programme could have contributed to the vulnerability to drought of communities who were recipients of relief interventions.

- If planning for drought continues to be seen as a short-term, emergency measure, inappropriate and unsustainable responses and strategies will continue to be implemented. Boreholes that were drilled as temporary "relief" measures in the 1992/93 drought period are now being used on a permanent basis. This has increased stress on natural resources.

- Dependence on foreign aid in funding drought programmes may derail efforts by policy makers and development planners to incorporate drought in long-term development planning.

- A poor understanding of an arid environment in Namibia is reflected in the continued declaration of drought as an emergency, rather than a norm in Namibia. This has changed people's adaptive strategies to their arid environment. Coping strategies, other than adaptive strategies to ameliorate the effects of living in an arid environment, have evolved. Simultaneously, new institutions such as EMU have been created to deal with emergencies such as drought. This could lead to further fragmentation and duplication of resources between the EMU and the NPC.

- Top-down decisions which do not involve the communities in decision making processes, nor utilise local knowledge (for example, using local diviners in the siting of boreholes) can entrench a culture of dependency, and promote resentment towards new policies

- Lack of co-ordination of government policies leads to dissemination of conflicting messages to rural communities. The introduction of a cost recovery policy and community ownership for rural water points (and other natural resources) cannot be addressed in isolation from the land tenure issue. In order for sustainable natural resource management to occur, these policies need to be harmonised.

Community Resource Management in the Khorixas Area

The concept of conservancies is being promoted by locally-based organisations such as Save the Rhino Trust and the MET. However, issues such as land tenure security, definitions of what comprises a community, capacity building and equitable allocation of generated revenues still need to be addressed.

Conclusion

Inappropriate relief responses can have severe implications and may impact on the whole range of interacting physical, ecological, social and economic aspects of an area. The 1992/93 Drought relief programme should be seen as a valuable learning experience that will assist programmes and government in developing policies, designing strategies and implementing projects which will ensure that drought and its consequences are better managed in future, resulting in new hopes, aspirations and security for the majority of rural Namibians.

Provision of drought relief boreholes in Khorixas has had both positive and negative impacts. Provision of IMC boreholes initiated educational programmes on rural health

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Current land tenure systems and associated livestock management practices are not compatible with the semi-arid environment of the region and are consequently not sustainable (Marsh and Seely, 1992). Once reliance is placed upon grazing in one particular area of the Kalahari, rangeland degradation becomes a reality even at recommended stocking rates. The resultant degradation leads to the eradication of most palatable grass species and ultimately to bush encroachment (Environmental Information Services and EEAN, 1994b). This is evident in areas adjacent to Gam (e.g. in former east Hereroland) where high population densities of both humans and livestock have had profound negative effects on the environment [Environmental Information Services (EIS) and EEAN, 1994].

At the initial inspection of possible sites for the resettlement programme the department of Water Affairs expressed strong concern about the selection of Gam as a resettlement destination. They explained that the provision of water would create ongoing problems due to the difficulty of establishing permanent water points. This concern was detailed in a letter given to cabinet by DWA - DRWS, which was ignored (Confidential, pers. comm.). The MET reiterated the DWA's concern that the current livestock practices are incompatible with the characteristics of the semi-arid environment (MLRR, 1994).

Despite advice that the Gam area was not suitable for sustainable resettlement given the envisaged land use practices and limited water availability, resettlement occurred. The provision of boreholes made resettlement possible and has resulted in many negative impacts which are discussed below.

The Issues and Impacts Resulting from the 1993/1994 Herero Resettlement Programme at Gam

Water Supply and Borehole Maintainance

- The Ministry of Lands, Resettlement and Rehabilitation took on the responsibility of providing water through a borehole development programme. This was after DRWS refused to become involved in providing water due to the lack of potential groundwater reserves in this area and the technical difficulties involved in locating and extracting from these reserves. The drilling programme had a very low success rate: of 82 boreholes drilled, 19 are considered successful, and 7 have been installed. Further drilling for this resettlement programme has been concentrated further south in the Eiseb area which has a greater groundwater potential.

