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IWRM in Northern Namibia – Cuvelai Delta

Final Report
of a Preliminary Study

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This is the final report of the preliminary study "IWRM in northern Namibia – Cuvelai Delta". The study was part of the ideas competition "Integrated Water Resources Management" for the preparation of projects within the funding focus "Integrated Water Resources Management (IWRM) including the necessary technology and know-how transfers" by the Federal Ministry for Education and Research, Germany (Funding ID IWM 04/29, duration 11/2004–07/2005). Overall aim of the preliminary study was to analyse potentials and hindrances for further development of an integrated management of water resources and their linkages to other natural resources like land and energy. Based on the findings, a joint project for supporting IWRM activities in the Cuvelai-Etosha Basin located in North-Central Namibia has been proposed.

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I. Information on the Model Region

I.1 Definition of the Model Region

The preliminary study relates to the Namibian part of the Cuvelai catchment area, designated by the Ministry of Agriculture, Water and Forestry (MAWF)[1] as the Cuvelai-Etosha Basin. This area lies in North-Central Namibia and includes significant areas of the political regions Oshana, Ohangwena, Omusati und Oshikoto (the so-called Four O'Regions[2]). The model region is bordered by Angola to the north, by the Kunene Region to the west and by the Kavango Region to the east. The southern border of the Etosha Basin also forms the southern border of the model region.

A political process for the administrative division of river catchment areas is currently in progress in Namibia.[3] Because the MAWF has not yet made a conclusive decision regarding the demarcation of boundaries, the following refers to the suggestion developed by Bittner Water Consult under commission from the Ministry in 2004. This divides the administration of the Cuvelai-Etosha Basin into the following four sub-basins: Olushandja, Cuvelai-Iishana, Niipele Odila und Tsumeb (See also Annex 2).

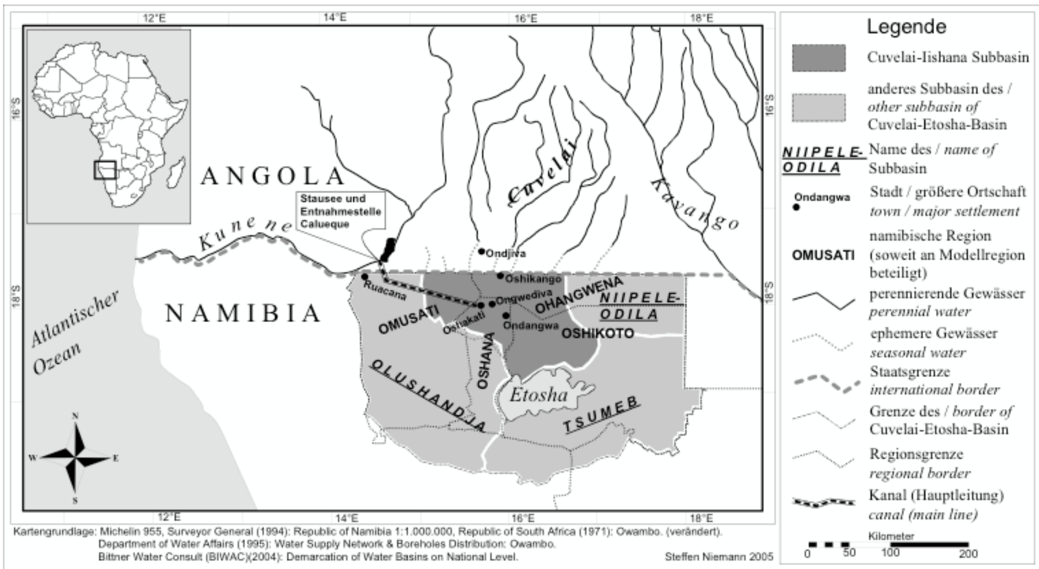

Figure I-1: The Cuvelai Lishana Sub-Basin and its regional environment

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1 The responsibilities of many Ministries were altered in March 2005 within the context of a change of President. The former "Ministry of Agriculture, Water and Rural Development" was renamed to the "Ministry of Agriculture, Water and Forestry".

2 Prior to Namibia's independence in 1990, the Four O'Regions were roughly the equivalent of the Homeland "Ovamboland".

3 The difficulties associated with the division of territories in the IWRM concept represent an important area of the projects work from both a theoretical-conceptual perspective and in the concrete application.

The Etosha Pan forms the lowest lying level of the study area and so determines the drainage direction of surface water. The catchment area for underground water is almost identical with that of surface water and provides the rational for the main criteria for demarcation of the Cuvelai-Etosha Basin. The model region is part of the intracontinental Kalahari Basin. Its eastern and western borders are equivalent to hydrological boundaries (the Kunene and Okavango/Cubango catchment areas), while in the south, the boundary is set by the geological structure, the Damara Sequence.

This region is of particular interest for an Integrated Water Resource Management (IWRM) project because its drinking water is supplied via a long-distance pipeline fed from Kunene River, which forms the border between Namibia and Angola: Because water is transferred across the river basins, decisions made in one river basin have an unavoidable influence on the other basin and vice versa, which makes the situation in the Cuvelai-Etosha Basin politically and administratively volatile. Due to political restrictions and also safety considerations in Angola, the preliminary study mainly concentrates on the Namibian part of the Cuvelai Basin.

