Promoting Best Practices for Conservation of Biodiversity of Global Significance and Sustainable Use of Resources in Arid and Semi-Arid Zones

Environmental Problem Solving for Sustainable Development

M K Seely[1], WJ Hamilton[2], P Klintenberg[1]
[1]Desert Research Foundation of Namibia, P O Box 20232, Windhoek, Namibia
drfn@drfn.org.na; www.drfn.org
[2]Division of Environmental Studies, University of California, Davis, California

Abstract

Introduction

Results and discussion

Nine field courses for tertiary students, undertaken over an intensive ten-week period each year, have addressed a variety of challenges to sustainable resource use and management in arid and semi-arid Namibia. These courses have purposefully addressed issues that are politically sensitive, that involve some aspect of biodiversity conservation and desertification control, that are often unacknowledged issues hindering sustainable development and, because they relate to social equity issues, are of interest to ambitious young professionals. The courses are led by experienced professional environmentalists with a long interest in the interface between the biophysical and socio-economic environments. The direction of the course, the information collected, the focus of analysis and manner of presentation have major inputs from the participating students. Lessons learnt from each of the nine field courses have shown similarities and differences from year to year.

SDP 1: Rainfall Range Map

Namibia is the most arid country south of the Sahel(reference). As aridity increases, the variability of rainfall increases with consequences for planning and sustainable development. Rainfall ranges from a mean of over 500 mm per annum of summer rainfall in the NE to less than 50 mm per annum winter rainfall in the SW and summer rainfall along the western, coastal desert(Dealie et.al. 1993; Hutchinson 1993). Nevertheless, the majority of the population is dependent on agriculture: crops in the north central and north-eastern areas, and livestock grazing throughout most of the remainder of the country(ref). In south- and north-western Namibia, very variable rainfall has resulted in the highest biodiversity of the country(Barnard 1998).

Two years after independence in Namibia, newly installed decision makers, who had been in exile in higher rainfall areas of Africa or in the northern hemisphere, and most of the population still focused planning and expectations for development on agriculture based on mean rainfall values(seely in french reference). Alternatives such as use of median rather than mean rainfall values had been recommended (Seely 1991) but mean rainfall is easier to calculate, is used globally and is more familiar to most people.

Project Title	**Primary Target/ Partner**	**Project Description (advisors)**	**Project Objective**	**Specific educational objective**
SDP1 Rainfall Range Map (1992/1993)	Namibian Agricultural Union/ University of Namibia	Using all long-term data from the Namibian Weather Bureau, and weather pattern information from the Climatology Unit of the University of the Witwatersrand, participants calculated range of rainfall experienced in 90% of years	To bring to the attention of farmers and the public the irrelevance of 'mean' rainfall in an arid environment.	To expose participants to characteristics of arid environments and experience application of simple procedures to create a useful product

Results and recommendations from SDP 1: The Climatology Unit of the University of the Witwatersrand has developed zones of characteristic rainfall patterns for the SADC region(ref.). These patterns as they applied to Namibia were integrated with the longer-term rainfall data available from the Namibian Weather Bureau. All rainfall records of longer than 40 years were analysed and the range (mean maximum and mean minimum) values identified at the 90% level and the 95% level.

From the characteristic rainfall patterns and the calculated rainfall ranges, a map of Namibia was elaborated incorporating these ranges and the high and low rainfall, expected 90% and 95% of the time.

The results were printed as posters in A2 format for broad distribution to decision makers and agricultural service organisations (government and private) throughout Namibia. Several years later, the map was reprinted by the Namibian Agricultural Union for distribution to all their members. It continues to be posted in government offices throughout the regions. In addition, an A5 illustrated booklet was prepared for extension personnel to use in rural communities.

Scientific lessons learned: This project involved use of existing information analysed in a new way. Although arid environments are known to be variable, particularly in terms of rainfall, the range of rainfall – that which can be expected in any one normal year – was surprisingly large and attracted the attention of potential users (resource users, agricultural planners).

Policy and management lessons learned: Many policy and management decisions are based on assumptions rather than solid information. Provision of information in an understandable format and distributed to appropriate stakeholders appears to have an impact on planning and management.

Lessons learned to assist local populations in using and managing resources sustainably: Local populations rapidly adopt relevant information if available in an understandable format.

Lessons learned to increase partnerships and coordination between institutions: Based upon this project, the level of partnership increased with the target audience. However, other professional institutions, who could have easily accomplished the same task, criticised the results based on the degree of accuracy involved (e.g. incorrect map projection used). Different institutions in Namibia appear to have adopted either the 'broad brush' or the '100% accurate' approach to information dissemination. A clearer picture of which approach works best with which issues appears to be required.

SDP 2: Use of water by stakeholders in an ephemeral river catchment

The northwestern 20% of Namibia has developed around 12 westward flowing ephemeral rivers. All but four of the smaller, northern rivers originate in commercial farmland. All but the two smaller southern rivers originate in or flow through communal farmland. The lower reaches of all 12 rivers flow through desert protected in parks, two ending in sand dunes >50 km inland from the Atlantic coast. Fog is an additional source of water for the diverse fauna and flora of these coastal, desert parks while the

ephemeral rivers allow numerous species to extend their ranges into the hyper-arid areas (Hamilton & Seely 1976; Seely & Hamilton 1976; Henschel, Robertson & Seely 2001; Jacobson, Jacobson & Seely 1995; Seely, Henschel & Robertson 1998 Seely & Pietruska 1996; Shanyengana et.al. 2001)

The Kuiseb river is the most developed of the 12, supporting the major coastal town with port, the prime coastal tourist and recreation destination and, until recently, a large uranium mine in addition to commercial and communal farmers, the Namib-Naukluft Park and the Gobabeb Training and Research Centre(Dausab *et.al.* 1994).