- The maintenance of boreholes, through the regional DRWS office in Tsumkwe, is subject to long delays - sometimes of up to 2-3 months. In cases where a borehole is no longer functioning, this has resulted in ecological impacts at surrounding boreholes which need to sustain far larger herds than usual. Furthermore, delayed maintenance makes it difficult for people to decide whether or not to establish permanent homes, as they need to be guaranteed a reliable water supply.

- All the installed boreholes are using diesel pumps. Farmers receive 210 litres of diesel per month from the government. This highlights the volumes of water required and

the scale of farming in this area in comparison to Khorixas, where farmers receive the same amount of diesel, but only every 3 months.

- Although some stepped pump tests were done to determine sustainable yields, many boreholes were recommended for installation using roughly estimated blow yield test results. This, together with the fact that no monitoring of volumes or water tables is taking place, raises concern as to whether these boreholes are delivering a sustainable yield in the long term. At Otjimihama (one of the three boreholes assessed in this study), water table levels seem to be dropping. The pumping depth has had to be increased by 15 m since installation. If this continues, the borehole will have to be deepened within 4 years.

Biophysical Impacts of Borehole Provision at Gam

- Despite the fact that the study was carried out during the rainy season, land degradation around the boreholes was clearly visible.

- Soil degradation was observed around all the boreholes. Soils were heavily trampled and in some areas highly compacted. Degradation was more prominent around boreholes than in the grazing area or in the vicinity of homesteads. Kalahari soils are fragile and from the damage observed during the study, it was apparent that the soils cannot sustain large numbers of animals concentrated at one point.

- Sedentarisation, overgrazing and trampling have destroyed all vegetation types immediately around the boreholes and chances of re-growth are limited. The heavily browsed trees and shrubs observed around the boreholes and near the homesteads give an indication that elimination of palatable species was already taking place. Moreover no signs of coppicing trees and/or young trees were observed. Such signs imply that in a short while palatable species will disappear leaving room for growth of unpalatable bushes (bush encroachment).

- The spread of unpalatable species such as *Sida cordifolia* in areas where palatable species have been lost is another sign of vegetation degradation which will consequently affect the quality of grazing in the area. The density of the poisonous plant *Dichapetalum cymosum* has increased due to grazing pressure which suppresses palatable plant species. It has been established that this species generally occurs at low densities, but spreads faster in areas with higher disturbance through trampling, overgrazing, and excessive fires (EIS and EEAN, 1994).

- Despite the fact that there is no data on the numbers of wild animals lost as a result of the resettlement programme, it can be clearly stated that the natural habitat of Gam is lost (Stander, pers. comm., 1997). Habitat disturbance or destruction will definitely lead to changes in species numbers and composition. Since the resettlement is still an on going programme, it is apparent that further population growth will lead to more biodiversity loss.

Socio-Economic Impacts

- Water supply provision has altered the previous land use practices of seasonal transhumance. Permanent settlements have developed around boreholes, particularly at Gam (receiving camp), despite the fact that existing amenities and infrastructure are unsuitable for a permanent human settlement of this size.

- The provision of boreholes to supply the people and their livestock with water has enabled permanent resettlement of the Herero and Mbanderu from Botswana. This has radically altered the composition of the previously existing Ju/'hoansi and Herero communities of the area and has resulted in increased pressure on the natural resources and social lifestyles of the San communities north of the 20° latitude veterinary fence. Due to the higher quality grazing, larger numbers of game, and the San's lack of political influence, the Herero are constantly trying to settle in this area.

- There are several diseases associated with water supply at Gam. These include diarrhoea, skin infections, worms and seasonal malaria. An example observed of the results of inadequate infrastructure has on health was the extremely high *E. coli* counts measured at Otjimihama where a tap had not been installed and drinking water is collected from the cattle trough. This problem was exacerbated by the fact that the trough was placed in the middle of a knee-deep pool of dirty, muddy water.

- The majority of the returning Hereros' cattle were destroyed due to a lung disease epidemic in Botswana before they returned to Namibia. These farmers are all engaged in rebuilding their herds as soon as possible. Unless appropriate and adaptable land-use management practices are immediately implemented in the area, land degradation will continue.

- Employment opportunities are almost non-existent in the area and alternative skills are limited. People with no livestock depended on food aid and assistance for their survival. In these cases very little money is available for other necessities such as school fees, medicine and transport.