I.2 Natural Area

I.2.1 Climate

The climate in the model region can be described as semi-arid, with 96% of the rainfall occurring in the summer months, from November to April – the months with the highest temperatures and the highest evaporation rate. These are the only months in which sufficient rainfall is received for agricultural use (rainfed agriculture). Because the region is located on the west of the continent, which is primarily influenced by trade winds of an easterly direction, the rainfall diminishes from an average of 550-600 mm in the east of the region to around 300 mm in the west. This east-west pattern of rainfall distribution is superimposed by a north-south decrease in the volume of rainfall caused by influences of the relief.[4]

High rainfall variability is an important characteristic of the region's climate. This relates to both the absolute volume of rainfall[5] and the point in time when rainfall is received and represents a high risk factor, especially for agriculture.[6] Another factor that limits water availability is the evaporation rate, which at an average of 2,500 mm per year, is five to six times the volume of the annual average rainfall. The evaporation rate is dependent on the factors temperature, humidity, wind and vegetation cover, and since the main volume of rainfall is received in the hot and

4 Cf. MENDELSOHN et al. 2000: 9, NIEMANN 2000: 72ff.

5 For example between 158 and 518 mm of rainfall were measured annually in Oshakati between 1986 and 1990. Cf. REPUBLIC OF NAMIBIA, NATIONAL PLANNING COMMISSION 1992: 10

6 Cf. MENDELSOHN et al. 2000: 9, NIEMANN 2000: 72ff.

windy months, most of the rainwater is lost through evaporation. The overall Namibian evaporation rate of 83%[7] provides an indication of the amount of rainwater lost immediately through evaporation, whereby it must also be taken into consideration that 14% is lost through evapotranspiration. This leaves only three percent to supply groundwater or rivers.[8] Although northern Namibia has high rainfall in comparison to the rest of the country, high temperatures mean that the situation is not significantly different here.[9] But not only is dryness a threat to agriculture in the region; above-average rainfall combined with highly variable rainfall volumes often lead to loss of the harvest.[10] In short, it is evident that rainfall for the regional water supply is limited to just a few months, is of insufficient volume due to the high evaporation rate and represents a very unreliable source of water due to its irregular distribution. The effect of climatic change on Namibia, particularly on the four O' Regions can only be described in very vague terms at this point in time[11] – partly due to the described variability.

Further, the lack of historical climatic data makes it difficult to develop reliable scenarios. However on the basis of assumptions derived from global climatic scenarios, the entire SADC Region can be expected to become hotter and drier over the next 50 years and extreme events and also rainfall variability can be expected to increase. For the areas influenced by tropical summer rain, which includes North-Central Namibia, some scenarios assume an increase in rainfall and especially intensive periods of rain that can result in flood catastrophes. At the same time, it is feared that droughts will be more frequent and more extreme and that El Niño events and their consequences will increase.[12]

I.2.2 Geological, Pedological and Topographic Conditions of the Water Resources in the Cuvelai-Etosha Basin

From a geological perspective, the Cuvelai-Etosha Basin lies within the Ovambo Basin, which in turn is part of the Kalahari Basin. The climatic history of alternate wet and dry periods over the last 70 million years has resulted in the Ovambo Basin being filled with layers of sand, silt and clay, producing a landscape with an altitude of between approx. 1,090 und 1,150 m above sea level and marked by little

7 DEPARTMENT OF WATER AFFAIRS, quoted by NIEMANN 2000: 76

8 Cf. GOLDBERG 1989: 25, DESERT RESEARCH FOUNDATION OF NAMIBIA et al. 1992: 7

9 Cf. NIEMANN 2000: 77

10 Cf. NIEMANN 2000: 80

11 Changes in climate have intensified the fluctuation in the beginning of the rainy season. This brings increasing problems for use and prognosis for the germination of life-sustaining grain. The consequence is the migration of the rural population to the cities in the region but also beyond the region and further soil degradation, increasing health problems (water hygiene, malnutrition) and unemployment.

12 Cf. TARR 1998: 15ff.

relief. Higher areas of between 1,200 and 1,500 m are only found on the periphery of the basin.

The landscape at the centre of the Ovambo Basin is dominated by the Cuvelai alluvial marshes, which have their source in Southern Angola and flow southwards over the Namibian-Angolan border in a delta-like network of many small waterways. On the Namibian side, the Cuvelai streams, locally known as Oshanas ("iishana"), only carry water sporadically/seasonally. The raised, flat areas between the multitude of interconnected Oshanas are often used for agricultural production. The water of the shallow Oshanas usually evaporates or seeps away, or in years of abundant water, collects in Lake Oponono before finally flowing into the Etosha Pan.[13]

Agricultural production in the Cuvelai Delta is also limited by the high proportion of sand in the soil, which gives it little capacity for water retention. In addition, nutrients are limited to a thin humus layer; the nitrogen content is too low to permit horticulture. The use of nitrate fertilisers can lead to high toxicity due to a lack of the trace element molybdenum.[14]

I.2.3 Hydrological Conditions: The Presence of Surface Water and Groundwater and their Development

The principle life-supporting resource and the most easily developed and accessible water source in North-Central Namibia is the Oshana water in the Cuvelai Delta, which is dependent on rainfall in Angola and Namibia. In the absence of a more sustainable alternative, this represents a very important, traditional water source in spite of the fact that, due to high evaporation, it is only available during the wet season. Groundwater is the second most important source or water supply in Ovambo tradition[15]. Good sources of groundwater have always been rare, which increases their importance for the population.[16]

Distinctions must be made in the quality of groundwater levels in the Four O'Regions. In some areas they overlay each other, separated by water impermeable layers. The increasing soil and groundwater salinity is mainly the result of the alternating water situation: although good water permeability could be expected of soil comprised of over 60% sand, single layers of clay and loam deposits often lead

13 However the last time that water from the Cuvelai reached the Etosha Pan as surface water was in 1954. Cf. NIEMANN 2000: 51f., MENDELSOHN et al. 2000: 7f.