The development of the Central Area Water Master Plan (CAWMP), including the Central Namib, revealed the limited information available in relationship to use and management of a single ephemeral river catchment(DWA 1993). Water Demand Management as a concept was not incorporated into the CAWMP and the scope for this approach was not known for all the users of a single catchment[GRN 1999, 2002]. Moreover, despite the interdependence of people using a single catchment, the varying political representation of different user groups and the differing degree to which livelihoods are directly dependent on the river had not been elucidated.

Project Title	**Primary Target/ Partner**	**Project Description (advisors)**	**Project Objective**	**Specific educational objective**
SDP2 Water usage patterns in the Kuiseb Catchment Area (1993/1994)	Department of Water Affairs/ public in Kuiseb catchment	Using direct measurements, observations and interviews, water use by the six major groups of users occupying the Kuiseb catchment was assessed. (two coastal towns, commercial and communal farmers, uranium mine and training and research centre) (P Jacobson, Virginia Tech)	To obtain information on and bring to the attention of DWA and public the per capita use of water in an arid river catchment	To enhance understanding of participants of application of 'first principles' and simple research techniques to obtain information relevant to sustainable development

Results and recommendations from SDP 2: Six major user groups were identified in the Kuiseb river catchment. They include commercial farmers in the upper catchment (estimated use 0.6 Mm^3 per annum) and Topnaar communal farmers (0.006Mm^3) and

the Gobabeb Training and Research Centre (GTRC) (0.007 Mm^3) both mainly located in the Namib-Naukluft Park of the middle catchment. The port town of Walvis Bay (4.3 Mm^3) is entirely supplied from the alluvial aquifer of the lower catchment that also supplements the supply to the tourist town of Swakopmund (using 2.9Mm^3, 1Mm^3 from the Kuiseb) and Rössing uranium mine (3.0 Mm^3, unknown proportion from the Kuiseb)(Dausab *et.al.* 1994).

On a per capita basis, the greatest amount of Kuiseb water used for domestic purposes is used for ornamental gardens at the GTRC and by the higher economic groups in the coastal towns. This suggests an important avenue for reducing water use. Evaporation from farm dams and reservoirs in the upper Kuiseb was identified as a potentially important avenue for water loss not easily addressed.

This study found that many people directly dependent on the Kuiseb catchment are aware of the developing water shortage. Recommendations from the study focused on conservation of existing sources, increasing awareness and action amongst all user groups, the interdependence of people using a single catchment and the importance of a holistic view of water development. The development of desalination to serve the west coast is strongly supported as scarcity of water is poised to undermine the prospects of sustainability of social and economic development(Dausab *et.al.* 1994).

The results were compiled as an Occasional Paper of the DRFN and information was used for Parliamentary 'Updates'(DRFN 1996) and in various presentations and discussions. The study benefited from research leading to Ephemeral Rivers and their Catchments and contributed to its formulation(Jacobson *et.al.* 1995).

Scientific lessons learned: Although not a new lesson, participants learned the difficulties of obtaining existing information from a variety of sources and then making comparisons based on differing degrees of accuracy. They also learned how to assess the validity of information from different sources collected for different reasons to 'triangulate' on the best approximation of a correct answer to questions posed.

Policy and management lessons learned: It became more clear from this study that various user and management groups are applying different policies and management approaches to a shared resource. This study and the larger 'Ephemeral Rivers' project have helped to firmly establish the concept of 'Basin Management' in the new policy and draft Water Resources Management Act in Namibia (GRN 2002).

Lessons learned to assist local populations in using and managing resources sustainably: Dissemination of information concerning 'water demand management', through the newspaper and by undertaking this study, has had a long-lasting affect, particularly on those higher-income user groups with ornamental gardens.

Lessons learned to increase partnerships and coordination between institutions: This study was a first step in the growing partnership between NGOs and the Department of Water Affairs in Namibia by demonstrating the results that can be generated from a simple approach applied by undergraduate students. The results were incorporated into Parliamentary 'Updates' contributing to appreciation of the need for additional information for decision making.

SDP 3: Climate variability and desertification

With the formulation of the UN Convention to Combat Desertification(UNCCD 1994) and the establishment of Namibia's Programme to Combat Desertification(Kamminga 199x), the question of how to distinguish between the effects of rainfall variability and (long-term) degradation in arid rangelands was being asked(Seely & Jacobson 1994; Wolters 1994). Representatives from aid agencies viewing the landscape with a northern perspective considered the area to be devastated by overstocking and over grazing while resident farmers knew that all depended on the next rainfall. Meanwhile, the drought relief policy was being revisited and the question of what is normal rainfall variation and what is a 'disaster' drought required clarification(GRN 1998).

Communal farmlands in northwestern Namibia are situated within westward flowing ephemeral river catchments (Jacobson *et.al.* 1995; Jobst *et.al.* 1996; !Guidao-Oab *et.al.* 1996). They are composed of areas that have always been in communal use, although not on a continuous basis, and of areas that were divided into private farms for a twenty-year period before being reintegrated into communal lands(Kambatuku 1996; Kamwi 1997; Sullivan 1996). They are considered to be marginal farming areas where small stock predominates and wildlife and scenery provide opportunity for alternative income generating activities through wildlife conservancies(Ashley, Barnes & Healy 1994). In the past, the area was used on a seasonal basis or only after good rain, although a growing population and extensive resettlement means that it is now farmed on a permanent basis leading to conflict between wildlife and livestock(Ashley 1995; Mouton, Mufeti & Kisting 2000).