Policy and Decision Making Issues

- A general lack of co-ordination between government sectors has existed during the Gam resettlement programme. This has resulted in many unnecessary problems, with issues such as basic health services, sanitation, veterinary extension services and education still needing to be adequately addressed by the respective ministries. Present agricultural offices and extension services are inadequate and this is resulting in farmers being denied adequate agricultural assistance.

- The decision to establish a resettlement area in Gam did not acknowledge the environmental constraints (social, biophysical and economic) of the area. The lack of an environmental assessment to determine site suitability prior to the resettlement bears testimony to this. It is predicted that the recent changes in land use will have severe negative impacts on the environment in Gam. Although local farmers' views were

positive regarding the present productivity of the area, signs of patchy deterioration around boreholes give negative indications for long term productivity.

- A general lack of structured policy and planning exists with regard to the sustainable use of natural resources. This extends to the provision and use of water points. During this study it became obvious that the provision of water is generally considered an engineering problem, and not one intrinsically linked to social and environmental issues.

Community Resource Management in the Gam District

In Gam the idea of conservancies is relatively unknown, and little enthusiasm was shown even after explaining the issue to the interviewed community members. Traditionally, cattle and large cattle herds play an important role in Herero culture. Thus a lack of interest is not surprising.

Conclusions

Planning for the Gam resettlement programme was shortsighted and ineffective, generally lacking in guidelines or any indication of a move towards integrated regional development. Environmental constraints (social, biophysical and economic) were not taken into account during the decision-making process of the resettlement programme. No environmental assessment was undertaken to determine site suitability prior to resettlement In addition, no consideration was given to the development of a holistic land-use plan for the region, and no guidelines were provided to contribute to the sustainable use of the natural resources upon which the programme's success is wholly dependent.

The principle symptoms of environmental degradation related to Herero repatriation to Gam include soil degradation, severe reduction of quality and quantity of grazing, bush encroachment and an increase in the density of poisonous plants. In the study area, several factors contributing to land degradation were identified:

- concentration and increased duration of livestock in grazing areas and at water points;
- lack of herding and rotational grazing;
- lack of accountability or responsibility for sustainable use of common property, mainly free access to resources;
- installation of boreholes with no monitoring of impact on water tables, vegetation and grazing due to inadequate extension services and awareness programmes.

Resettlement, made possible by borehole provision, has resulted in the imposition of a sedentary and intensive system on an ecologically fragile area. This has lead to a disruption of appropriate coping mechanisms, such as transhumance, which enabled sustainable use of the area.

A lack of clear ownership rights over the resources contributes to major problems in resource management. Without secure tenure, boreholes, like any other natural resource are regarded as government property. This contributes to the farmers' lack of incentives and opportunities to manage resources in a sustainable manner. Farmers utilising a borehole

are unable to deny other people either the right to grazing on surrounding land or to the use of the borehole. In the study area, dependency on the government seemed to frustrate farmers especially with regard to the long delays experienced in borehole maintenance.

KEY RECOMMENDATIONS

From the study it is clear that the presence of boreholes can significantly influence the social, economic and biophysical environment of an area. Therefore, the primary recommendation is that borehole provision must be subject to a process of environmental assessment, holistic environmental planning and appropriate land use management. To this end key recommendations are presented at national, regional and local levels.

Key Recommendations at the National Level

- Every development plan, policy and programme should be assessed at a strategic level in terms of its impact on the environment. This is of particular importance in addressing the cumulative effects of boreholes in communal areas.

- A national strategy should be developed to reduce the country's vulnerability to drought, thereby reducing the social, economic and environmental impacts resulting from drought.

- Effective co-ordination is required for government policies at national, regional and local levels. The establishment of the Land Use and Environmental Board (LUEB) at a national level and the appointment of an Environmental Commissioner will promote this co-ordination and ensure that environmental considerations are taken into account during a project's appraisal.

- A flexible approach to land tenure needs to be adopted that will enable constituted communities and groups to exercise joint ownership rights over land. Community tenure will be central to the success of the policy for community ownership of boreholes and other natural resources which need to be managed collectively.

- In conjunction with a flexible approach to land tenure, holistic land-use planning is required to address sustainable resource management in Namibia. The provision of all water points in rural areas should be subject to this planning.