14 Cf. MARSH/SEELY 1992: 14

15 The Ovambo ethnic group represents the majority of the population in Namibia as well as the majority of the population of the Four O'Regions. It is assumed that the Ovambo settled in the south of present day Angola and the Four O'Regions in the course of the southwards migration of Bantu tribes in the 16th century. They do not form a homogenous group but are rather divide themselves into kingships, which still exist today (cf. MARSH/SEELY 1991: 1).

16 Cf. NIEMANN 2000: 88

to low permeability. So rather than moistening the individual layers of soil, which would be welcome from an agricultural perspective, the wet season too often results in many days or weeks of flooding with high evaporation and the associated phenomena of salinity.[17]

The higher lying groundwater levels are traditionally accessed by hand-dug wells. With a depth that rarely exceeds ten meters,[18] these conical hand-dug aquiferous pits, referred to locally as "omifima", are fed by rainfall and run-off water and are usually available only to a limited extent and for a limited period. Depths of more than 30 m are reached by the "oondungu", which are also usually hand dug, but which have a lining of tiles, cement or wood. In contrast to the "omifima", these can be regarded as permanent water sources, which at most run dry during prolonged periods of sustained drought. There are considerably more "oondungu" in the western and southern fringes of the Four O'Regions than in the central area on account of groundwater salinity.[19] In the past, these aquifers represented the most important source of drinking water in many rural areas in the Four O'Regions. The volume of both traditionally used, higher water tables has proved to be very limited over time and therefore inadequate for a comprehensive supply. The fact that alongside surface water and rainwater, groundwater accessed using traditional methods also fails to provide an adequate water supply, makes the groundwater situation an important determining factor in the establishment of settlements in the Four O'Regions.[20] There is a third water table at a depth of 60 to 80 m. However, this is very saline especially in the highly populated, central part of the region.[21]

The region can therefore be divided into three zones with different water resources: A maximum salinity of 1,000 mg/L TDS, which is identified by the World Health Organisation as the maximum possible salinity level for drinking water, is found only on the periphery of the model region. As we move from here towards the centre of the region, we find zones of groundwater with a salinity of between 1,000 and 5,000 mg/L TDS, a level that is only acceptable for watering livestock. Finally, large areas of the central and more densely populated parts of the region demonstrate a groundwater quality of over 5,000 mg/L TDS; here the water is too saline (sodium, fluorine, sulphate) for any possible use. Useable groundwater is found almost exclusively in the north eastern area of the Four O'Regions. Freshwater lenses can be used to supply remote schools or hospitals in some parts. Less saline aquifers are often found between or above the saline water tables and it is possible to use boreholes to access this water for use in the immediate area.

17 Cf. DESERT RESEARCH FOUNDATION OF NAMIBIA 1992: 12

18 Cf. NIEMANN 2000: 88ff.

19 Cf. DESERT RESEARCH FOUNDATION OF NAMIBIA 1996: 42 and map included in Annex 2

20 Cf. NIEMANN 2000: 95f.

21 Cf. NIEMANN 2000: 97

It is not the general availability of groundwater in the Four O'Regions that poses the most pressing problem, but above all, the water quality.

I.3 Cultural, Social and Economic Requirements

I.3.1 Outline of the historical and political development of the Cuvelai region

It is estimated that the region has been inhabited by the Ovambo since the 16th Century and was assigned reservation status by the Colonial German Government at the beginning of the 20th Century. To consolidate the system, from 1917 onwards local inhabitants were forbidden from participating in any economic activity outside the region unless it was related to the contractually regulated work in the mines or similar.[22]

Legislation and the general condition of the social and transport infrastructure created by the South African Government's neglected the region and left the employable, male population no other alternative but migration.[23] In the course of applying apartheid legislation to Namibia and the designation of the Homelands "Ovamboland", the living conditions in the region and in the itinerant worker's settlements deteriorated rapidly. A resistance movement began in 1957, which developed into a war in 1966 and led to the declaration of a state of emergency within the region and the cordoning off of the area.

The situation first changed for the population of the Four O'Regions with independence in 1990. The newly-won freedom of movement following the end of the Homeland status was an important change. The followers of the governing South West Africa People's Organisation (SWAPO), unchallenged since 1990, were primarily recruited from the Four O'Regions and consequently the improvement of living conditions – especially in this region – was of central concern for national politics.

I.3.2 Institutional framework and land rights

With independence, the institutional framework of the former Homeland Ovamboland also changed. It was – with the addition of the Tsumeb region, which formerly belonged to the "white farm zone" – divided into four administrative units (Ohangwena, Omusati, Oshana, Oshikoto). In addition to the traditional authorities, a new democratic institutional landscape was created, which now governs the region together with the traditional institutions. The traditional institutions, which are based on eight old kingdoms[24], were not robbed of their power, which considerably lies in

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[22] Cf. HAYES 1998: 124f., SMITH 1986: 27

[23] Cf. HAYES 1998: 124

[24] At the time of settlement the Ovambo divided themselves into different groups. This process provided the basis of the grounding of the Ovambo Kingships of Ondonga, Uukwanyama, Ogandjera, Uukwambi, Uukwaluudhi, Ombandja and Ombalantu. The independent Kingships played an im-

the allocation of land use rights. On the contrary, some authors assert[25] that the power vacuum of the restructuring period that followed independence and the associated insecurity in the population led to a greater endowment of power in traditional authorities. During the South African Mandate period, the power of selected traditional authorities had been instrumentalised and artificially strengthened by the central government. Consequently, the institutional landscape of the Four O'Regions can be divided into state and traditional institutions today. In addition to "Regional Governments", which have an administrative office in each of the four administrative units and which recruit from a total of 41 electorates, the state institutions include "Local Governments", which are comparable to the Municipal or City Administration.