Project Title	Primary Target/	Project Description (advisors)	Project Objective	Specific educational objective

	Partner			
SDP3 Summer Desertification Project (1994/1995)	Namibia's Programme to Combat Desertification ; CCD	Focusing on soils and vegetation, participants used direct measurements, observations, laboratory analyses and interviews with communal farmers, government advisors and local business persons to assess changes in productivity of arid (50 – 200 mm mean rainfall; rainfall range) rangelands (Abrams *et.al.* 1997)	To evaluate roles of normal climate variability and long-term loss of productivity (desertification) on current rangeland conditions in an arid environment.	To enhance understanding of participants concerning effects of variability of arid environments and the relationship of this variability to potential livelihoods

Results and recommendations from SDP 3: Examining areas close to and far from boreholes and on both sides of fences where management was obviously different, soils, grasses and woody vegetation did not conclusively indicate any long term degradation but simply effects of responses to recent low rainfall. Two of three indicators of biological integrity studied did correlate with hints of possible degradation while one did not. Similarly, results from the Integrated System for Plant Dynamics developed for the SADC region at Potchefstroom and tested in this study, showed weak correlation with other indications(Kellner 1996).

Some problems that could lead to land degradation were identified as population pressure of people and animals, underdevelopment, poverty and communal land tenure contributing to poor management. These factors are reinforced by overgrazing, over stocking and deforestation and underlain by government land policies applied in the area. Although exploitation of alternative incomes such as tourism and poultry could improve livelihoods and are not fully developed, the over-riding cultural importance of livestock must be addressed in terms of sustainability. Education and training to provide necessary skills and information were identified by community and researchers as essential.

The question of whether long-term degradation, or desertification, is taking place in the areas studied was not resolved. On a *per capita* basis, natural resources are becoming less available. Migration of much of the working-age population to towns is evidence of this inability of available resources to provide for needs of the resident population. Similarly, the number of dry boreholes and the lack of woody vegetation around homesteads suggest an overall decrease in productivity although not necessarily in grazing.

The results of this study were compiled as Occasional Paper 2 of the DRFN and the concepts integrated into implementation of Namibia's Programme to Combat Desertification(Jobst et.al. 1995).

Scientific lessons learned: One or even a few indicators are not necessarily sufficient to provide answers in highly variable environments. Wildlife populations, as with livestock, vary from year to year, partly because of migration. Long term or very comprehensive measurements are essential to differentiate between natural variation in an arid environment and long-term change.

Policy and management lessons learned: It is essential that natural climatic and resultant environmental variation be taken into account for all policy development and management planning. The Namibian Drought Policy and Strategy was informed by this study and, although not yet implemented, it incorporates this principle.

Lessons learned to assist local populations in using and managing resources sustainably: Diversification of sources of income and livelihoods in general is an essential coping strategy in variable environments. Long term planning is important if basic poverty is not the overriding issue.

Lessons learned to increase partnerships and coordination between institutions: The group again found that government and other institutions were willing to assist and cooperate with serious research and when solid data was being collected. Partnerships are enhanced when both parties have something to offer.

SDP 4: The role of elephants on farmland with differing tenure regimes

Northwestern Namibia, straddling the Great Western Escarpment extends westward to the Namib Desert and the Atlantic Ocean. The escarpment supports a high species diversity including many endemic plants and animals(Barnard 1998). The mountainous scenery combined with free ranging elephants, rhino, lions and other attractive game species imbues this area with a high tourism potential.

Tourism and associated activities are considered to be an important source of alternative income in communal areas of arid NW Namibia. By shifting focus from livestock toward game and tourism, potential land degradation can be slowed or halted. Conservancies are one organisational vehicle for managing wildlife, tourism and income generated thereof (Ashley 1995). Many

communal farms are not incorporated into conservancies and commercial farms may or may not be so organised. We examined the costs and benefits of elephants to people living on commercial and communal farms who are not part of an organised conservancy. This question was placed in the context of attempting to distinguish effects of long-term degradation, particularly of woody vegetation, versus short term rainfall variability.

Project Title	Primary Target/ Partner	Project Description (advisors)	Project Objective	Specific educational objective
SDP4 Elephants, communal and commercial farmers Engelbrecht (1995/1996)	Namibia's Programme to Combat Desertification ; CCD	Working at the border between communal and commercial farmlands in the Huab river catchment, participants assessed vegetation condition, used PRA and interviewed farmers, government officials and service providers to assess effects of elephants on current and changing productivity (Dr D Ward, Ben Gurion University)	To evaluate the role of elephants on livelihoods and income generation under two land tenure regimes in an arid environment	To develop an appreciation for the comparative roles of environmental, social and political determinants on livelihood potentials

Results and recommendations from SDP 4: Two adjoining farms, on the boundary between communal and private land tenure, straddle the Huab river, an ephemeral river with a high population of elephants. One farm focuses on tourism and protection of elephants, the other considers elephants a danger to people and livestock. The commercial farm was recently converted to a private wildlife reserve, while next door, communal farmers are attempting to eke out a living with cattle and goats.

The study of woody vegetation revealed a quantitative decrease near the homesteads where people use it for building and for fuel. At boreholes distant from homesteads, response of woody vegetation to browsing pressure decreased with distance from the boreholes. However, it was not clear if this was caused by livestock or game. Death of woody vegetation in ephemeral water courses, particularly pod-bearing acacia species, was noted but not explained. As with the previous study, the question of whether long-term degradation, or desertification, is taking place was not resolved.

On a per capita basis, natural resources are becoming less available on the communal farm. Migration of much of the working-age population to towns is evidence of inability of natural resources to provide for needs of the resident population. This was in sharp contrast to the farm involved in tourism and wildlife where the income generated is high and employment is provided to several young men from the neighbouring communal farm. At the same time, the level of investment in the two farms differs by orders of magnitude.