- Land-use planning needs to take cognisance of the necessity of flexible farming strategies to cope with Namibia's arid environment.

- To alleviate the pressure of livestock farming on natural resources, alternative land use and livelihood options need to be explored and developed where possible. These could include tourism, use of wildlife to benefit communities and the development of alternative markets and skills. The concept of Community Based Natural Resource Management (CBNRM) may serve as a useful framework for achieving this economic diversification.

- Any foreign donor assistance needs to be subject to a process that ensures that these plans, programmes and projects are appropriate to the particular ecological, social and economic characteristics and needs of the Namibian environment.

Key Recommendations at the Programme Level

It is imperative that borehole provision programmes, whether under emergency conditions or as ongoing rural water supply, be submitted to a full process of environmental appraisal. The following are highlighted as important features of the environmental assessment of a borehole provision programme:

- Commitment to transparency and accountability;
- Needs assessment (including the need for water or grazing);
- Consideration of alternatives to borehole provision;
- Assessment of environmental impacts should include the following:

Social impacts

- effect on settlement patterns;
- influx of people into the area;
- effect on indigenous sustainable land use practices;
- quality and standard of infrastructure with respect to the provision of safe water.

Economic impacts

- costs to the community of maintaining boreholes;
- application of appropriate technology.

Ecological impacts

- cumulative effects of boreholes on ecology;
- spacing of boreholes;
- entrenchment of land uses inappropriate to environmental conditions;
- loss of, or degredation of, habitat.

Key Recommendations at Individual Borehole Level

Pre-requisites and conditionalities of borehole provision

- Full community participation shall be encouraged at all stages of decision-making and planning.

- Before a borehole is provided to a community there must be a well defined and documented need for it.

- Boreholes should not be installed unless there is a clear understanding of the need for management of natural resources and a strong community structure to do this. This will require capacity building within communities and the creation or strengthening of community based organisations, possibly including CBNRM principles.

Siting of Boreholes

- Conflicts between geohydrologists and local community knowledge and requirements with respect to siting need to be recognised and negotiated openly.

- Areas of low groundwater potential need to be recognised, and a moratorium on further drilling placed on those areas.

- Available groundwater resources need to be taken into account to prevent unsustainable drawdown of water tables.

- Boreholes need to be sited such that their zone of impact does not overlap with zones of impact of surrounding water points.

- Boreholes should not be sited in areas of high biodiversity or ecological sensitivity such as wetlands. Instead boreholes should be sited such that they attract settlement and human activity away from such areas. Consideration of the sensitivity of soil and vegetation to degradation is needed in the siting of boreholes.

Appropriate Technology

- The pump capacity should not be able to exceed the sustainable yield of the borehole. Recommendations regarding sustainable borehole yields need to be based on stepped pump test results, not simply on inaccurate blow testing results.

- The most appropriate pump mechanism should be installed. It is suggested that in most cases solar powered pumps are the most appropriate given the local economic and environmental considerations.

- Water storage and water outlet points should be planned and designed in such a way as to ensure a safe user environment. To provide high quality water, water storage should be in closed plastic tanks and reticulated through a closed system.

Operation and Management

- Although CBNRM currently only applies to rights over wildlife, the concept of community based natural resource management should arguably be extended in the future to include rights over, or ownership of, other natural resources such as water and grazing.

- Attention needs to be given to developing appropriate monitoring and management plans, in conjunction with communities, to reduce the impacts on sensitive soil and vegetation.

- Water point provision in conjunction with land use planning, could incorporate seasonal or occasional use of boreholes in emergencies. Thus seasonal grazing areas would remain and sedentarisation in these areas would be dissuaded.

Record Keeping and Monitoring

- Accurate, regularly updated records of borehole data must be kept. These should include information about rock strata, water tables, depth drilled and results of stepped pumped tests.

- Regular monitoring of pumping volumes needs to be implemented. These data could be incorporated into a regional data base indicating seasonal changes in borehole yields and water tables, and provide information towards determining longer term sustainable yields.

- Water quality in terms of bacterial contamination and salt content should be monitored on a routine basis as well as at the time of installation. Where there are abnormal findings or indications of a potential problem these should be fully investigated.

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