There are eight traditional institutional systems within the Four O'Regions, each of which possesses its own legislation and political structures and is headed either by a king together with a Council of Elders or by a "Senior Headman". The main tasks of the traditional authorities are related to the appropriation of land, the assignment of grazing rights and the resolution of conflicts.[26]

Since independence, the assignment of land and land ownership has been regulated by the Constitution of the Republic of Namibia (Art. 16) and the "National Land Policy" (1998). In the case of *Communal Lands*[27], both pieces of legislation stipulate that the State is the owner of the land. Traditional authorities were previously in possession of this land and they regulated its appropriation using customary law. Further, the constitution stipulates that both systems of rights, the traditional and the general legislation are valid in Namibia, as long as the two legal systems do not come into conflict with one another.[28] The "Communal Land Reform Act" was enacted in 2002 and brought into force in 2003 to regulate the communal appropriation of land.[29] This Act has the specific goal of securing the application of customary law in respect to land ownership and therefore of protecting the disadvantaged, poor population groups in the Communal areas against the loss of their ancestral lands. The heart of the "Communal Land Reform Act" is that all land rights must be registered and that a distinction is made between customary law and leasehold rights. In relation to land ownership under customary law, the traditional authorities retain the right to allocate land or to withdraw the title of possession. At the same time, the administration of customary rights has been formalised and institutionalised in "Communal Land Boards". These control the allocation and with-

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portant role in the distribution and use of land and other resources such as water, trees, grass etc. and in guaranteeing sustenance (cf. WILLIAMS 1991: 116ff.).

[25] Cf. WERNER 2000: 3ff.

[26] Cf. MENDELSOHN et. al. 2000: 45f.

[27] The private ownership of property was not permitted in the former Homelands – which accounts for the established term "Communal Lands" in the country and the region.

[28] Cf. WERNER 2000: 3f., BLACKIE 1999: 5ff.

[29] The assignment of commercial land is also regulated by legislation, however these regulations are not relevant since commercial agricultural areas are almost non-existent.

drawal of titles of possession and secure them through the issue of certificates of possession. There is close cooperation between the "Communal Land Boards" and the traditional authorities.

According to "Communal Land Reform Act", land that is not assigned under a customary law title of possession should be made available for agricultural use under leasing contracts. This new legislation limits de facto the traditional authorities' power of control since it brings land that was formerly administered under customary law under State control. Nevertheless lease agreements can only be entered into with the approval of the traditional authorities on the "Communal Lands Board".[30] Land Boards have been established in the model region and the registration of titles of possession has begun. There has been no open, violent conflict over the allocation of land to date.[31] However it is assumed that the various centres of power involved in the allocation of land are not (yet) stable, especially in the city areas and it therefore remains unclear just how problematic the land question will be here.[32]

I.3.3 Population Distribution, Migration and Household Income

Central-Northern Namibia is the most densely populated region in the country – in 2001 780,149[33] people, which represents around 50% of the total population (See Annex 2), lived on approx. 15% of the total area of the State. The greatest population density is found in the urban areas of Oshakati, Ongwediva and Ondangwa, which have experienced rapid growth over the last 30 years. The extreme population growth and dense settlement, especially in the Oshana region, exert severe stress on the fragile ecological system and therefore pose a threat to the population's livelihood. The population that does not live in the urban area lives strewn in single homesteads, which has led to urban sprawl across the land and a shortage of resources, i.e. agricultural land and pastures, water and wood.[34] Further, the overuse of land (agriculture and livestock breeding) has already lead to obvious soil degradation.

The development of settlements in the model region is strongly influenced by the availability of drinking water. From the beginning to the middle of the 20th Century, a large proportion of the population settled around the Oshanas described above or in areas with easily accessible, drinkable groundwater. Consequently settlement concentrated around Ondangwa, Oshikuku, Okahao, Tsandi and Onesi, and then slowly developed in the area in between. Today there are urban structures in the Cuvelai Delta outside the urban centers of Oshakati und Ondangwa, especially along

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30 Cf. WERNER 2003: 10ff.

31 Verbal information, B. Fuller, NEPRU, March 2005

32 Cf. GRAEFE 2003

33 Cf. CENTRAL BUREAU OF STATISTICS 2003. The cited data is derived from the official population census of 2001; a census is carried out every ten years.

34 Cf. MARSH/SEELY 1992: 21

the main road between the two locations and to the west of the Ohangwena administrative area. Population densities of up to 300 persons per km^2 can be found outside the urban centers. Beyond these densely populated areas, the population density in the Cuvelai Delta drops rapidly to between 10 and 40 persons per km^2.

The population of the Four O'Regions has increased at an average annual rate of 2,8% since 1980 and has consequently doubled within the last 20 years.[35] However, it can be expected that this growth will slow down in coming years and that the population structure will be subject to dramatic changes. In addition to the immune deficiency disease AIDS, this change is expected to be brought about by changes in the fertility and migration rates.

As mentioned above, the rapid spread of HIV/AIDS in den Four O'Regions has had a significant effect on the population growth rate. It is estimated that more than 24% of the population was infected with the virus in 1998 and in 2002 the statistic for the densely settled region of Oshana exceeded 30%.[36] It can be assumed that this trend has not altered significantly in the recent past.