During field work associated with this project, a video (entitled Covering Ground) was made and is regularly shown to illustrate some of the principles associated with combating desertification in an arid, variable environment(Mamokobo 1995). The results and concepts identified were published in the Namib Bulletin #8 and are integrated into implementation of Namibia's Programme to Combat Desertification.

Scientific lessons learned: Water points serve as focus for both game and wildlife, although the impacts of game and wildlife are difficult to differentiate without extensive study.

Policy and management lessons learned:
Lessons learned to assist local populations in using and managing resources sustainably:
Lessons learned to increase partnerships and coordination between institutions:

SDP 5:

The population of the north-central region of Namibia became established and grew around the ephemeral oshana drainage system of the Cuvelai basin that originates in Angola and flows southward to Etosha Pan. Records indicate that the human population has increased from less than 100 000 to more than 600 000 and the cattle population from 60 000 to 450 000 during the twentieth century(Marsh & Seely 1992). Until recently, people were dependent almost entirely on natural resources in the region. With the increase in population, the settled area has expanded and use has intensified(Mendelsohn, Obeid & Roberts 2000).

During the past 30 years, woody vegetation, used extensively for constructing buildings, fencing and fuel, is less readily available and either being transported from great distances and sold in the towns or substitutes being developed(Erkkilä & Siiskonen 1992; Flower, Wardell-Johnson & Jamieson 1996; Matthew 2001). East and west of the oshana system are woodlands on Kalahari

sands while south are predominantly saline grasslands. Saline groundwater underlies the oshana system while fresh but deep groundwater underlies the Kalahari sands(Marsh & Seely 1992). As a consequence, water from the Kunene River is imported and distributed by pipeline throughout the oshana region at cost of supply[ref. FIND].

Natural resources available from the environment are not valued by people using them until they must pay for substitutes or transported goods(Ashley 1998). People recognise that natural resources are becoming scarce, in the case of water, expect government to supply the commodity free of charge. Unavailability of natural resources and the necessity of paying for replacements contributes to the growing gap between rich and poor.

Project Title	**Primary Target/ Partner**	**Project Description (advisors)**	**Project Objective**	**Specific educational objective**
SDP5 A study at Onaadi and Okatjali (1996/1997)	Namibia's Programme to Combat Desertification ; CCD	Using structured interviews and PRA with communal farmers and government officials, observations combined with cultural experience and selected vegetation measurements, participants estimated the economic value of natural resources (particularly woody vegetation) used to maintain rural livelihoods in two contrasting villages (recently and long-time settled) (Ms M Zeidler, Consultant with GTZ?)	To assess the replacement value of declining natural resources used to support rural livelihoods (wood-intensive culture)	To gain an understanding of natural resource economics and its key role in planning for sustainable development

Results and recommendations from SDP 5: With increase in population, there has been an increase in number of homesteads. The pattern of growth has been away from the central oshana areas into surrounding woodlands. Cattle posts are established in a wooded area and their number increases. Next mahangu fields are cleared to support cattle posts, followed by homesteads. Lastly, water is provided, by pump or pipeline, and a village is established. By this time most woody vegetation, expect for valuable fruit trees, has been reduced if not eliminated. This is accelerated by constant pressure from cattle that graze on germinating or newly established seedlings creating a 'desert beneath the trees'. One study site was in an area that had been settled for half a

century and almost devoid of woody vegetation while water was newly established at the second study site and mature woody vegetation still common, clearly illustrating the results obtained from observations and interviews with residents.

Fences are an important part of this development pattern and the following results were obtained concerning their cost if purchased

	Traditional fence	Commercial fence
Big poles	1 000	60
Small poles	27 000	300
Wire	10 000 m	10 000 m
Total cost	N$38 680	N$ 2 990

Students identified the relationship between poverty and environment and the relationship between development and environment if development is based upon intensified use of limited natural resources. They also identified the potential for alternative development trajectories if poverty and the tradition of free access to common property (in contrast to communal management) are not such pervasive components of the equation.

The results of this study were shared with the Directorate of Forestry, presented as a role play to government, diplomatic, technical representatives and journalists at the Information Weekend at the GTRC, returned to stakeholders in the region in an abbreviated report format and used to inform Napcod and its programmes in the two study sites(reference – Cecilia Napcod library?).

Scientific lessons learned:
Policy and management lessons learned:
Lessons learned to assist local populations in using and managing resources sustainably:
Lessons learned to increase partnerships and coordination between institutions:

SDP 6:

Fencing off portions of communal land by richer members of the community including government officials has accelerated since independence in Namibia in 1990(Johnson 1997; Kerven 1997; Maletsky 1997a). This is undertaken by people able to pay for labour while taking advantage of free natural resources in the form of woody vegetation and water. Often boreholes established by government are thus privatised as well as traditional wells and temporary water sources(Maletsky 1997b). Movement of migratory herds of smaller farmers are thus curtailed intensifying grazing pressure and reducing productivity of their herds and of grazing and browsing resources.

Fencing of communal lands by private individuals is illegal and has been condemned by the President, however, it is condoned and continues to the distress of many(Maletsky 1997c). The process of fencing puts valuable woody vegetation into the hands of the already relatively wealthy farmers, disadvantaging smaller farmers and those with access to fewer resources (Conroy 1999; Kerven 1997).

Project Title	**Primary Target/ Partner**	**Project Description (advisors)**	**Project Objective**	**Specific educational objective**
SDP6 Fencing (1997/1998)	Namibia's Programme to Combat Desertification ; CCD	Using structured interviews and PRA with communal farmers, workers on newly fenced farms, government officials and regional service organisations coupled with assessments of the state of woody vegetation, participants examined the social and environmental impact of fencing off of large tracts of communal land for private use (C Kerven)	To assess the impact of 'wildcat' fencing on the environment through induced management changes	To gain an understanding for the environmental economic background to many issues perceived solely as political or social

Results and recommendations from SDP 6: Because the privatisation process is recent, we were unable to document differences of grazing or browsing conditions inside and outside of newly erected fences. As most of the fences were modern using less wood than the traditional palisade fences, the impact of the woody vegetation was less than anticipated. The main impact of this privatisation process is exclusion of smaller farmers from their traditional water and grazing areas.

The results of this investigation were prepared in a short report and distributed to interviewees and other stakeholders. They were presented as a role play to government, diplomatic, technical representatives and journalists at the Information Weekend at the GTRC and used to inform Napcod and its programmes in the study area.

Scientific lessons learned:
Policy and management lessons learned:
Lessons learned to assist local populations in using and managing resources sustainably:
Lessons learned to increase partnerships and coordination between institutions:

SDP 7:

At independence in Namibia, a number of San people who had been involved in the struggle were no longer able to live in their areas of origin. People from diverse localities and groups were resettled by the government in a sparsely populated, wooded region on Kalahari sands. Groups were resettled under different village leaders and there is no overall organisational structure(Suzman 2000).

The area previously had been exploited by a government-supported sawmill that appears to have removed most of the valuable timber from the area. A tourism enterprise is now being located at the sawmill. The Directorate of Forestry has a station in the area promoting cultivation of fruit trees amongst the resident population. Veld fires are a frequent occurrence in the shrubby landscape.

The Summer Desertification Project was invited by the Ministry of Lands, Resettlement and Rehabilitation to investigate the development options available to residents in this area(Shilomboleni *et.al.*1999). A number of boreholes had been established by the government and villages were all sited at a borehole. Extensive grazing appears to be available where there are no boreholes.

Two years after this investigation was undertaken, the Ministry of Foreign Affairs has selected this area for relocation of the Osire Refugee Camp with its long-term resident population of over 5000 refugees from neighbouring countries(Amupadhi & Inambao 2001; Inambao 2001)

Project Title	Primary Target/ Partner	Project Description (advisors)	Project Objective	Specific educational objective
SDP7 Potential value of land and water resources in northeast Otjozondjupa (1998/1999)	Directorate of Resettlement and Rehabilitation, Ministry of Lands	Focusing on soil, groundwater, state of vegetation and economic activity of the recently resettled San population, structured interviews, PRA, direct measurements and observations were used to assess options for development in 'western Bushmanland' on behalf of the Directorate of Resettlement and Rehabilitation (S Simmons, Consultant with Interconsult)	To identify development options for 'western Bushmanland' in the best interests of the resettled San people and appropriate for this arid environment	To experience the strong, often contradictory, relationships among political, economic, social and environmental issues in planning for sustainable development.

Results and recommendations from SDP 7: Interviews, use of PRA, and observation confirmed that the settlers came from a tradition based on hunting and use of veld foods and still prefer these foods. They are mainly dependent, however, on food relief supplied by government.

Agricultural advisors assigned to the area strongly advocate planting of mahangu (millet) and introduction of livestock. Meanwhile, each village has one wealthy person from elsewhere in Namibia who maintains a herd of cattle at the village and has hired residents to manage the herd. Most of the village opposes the presence of these cattle as they trample the veld and require people to walk great distances to find natural foods.

Investigation of soils, water availability, and woody vegetation, when combined with the information gained from the residents led the team to conclude that cattle ranching would not be sustainable under current conditions and should not be promoted in the area. Instead, the residents should be allowed to establish their own preferred course of development for at least a ten year period.

The results of this investigation are available as Occasional Paper No. 9 of the DRFN(Shilomboleni *et.al.*1999). They were presented to representatives of the MLRR, diplomatic and technical colleagues. Although strongly presented by students and supported by staff of the investigation team, the results were not generally accepted by the MLRR. When the plans for transfer of the refugee camp to the area were made public two years later, requests were made by the diplomatic corps for copies of the report to provide background information about the area.

SDP 8:

Many developments have taken place in the Kuiseb catchment and in the policy milieu surrounding water resources management in Namibia since the study on water use was concluded by SDP2 in 1994 (Amoomo *et.al.* 2000; Dausab *et.al.* 1994; GRN 1999). Depletion of the lower Kuiseb aquifer was receiving more attention and desalination of seawater at an increased cost to coastal users was being discussed. In addition, the role of farm dams in reducing Kuiseb flow was raising questions.

In the central catchment, the Topnaar communal farmers who use an indigenous cucurbit to generate cash income were reporting lower yields and dying plants, particularly in that part of the river course dammed to prevent flooding of Walvis Bay (Henschel, Dauseb & Moser 2002; Storad 1991; Widlok 1996). They also reported a decline in pods produced by the riverine acacia trees dependent on the alluvial aquifer.

New legislation in South Africa and draft legislation in Namibia had identified the 'environmental reserve' as an important concept in the sustainable management of river catchments(GRN 2002). Determination of an environmental reserve had never been tried in an ephemeral river basin.