Most effected is the population of reproductive and therefore also of employable age, with corresponding negative consequences for the economic and social structure within the region.[37]

Supported by interregional and intraregional migration, the population structure of the Four O'Regions displays a number of idiosyncratic features that distinguish it from other areas in Namibia: In all four administrative units, the number of women exceeds the number of men especially in the ages between 20 and 60 years.
Three relevant streams of migration can be identified:

- Firstly, the region was and is a destination for migrants from Angola.
- Secondly, it is above all young men of employable age who migrate, mainly to Namibia's political and economic centres, particularly the capital city Windhoek and the coastal areas of Walvis Bay and Swakopmund. Migration for employment purposes leads to a loss of men between the ages of 25 and 44 from the Four O'Regions. In contrast, many migrants return to the Four O'Regions when they retire, which results in increasing numbers in the over 55 age group.[38]
- Thirdly, an additional stream of migration within the Four O'Regions is the migration from rural areas to the urban centres Oshakati, Ondangwa and Ongwediva. The example of Oshakati clearly illustrates the extent of rural-urban

35 Cf. MENDELSOHN et al. 2000: 36

36 Cf. FHI Namibia 2005

37 Cf. MENDELSOHN et al. 2000: 43

38 Cf. MENDELSOHN et al. 2000: 40f.

migration: In 1981 Oshakati had 3.700 inhabitants; 20 years later, its population had already reached 28.255.[39]

Many household incomes are derived from combination of subsistence economies and supplementary income sources such as wages from itinerant work or other employment (e.g. public servants).

	No. of households	Percent distribution of households by main source of income (2001)						
		Farming	Business activities (non-farming)	Wages and salaries	Pension	Cash remittance	Other	Not stated
Ohangwena	35.958	51,7	7,5	13,0	20,4	4,7	1,3	1,3
Omusati	38.202	45,5	7,5	16,0	22,0	6,1	1,9	1,1
Oshana	29.557	35,8	12,5	32,3	11,5	5,2	1,5	1,2
Oshikoto	28.419	56,3	6,1	20,6	10,6	3,2	1,5	1,7

Source: Central Bureau of Statistics (2003)

This dynamic mix of various income sources distinguishes household income in the model region from that of many other African communities. The wealth or poverty of a household is closely linked to the number of family members and so to the labour power available for agriculture and other employment. The average size of a city household varies from five to seven members depending on the region; averages of eight to nine persons can also be found in rural areas.[40]

The current population projections assume continued, positive population growth whereby the existing heterogeneity in the region is expected to continue and the greatest population growth is expected to occur in the densely populated region of Oshana.[41]

I.3.4 Economic Structure

The economic structure of the region is dominated by small scale agriculture. The land is used for the cultivation of crops, livestock breeding and of significantly less importance, forestry. The main product is drought tolerant millet, which is cultivated primarily for local consumption. The millet fields occupy approx. 90% of the

39 Cf. MENDELSOHN et al. 2000: 41, CENTRAL BUREAU OF STATISTICS 2003

40 Cf. MENDELSOHN et al. 2000: 66, CENTRAL BUREAU OF STATISTICS 2003

41 Cf. MENDELSOHN et al. 2002: 166

cultivated land. Sorghum, beans, pumpkin and melons are also grown, sometimes cultivated as interim crops between crops of millet. In the Four O'Regions, all crops are cultivated using rainfed agriculture so that the volume of produce varies greatly, not only from year to year but also from field to field. Irrigation exists only on a state experimental farm in the northern Omusati region[42] and on a few farms in the area around Tsumeb, which do not lie in the immediate area of influence of the Cuvelai. Only very few farmers use synthetic fertiliser to increase their crop return. Above all, organic material is used to improve soil quality.[43]

The second most important agricultural activity in the region is livestock breeding. In addition to being a sign of prosperity, the possession of livestock is a source of animal derived foodstuffs (e.g. milk and meat) and also for manure. The structure of livestock ownership appears to have changed significantly in recent years. While in the past most households kept a large number of cattle, a concentration process appears to be in progress, whereby livestock breeding is concentrated among fewer households. There is broad variation in livestock farming within the Four O'Regions, in terms of both the number and nature of livestock kept. Due to their symbolic value and because they produce the greatest amount of meat, cattle are the most important animals in the region. The average number of cattle per household is six, however 80% of the cattle in the Four O'Regions are owned by only 20% of the households. Prosperous persons, usually shopkeepers or government employees own the largest herds of cattle in the region. Goats are kept by a much larger number of households than cattle. The average number of goats per household is more than twelve however it can be established that one third of households do not possess any goats. Poultry also represents a large proportion of the livestock held: 90-95% of all households keep chickens.[44]

An elaborate system of transhumance has been developed in the Ovambo region as a means of providing sufficient food and water for the cattle: at the end of the dry season, the animals are driven to the "Ombuga", grassland and scrubland to the south, south-west and east of the Ovambo region. Then at the end of the wet season, they are brought back to the more densely settled regions, where they can graze on the harvested fields. Various factors have altered this system of transhumance in recent years. Firstly, the previously limiting factor, water has become much more accessible in many areas through the development of the long distance

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42 Although agriculture with irrigation is insignificant in the model region, the Omusati regional development plan formulates the goal of opening up regional development perspectives through improved water supply (water harvesting) but also through modified cultivation methods. concrete projects have already been initiated, e.g. "Smallholder cash crop production, processing and marketing in Omusati" or "Irrigated crop production in Elim, Oshikuku, Okalongo and Ogongo" (cf. OHANGWENA REGIONAL COUNCIL 2000, OMUSATI REGIONAL COUNCIL 2000, OSHANA REGIONAL COUNCIL 2000, OSHIKOTO REGIONAL COUNCIL 2000). The local activities could be supported and supplemented through the planned joint project.