Project Title	**Primary Target/ Partner**	**Project Description (advisors)**	**Project Objective**	**Specific educational objective**
SDP8 Water Balance of the Kuiseb (1999/2000)	Department of Water Affairs; NamWater	Building on SDP2, using structured interviews, PRA, measurements and observations, the participants investigated approaches used by the major water	To assess the interrelated impacts among the various managers and users	To develop an understanding of completing demands and needs on a single

		managers and users in the upper, middle and lower Kuiseb catchment and the impacts these have on the environment and sustainable development	of water in the ephemeral river catchment	critical resource in the context of sustainable development

Results and recommendations from SDP 8: Water balance in the upper, middle and lower Kuiseb river catchment was modeled from first principles based on rainfall and measurements of water flow at gauging stations. Information was assembled from a variety of sources including the Department of Water Affairs, the Weather Bureau, the Namibian bulk water supplier: NamWater and the municipality of Walvis Bay. A workshop involving all stakeholders at the national level was held in Windhoek to which commercial farmers in the upper Kuiseb were invited. The format of the workshop was based on the information required to estimate the environmental reserve (Resource Directed Measures). Two further workshops using PRA approach were undertaken with communal Topnaar farmers in the middle and lower Kuiseb. Individual interviews were made with persons from other identified stakeholder institutions. In addition, measurements were made of vegetation condition in the middle and lower Kuiseb river course.

Results indicated a measurable mortality of woody vegetation in the lower Kuiseb, however, it could not definitely be assigned only to lowering of the water table, natural variability in river flow or long term degradation (Amoomo *et.al.* 2000). The short-term impact of villages upon browse in the Kuiseb was also noted. Data from authorities did confirm the unsustainable lowering of the lower Kuiseb aquifer and more rapid water abstraction rates than recommended.

Modeling of the Kuiseb basin using SA methodology for determining water reserves, highlighted the large losses of surface flow in the upper and middle Kuiseb to either evaporation, infiltration, aquifer recharge or other sinks.

The results of SDP8 were prepared in a short report and presented to communal farmers who participated in the PRA sessions. They were presented as a role play to government, diplomatic, technical representatives and journalists at the Information Weekend at the GTRC and repeated, on invitation, to management of the Department of Water Affairs in the capital. The results are available as a Occasional Paper No.8 (Amoomo et.al. 2000). The overall model served as a basis for further investigation of the viability of Basin Management Committees undertaken by various authorities and the DRFN and for development of the Environmental Learning and Action in the Kuiseb programme that is being initiated (ELAK 2001).

Scientific lessons learned:
Policy and management lessons learned:
Lessons learned to assist local populations in using and managing resources sustainably:
Lessons learned to increase partnerships and coordination between institutions:

SDP 9:

New water legislation in Namibia has reached the final draft stage with several innovative components(GRN 1999, 2002). One chapter proposes Basin Management Committees as the fundamental institution for planning and management of water resources coordinated by a central Agency. The Kuiseb catchment is thought by many authorities to represent a suitable 'pilot' area to test some of the concepts.

One requirement of the new legislation is that all water sources should be registered. Since many commercial farmers have established and financed their own earth dams and boreholes, some resistance may be expected. In a similar vein, the Department of Water Affairs might be expected to visit and measure every water source and the expense in manpower and transport would be prohibitive. Alternative methodologies needed to be identified and tested and the process of awareness raising to be initiated.

Working with the Department of Water Affairs, the DRFN SDP9 project undertook to test a methodology for sampling earth dams, in two sub-catchments that had good data available from gauging stations, and modeling their effect on water flow. Awareness raising would be supported by informing and interviewing commercial farmers in and around these two sub-catchments. Methodologies involved ground measurements of dam capacities and surrounding soil and vegetation conditions, structured interviews with farmers, use of remote sensing and testing of an excel-based water flow model. The question asks was: 'which components, if any, of this constellation of methods would serve to provide a cost effective way to implement the requirements of the proposed legislation'.

Project Title	Primary Target/	Project Description (advisors)	Project Objective	Specific educational objective

	Partner			
SDP9 Influence of farm dams on water flow in the Kuiseb (2000/2001)	Department of Water Affairs, Hydrology Division	Building on SDP8, using dam surveying techniques, vegetation and soil analyses, structured interviews, modeling and remote sensing, participants investigated in detail two sub-catchments of the ephemeral Kuiseb river and extrapolated this to the entire river system (G Van Langenhove, Department of Water Affairs, Hydrology Division)	To develop and test a methodology for rapid determination of the effect of farm dams on the water flow balance of an ephemeral river	To develop an understanding of the importance of basic information and participation for planning and management of a critical resource

Results and recommendations from SDP 9: The results of this study revealed that a group of recently training people could rapidly and satisfactorily survey farm dams(Amoomo *et.al.* 2000). Most farmers willingly participated in interviews lasting several hours and gave students free access to their farms. With the technical supervision of DWA, a satisfactory water flow model was developed for the two sub-catchments based on the 29 dams surveyed. The size of the dams hindered extrapolation of the model to the entire catchment using remote sensing techniques based on satellite images. Recent air photos are available and, although more expensive, could provide a thorough coverage in relatively little time. This would be based on the high correlation found between dam surface area and volume caused by the high proportion of dam capacity filled by sediments in most instances.

The results of the modeling showed differences between higher and lower rainfall sub-catchments. In both instances, the size and impact of the dams was considerably lower than expected. Also contrary to expectations, no new dams had been constructed in the past one and maybe two decades, although farmers would do so if funds were available. Farmers were, in general, very cooperative and interested in the concept of a Basin Management Committee although they would appreciate further information. The study also revealed the marginal quality of farming as a sustainable livelihood with almost half of the farmers supporting their farming with jobs in town and more than half incorporating wildlife and tourism, into their livestock-based operations, with several considering abandoning livestock entirely.

The results of SDP9 appear in an Occasional Paper that was distributed to all farmers participating in this study as well as other stakeholders(Amoomo et.al. 2000). They were presented as a role play to government, diplomatic, technical representatives and journalists at the Information Weekend at the GTRC and repeated, on invitation, to management of the Department of Water Affairs

in the capital. Details of the model and the remote sensing were demonstrated in an Information Market to interested participants. Experiences gained from SDP9 are being incorporated into the approach formulated by DWA to implement the draft legislation.