43 Cf. MARSH/SEELY 1992: 23, MENDELSOHN et al. 2000: 51f.

44 Cf. MENDELSOHN et al. 2000: 55

supply line, which allows the animals to remain in the vicinity of the watering place. Through the illegal fencing and therefore the quasi-privatisation of increasingly large areas that previously belonged to communal pastureland, the pastures that are not fenced are subject to ever increasing use. The combination of these two factors increases the degradation of the communal pasture areas.[45] An accelerating problem spiral can be identified here: The growing population numbers on the one hand and on the other, the water supply, ensured for the time being by the long-distance pipeline, leads to an increase in the now concentrated cattle herds. The increase in livestock concentration per hectare increases the pressure on soil resources and so leads to a progressive degradation of land and water resources. There are also conflicts regarding the "right" to water.

A further economic activity that is typical of the Four O'Regions is the active involvement in trade. In addition to the conspicuous Cuca Shops[46], which are estimated to number 7,000[47], the urban areas have large shopping malls with South African, Lebanese and Iranian trading companies and wholesale trading centres whose proprietors come from the region. There is almost no industry in the region. There is also trade across the border with Angola.[48] However, in recent years the local market has met increasing competition from abroad. Trading houses from Botswana and China offer their products at dumping prices, especially on the Angolan border. The low level of industrialisation in the region can be attributed to the relatively small domestic market within Namibia and also within the region, but also to the strong dominance of South African products whose high standards and low prices retard industrial development within the region. Where industrial production is found in the Four O'Regions, it exists only in small and middle-sized businesses. Most are family businesses, involved in the production of textiles, furniture or car parts for niches in the local market. Food stuffs such as sugar, vinegar and flour are also produced to a lesser extent. Nothing has changed in this respect, even in the Export Processing Zone in Oshikango near the Angolan border, which was made possible by the EPZ Act of 1995. As indicated, it is mainly foreign stores rather than industrial companies that have established themselves here.[49]

I.4 Infrastructure with Special Consideration of the Water Infrastructure

The development of infrastructure in the model region must be viewed against the background of the natural, cultural, social and economic conditions described above. For example the vigorous trading activity is supported by the – for a rural area in a developing country – exceptionally well developed transport network. The

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45 Cf. MARSH/SEELY 1992: 28f., MENDELSOHN et al. 2000: 57ff.

46 Small mixed goods shops are referred to as Cuca Shops in the Ovambo region.

47 Cf. HALBACH 1999: 280

48 Cf. MENDELSOHN et al. 2000: 68

49 Cf. KNUTSEN 2003: 559; MOYO 1999

South African Government pushed development of the main roads for military purposes during the war of independence. Because they were developed only for military purposes, they do not reflect the needs of the rural population today. There are still basic deficiencies here[50] in spite of substantial effort by the Government since independence. There is also no comprehensive water or electricity supply. It is assumed that approx. 110,000 people (approx. 15% of the population of the Four O'Regions) live further than 2.5 km from clean drinking water.[51] More problematic is the provision of sanitation, especially in the predominantly rural regions of Ohangwena, Omusati and Oshikoto. 88.8% of households in the Ohangwena region and 83% of households in the Omusati region have no access to sanitation and even in Oshana, the area with the best sanitation, almost half of the households lack facilities.[52] But a special dynamic can also be identified in the urban areas: above all the periurban areas, including the rapidly growing, unofficial settlements cannot be supplied with water and sanitation as rapidly as their populations are increasing.

Population growth and political developments led the South African Colonial Administration to pay increased attention to the question of water supply in the former Homeland Ovamboland during the first half of the 20th Century. The methodical construction of dams, particularly using the process of deepening the existing Cuvelai streams, began in an attempt to improve the ability to store rainwater.[53]

The first major artificial intervention in the water balance and circulation in the region brought a significant improvement at the location of the dam but led to a clear drop in the water level in wells south of the newly created barrier. Nevertheless dam construction was increasingly pursued till the middle of the 20th Century and finally in August 1954[54] coordination finally began with the first five-year plan by the State Water Resources Management Department. Its goal, to secure the nutritional situation and population growth, was to be achieved through the improvement of dam technology, the construction of boreholes to access the previously unused groundwater and through the construction of connecting canals.

Consideration was given to the possibility of redirecting Kunene water to supply Northern Namibia as early as the beginning of the 20th Century. However, the decisive factor for construction of the long distance pipeline system came in 1974 when the South African Army established a military camp in Oshakati. The water supply for the camp had to be guaranteed.[55]

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50 Cf. MARSH/SEELY 1991: 22

51 Cf. MENDELSOHN et al. 2000: 16

52 Cf. CENTRAL BUREAU OF STATISTICS 2003

53 Cf. WIPPLINGER 1966: 1

54 Water from the Cuvelai last reached the Etosha Pan in this year (cf. Section I.2.2).

55 Cf. NIEMANN 2000: 108f.

On the basis of contracts concluded between South Africa and Portugal for that purpose in the 1960s, Kunene water first flowed from the source Calueque, in Angola through a 160 km long canal to the recipient dam in Oshakati in 1973. From a South African perspective, this appeared to provide the Northern Namibian water supply with a long-term, secure basis from the beginning of 1974.[56]

The South African mandate government pursued the further development of the remote pipeline network south of the border without consideration of political changes on the upper reaches of the Kunene in Angola. In 1975 work began on the construction of an inland reprocessing plant and a pipeline for the transport of purified water.[57] In comparison to the canal, the pipeline has the advantage that it runs under the crossing Oshanas (or also above them) and can therefore prevent the damming of the Oshanas (resulting in increased water shortage in the south of the region). The separating effect of a canal has not only dangers for the part of the region cut off by the surface water: it is not uncommon for livestock that come to drink in the canal, to fall in and drown since the cement framework makes escape impossible. The inhabitants draw the polluted water for drinking and household purposes; sickness is often the result. There was discussion about whether a pipeline or a canal should be constructed to transfer the necessary volume of water from the start of construction.[58] In end effect, cost considerations were the main influence in the decision to construct an open canal for the main supply to Ogongo (purification plant) and first from here to transport the purified water through a pipeline and distribute it via branching lines.[59] Between 1972 and 1977 a concrete dam was also constructed in the vicinity of the Namibian town of Olushandja, i.e. in proximity to the point where water is drawn from the Kunene. The intention was to store water taken from the Kunene on the other side of the city boundaries in a reservoir with a surface area of 29 km^2 and so make it possible to “compensate” for seasonal deviations in flow.[60] This system continues to be developed.

The hydroelectric power station planned for below the Ruacana Falls in 1968 finally went into operation in 1978. With a supply capacity of approx. 200 Megawatt, it supplies around two thirds of Namibia’s electricity requirements.[61] The ambitious plans for an additional eleven electricity generation projects[62] on the lower Kunene fell victim to aggressive confrontation between South Africa, SWAPO, the Angolan

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56 Cf. NIEMANN 2000: 110

57 Cf. DESERT RESEARCH FOUNDATION OF NAMIBIA et al. 1992: 17

58 Cf. SOUTH WEST AFRICA ADMINISTRATION 1968: 61f.

59 Cf. NIEMANN 2000: 111f. In the meantime there are four purification plants along the dam which continues to Oshakati, which provide their respective surroundings, i.e. the purification plant at Oshakati supplies the easterly lying regions with purified drinking water.

60 The four high dam walls provide the Olushandja Dam with a capacity of 42 million m^3 of water (cf. REPUBLIC OF NAMIBIA, NATIONAL PLANNING COMMISSION 1992: 90f.).

61 Cf. SCHNEIDER 1989: 215

62 Cf. SCHÜMER 1977: 307

Government Army and the UNITA. Regardless of these difficulties, a central goal of the long distance pipeline network was achieved: in 1979, the State Department of Water Affairs in South-West Africa/Namibia established with satisfaction that they had managed to eradicate drought-caused famine in Ovamboland.[63]

In May and June 1989 – parallel to the internal political upheaval in Namibia – negotiations were renewed with the Angolan Government. The aim was to complete the Calueque Dam as quickly as possible and so stabilise the Ovamboland water supply. At the same time, it was intended to extend the electricity generation facilities at the Ruacana Waterfalls.[64] The establishment of a joint border committee in May 1990 followed four months after signing a cooperation contract for the development and use of the Kunene's water resources. In January 1991 when the Namibian President, Sam Nujoma, first visited the Angolan Government led by José Dos Santos, the Kunene was considered a mutual resource particularly in respect to water and energy supply.

Completion of the canal from the Kunene to central Ovamboland and its numerous connections considerably reduced the necessity of resorting to the use of Oshana water in many areas. An important argument for the use of piped water is undoubtedly the questionable hygiene of using the stagnant, i.e. indiscernibly flowing Oshana water.[65] At the same time, efforts were invested in – at least during the construction phase of the main canal – not leaving the periodically available surface water unused in those areas that could potentially be supplied by the canal. In spite of such attempts to also made use of the surface water, it was observed that the absolute volume of canal water used in the settlements connected to the network, such as Oshakati and Ondangwa, was steadily increasing.[66]

Today the long-distance water supply network is operated by the national water supplier, NamWater, a private company owned by the State. NamWater supplies water to the urban areas and their environments. It operates its own network for further distribution and can control the supply to areas of need (bulk water supply).[67] The water supply in rural areas is currently controlled by MAWF (Department of Rural Water Supply). The associated infrastructure is owned by the State; in some cases NamWater functions as operations manager for facilities in rural areas, i.e. the State uses NamWater's expertise for construction, repairs and maintenance. NamWater supplies water for a price of 5.58 Nam\$/m^3 (approx. 0.68 EUR) in the model region. The cities also levy an administration charge for water redistribution so that the water price for the end customer lies at approx. 6 Nam\$/m^3. This pricing policy

63 Cf. NIEMANN 2000: 114ff.

64 Cf. SCHNEIDER 1989: 226

65 Cf. GOLDBERG 1989: 93

66 Cf. STENGEL 1965: 210, NIEMANN 2000: 116

67 NamWater also supplies some water directly to private connections when these are located on the existing NamWater network.

attempts to cover the operating costs however, according to NamWater and the MAWF, this is not achieved in all parts of the area supplied in the model region. Measures are being taken to enforce the pricing policy.