Scientific lessons learned:
Policy and management lessons learned:
Lessons learned to assist local populations in using and managing resources sustainably:
Lessons learned to increase partnerships and coordination between institutions:

References

Abrams, M.M.; Jacobson P.J.; Jacobson K.M. & Seely M.K. 1997 Survey of soil chemical properties across a landscape in the Namib Desert" Journal of Arid Environments 35(1): 29-38

Amoomo H.; Elago P.; /Gaseb N.; Hoveka V.; Khairabes M.; Mbangula E.; Muharuhua V.; Mukuya S.; Ndjeula H.; Noongo E.; Shinedima R. & Zaaruka B. 2000 Determining a water reserve for the Kuiseb." DRFN Occassional Paper No.11, Desert Research Foundation of Namibia, Windhoek, Namibia. p66

Amupadhi T. & Inambao C. 2001 "Govt, UN cross swords over Osire camp move." Namibian 13th February, Windhoek, Namibia.

Angula H.; Goreseb J.; Hainbodi N.; Iiputa G.; Katshuna M.; Matros A.; Muduva T.; Muvi-Tjikalapo M.; Nakale T.; Nakathingo H.; Nampila J.; Nantanga K.; Nashipili N.; Shigwedha L. & Thomas T. in press "Infleunce of farm dams on an ephemeral river system: the Kuiseb basin/catchment" DRFN Occassional Paper, Desert Research Foundation of Namibia, Windhoek, Namibia.

Ashley C. 1995 "Promotion of community based tourism as a strategy for CBNRM: options and potential for achieving conservation and development through non-cpnsumptive tourism in Namibia." DEA Research Discussion paper, Directorate of Environmental Affairs(DEA), Ministry of Environment and Tourism(MET), Windhoek, Namibia.

Ashley C. 1998. "Intangibles matter: non-financial dividends of community-based natural resource management." WWF-LIFE Draft Report, Windhoek. 31pp.

Ashley, C, Barnes, J & Healy, T. 1994. Profits, equity, growth and sustainability: the potential role of wildlife enterprises in Caprivi and other communal areas of Namibia. EEU Working Paper 1994:11, Unit for Environmental Economics, Department of Economics, University of Gothenburg, Sweden. 26 pp.

Barnard P. 1998 "Biological diversity in Namibia: a country study" Namibian National Biodiversity Task Force, Windhoek, Namibia 332pp.

Conroy C. 1999 "Socio-economic aspects of Colophospermum mopani use in Omusati Region, Namibia." In "Management of mopane in southern Africa." Flower C.; Wardell-Johnson G. & Jamieson A. (eds.) Proceedings of a workshop held at Ogongo Agricultural College, northern Namibia, 26th to 29th November 1996, Ogongo, Namibia. 88pp.

Dausab F.; Francis G.; Jöhr G.; Kambatuku J.R.; Molapo M.; Shanyengana S.E. & Swartz S. 1994 "Water usage patterns in the Kuiseb Catchment area: with emphasis on sustainable use, DRFN Occassional Paper No.1, Desert Research Foundation of Namibia, Windhoek, Namibia. 118pp.

Dealie F.F.; Hamata, S.A.; Kambatuku J.R.; Molapo M.; Parenzee L.G. & Soroses F.W. 1993 "What is normal rainfall in Namibia", Desert Research Foundation of Namibia. 13pp.

DRFN 1996 "Namibia's twelve life-lines in the desert", Parliamentary Update No.1(2), Desert Research Foundation of Namibia, Windhoek, Namibia.

DWA 1993 Central Area Water Master Plan, Vols 1-11, Department of Water Affairs(DWA), Ministry of Agriculture, Water & Rural Development(MAWRD), Windhoek, Namibia

Erkkilä A. & Siiskonen H. 1992 "Forestry in Namibia 1850-1990" *Silva Carelica 20*, University of Joensu, Finland. 244pp.

Flower C.; Wardell-Johnson G. & Jamieson A. 1999 "Management of Mopane in southern Africa," Proceedings of a workshop held at Ogongo Agricultural College, northern Namibia, 26th to 29th November 1996, Ogongo, Namibia.

GRN 1998 "National Drought Policy" Ministry of Agriculture, Water & Rural Development(MAWRD), Government of the Republic of Namibia, Windhoek, Namibia.

GRN 1999 "Namibia's National Water Policy" Department of Water Affairs(DWA), Ministry of Agriculture, Water & Rural Development(MAWRD), Government of the Republic of Namibia, Windhoek, Namibia.

GRN 2002 (draft) "Namibia Water Act" Government of the Republic of Namibia, Windhoek, Namibia.

!Guidao-Oab J.; Humavindu M.N.; Kakukuru E.; Ngairorue T.; Nghishoongele; Nghitila T.M. & Ngololo E.N. 1996 "A study of desertification at Engelbrecht." DRFN Occasional Paper No.3, Desert Research Foundation of Namibia, Windhoek, Namibia. p118

Hamilton W. & Seely M.K. 1976 "Fog basking by the Namib Desert beetle, *Onymacris unguicularis" Nature* 262(5566): 284-285

Henschel JR, Dausab R, Moser P (eds). in press. NARA NAtural Resource management by the ǂAonin: !nara fruit as basis for development of the !Khuiseb Topnaar. Ecological and socio-economic factors affecting the potential for development. (With contributions by Berry C., Botha C., Büttendorf U., Dausab D, Gruntkowski N, Hebeler F, Henschel J, Kooitjie S, Moser P., Müller M., Mayer C., Shilomboleni A., van Bel A., Widlok T.). Desert Research Foundation of Namibia and Indigenous Fruit Task Team of Namibia, Windhoek, Namibia.

Henschel J.R.; Robertson M.B. & Seely M.K. 2001 "Animal physiology in the Namib Desert: coping with little water, scarce food & elevated temperatures" In: I. Prakash (ed.). Ecology of Desert Environments (A Festschrift for Prof. J.L.Cloudsley-Thompson on his 80th Birthday). Scientific Publ., Jodhpur, India.

Hutchinson P. 1993 "The climatology of Namibia and its relevance to the drought situation" p1-34 Final draft of a papers presented by authors to a concluding worshop, Safari Hotel, Windhoek, Namibia 8-9th December 1993. NEPRU/UNEP

Inambao C. 2001 "Experts probe feasibility of new refugee camp." Namibian 31st August, Windhoek, Namibia.

Jacobson P.; Jacobson K. & Seely M.K. 1995 "Ephemeral rivers and their catchments: sustaining people and development in western Namibia" Desert Resert Foundation of Namibia(DRFN/DWA, Windhoek, Namibia. p160

Jobst P.; Kakukuru E.; Kambatuku J.R.; Mouton D.; Netha L.; Nghitila T. & Shanyengana S.E. 1995 "An investigation into the biophysical aspects and socio-economics of desertification in north-western Namibia", DRFN Occasional Paper No.2, Desert Research Foundation of Namibia, Windhoek, Namibia.

Johnson O. 1997 "Fencing goes out of control: northern poor being 'cut off' from the land" Namibian 24th October, Windhoek, Namibia.

Kambatuku J.R. 1996 "Historical profiles of farms in former Damaraland" DRFN Occasional Paper No.4, Desert Research Foundation of Namibia, Windhoek, Namibia. 56pp.

Kamwi, J.A. 1997 "Overview of environmental issues in former "Damaraland"" **DRFN Occasional Paper No.7,** Desert Research Foundation of Namibia, Windhoek, Namibia. 57pp.

Kellner, K. & Booysen, J. **1996**. ISPD - Integrated System for Plant Dynamics. *Proceedings of the All Africa Conference on Animal Agriculture in Pretoria*, 1-4 April 1996 (section 5, 5.9).

Kerven C. 1997 "The knife cuts on both sides: redefining rpoerty rights in Eastern Oshikoto region, Namibia" unpublished manuscript.

Maletsky C. 1997a "Fencing goes out of control: northern poor being "cut off" from the land." Namibian 24th October, Windhoek, Namibia.

Maletsky C. 1997b " Govt built boreholes behind my back." Namibian 3rd April, Windhoek, Namibia.

Maletsky C. 1997c " Fencing ban a 'non-starter': Nujoma's moratorium appears groundless." Namibian 24th September, Windhoek, Namibia.

Mamokobo 1995 "Covering Ground", Mamokobo Video and Research, Windhoek, Namibia.

Marsh A. & Seely M.K. 1992 "Oshanas: sustaining people, environment and development in central Owambo" DRFN/SIDA. p57

Matthew C. 2001 "Namibia's biomass energy management programme: results of a baseline survey in northern Namibia.", ProBEC Working Document, Desert Research Foundation of Namibia. 19pp.

Mendelsohn, J.M.; Obeid S. & Roberts C. 2000 "A profile of northcentral Namibia.", Directorate of Environmental Affairs (DEA), Ministry of Environment and Tourism(MET), Windhoek, Namibia.

Mouton D.; Mufeti, T. & Kisting, H. 2000 "A preliminary assessment of the land cover and biomass variations in the Huab catchment." DRFN Occasional Paper No.12, Desert Research Foundation of Namibia, Windhoek, Namibia. 64pp.

Seely M.K. & Hamilton W. 1976 "Fog catchment sand trenches constructed by tenebrionid beetles, *Lepidochora*, from the Namib Desert." *Science* 193(4252): 484-486

Seely M.K. & Jacobson K. 1994 " Desertification in Namibia: a perspective." *Journal of African Zoology* 108(1): 21-36

Seely M., Henschel J. R. and M. Robertson 1998 "**The ecology of fog in Namib desert dunes"** Proceedings of the 1st International Conference on Fog and Fog Collection, 19th to 24th July, Vancouver, Canada. p183-186

Shanyengana, E.S.; Henschel J.R.; Mtuleni V.S. Mwenya E. & Seely M.K. "**Exploring fog as a supplementary water source in Namibia"** Proceedings of the 2nd International Conference on Fog and Fog Collection,15th to 20th July, St.Johns, Newfoundland, Canada. p273-276

Shilombeleni A.; Lubanda P.; Masheshe L.; Muharukua V.; Nawa R.; Nandehasho N.; Noongo E.; Persson J.; Shiponeni N. & Shimali P. 1999 "Potential value of land and water resources in northest Otjozondjupa." DRFN Occasional paper No.9, Desearch Research Foundation of Namibia, Windhoek, Namibia. 94pp.

Storad, C.J. 1991 "Fruit of the Dunes." ASU Research, Tempe, Arizona, USA p3-5

Sullivan S. 1996 "The 'Communalisation' of former commerical farmland: perspectives from Damaraland and implications for land reform." SSD Research Report No.25, UNAM, Windhoek, Namibia.

Suzman J. 2000 "**An Assessment of the Status of Namibia's San Population.**" Land & Environment Development Project (LEAD), Legal Assistance Centre, Windhoek, Namibia.

UNCD 1994 "United Nations Convention to Combat Desertification in those countries experiencing severe drought and/or desertification, particularly in Africa", United Nations, New York, USA. 58pp.

Widlok T. 1996 "!Nara harvesting: a thing of the past." DERU Preliminary report, Desert Ecological Research Unit, Gobabeb, Namibia.

Wolters S.(ed.) 1994 "Proceedings of Namibia's National workshop to combat desertification." Desert Research Foundation of Namibia. p214