II. Further Development of the IWRM in the Model Region

II.1 Relevant Problem Dynamics

The comparatively high population density and high population growth generate a problem dynamic in the model region: the number of people to be supplied is a challenge not only for the water supply and waste water disposal, but also for the supply of food. On the basis of a simple projection, it can be assumed that increasing population numbers – without change in the supply systems – will exert increasing demand on the supply of drinking and household water and cause increasing pollution of the few available freshwater resources due to the lack of or inadequate waste water disposal systems, particularly in urban areas. This is also associated with an increase in hygiene problems, not only in the city but also in rural areas where there is often no sanitation. Further, securing the food supply increases the pressure on soil resources (increasing degradation due to poor agricultural practices and growing livestock numbers) and also increases the demand for water for agriculture. The progressive loss of communal areas for grazing and the consequent increase in the number of livestock per hectare is also problematic for pasture farming.[68] If water for livestock were secured using a purely supply orientated strategy, the pressure on soil resources would increase since secure water sources are also likely to attract increasing livestock numbers. A consequence of the shortage of the resource land and the deteriorating soil quality is increased migration of the rural population to city areas with corresponding consequences for both the social structure in rural areas and for resource problems in the city areas is.

Current technology can only provide a limited response to the overall increasing pressure on the water infrastructure: In the central parts of the model region the groundwater is too saline for human consumption or agricultural use in the absence of desalination facilities and the surface water (Oshana System), like the rainfall, is subject to high variability, which is expected to further increase in the future (climate change). Although the model region lies in one of the more favourable regions of Namibia, it must be stated that the surface and groundwater resources are currently overused and that there are simultaneously conflicts over water rights. At the moment, it is possible to guarantee the supply of drinking water wherever there is a connection to the remote water supply. However, there are two central challenges: firstly, the development of the water supply in rural areas that have neither access

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68 This is increased through the investment in the land and livestock by families that have achieved a certain level of prosperity through trading activity or itinerant labour, whereby increasingly large parts of the model region are moving into private ownership and so the agricultural land available to the poorer sectors of the population is reduced.

to boreholes nor to the long-distance pipeline and secondly, the increasing insecurity of the continuity of the long-distance water supply, if an increased demand for water occur on the Angolan side. There is increased competition for use on various levels: between the sectors within the model region and between the model region and the neighbouring areas, especially Angola. Therefore, in addition to demand-oriented management considerations (rational water use), it is also necessary to develop alternative water sources and so minimise the redirection of water from the Kunene, avoid any (potential) conflicts for use and establish a multi-resource mix. In light of the existing, not only natural difficulties associated with water quality (lacking or inadequate collection of waste water or leaking supply lines), various technologies for the establishment of new water sources such as rainwater collection, decentralised desalination and artificial groundwater enrichment must be considered as elements of a multi-resource mix. This applies equally to the use of waste water as a resource for the generation of energy, mineral nutriments (nitrogen and phosphorous for the degraded soil) and humus. The consideration of water pricing that selectively steers patterns of consumption is very important in conjunction with a multi-resource mix that provides a use-specific regulation of water requirements (e.g. water quality dependent on the proposed use).

The generation of income from (small scale) agricultural activity, i.e. the manufacture of products for local markets will be a central component in the fight against poverty and a means of securing the region's economic potential. Securing natural resources, especially soil and water is a prerequisite for these activities. However, there is the danger that the problem spiral associated with the quantity and quality of these resources, described at the beginning of this chapter, will intensify. The border river, Kunene will not only supply drinking water for the model region in the future, but will be of increasing importance for irrigated farming in both of the bordering states (also for energy production and therefore also for manufacturing and industry).[69] It is unlikely that the various sectors and the rivalling uses associated with them can be adequately regulated by existing institutional structures because the current water and land rights reforms are too loosely coordinated. This is one of the greatest challenges of the IWRM process: the infrastructure systems must be able to support themselves organisationally and financially in the long term. Water and the regional economy must become reciprocally stimulating factors. The current "weak governance" resulting from the top-down organisation of the administration requires comprehensive participation processes to achieve institutional consolidation in the reform processes. This requires great political effort, financial resources and long-term perseverance because the processes must be readapted again and

69 There are plausible strategies that consider Northern Namibia and Southern Angola as a single economic area. This could be realised through joint investment and joint use (joint development of the supply network, investment in irrigation for agriculture, joint use of energy resources etc.) The success of such initiatives must be viewed from a historical and political context in the first instance since it entails a complex and difficult process, for which measures for developing trust and a joint understanding of the problems and possible solutions is central.

again.[70] A suitable instrument must be found, which is capable of balancing existing and potential conflicts in water use (a multi-criterial, multi-dimensional decision support system). This should bring the water-related sectors and uses into an equitable balance and direct them into a corridor of social-ecological regulation.

II.2 Status of the IWRM Implementation

The current change in the Namibian institutional landscape and in particular the restructuring within the water sector, prompted by the decentralisation process, make this a particularly favourable point in time for cooperative development of the Namibian IWRM concept with local partners. In addition to the Millennium Development Goals as quasi globally-targeted objectives, a further positive condition is the self-imposed commitment of the Namibian Government, in the National Water Policy White Paper (2000) and in Vision 2030, to the integrated management of water resources as a leading policy principle*: "It is recognised that the enforcement of Integrated Water Resource Management and Water Demand Management strategies are essential if our goals regarding social well-being, economic development and environmental health are to be realised."*[71] Water is recognised as a necessary resource for life here, making holistic management and the integration of land and water use indispensable.[72] The cross-sector and cross-department coordination of all water associated activities is prescribed here, as is the participation of the diverse stakeholders in the planning and management processes and the maintenance of transparency at all levels. The legal framework for the realisation of these principles was provided by the Water Resources Management Act 2004, which came into force in December 2004. Control over water resources lies with the MAWF, which is responsible for establishing and determining the role of all institutions entrusted with water management functions. The demand for participation included in the IWRM concept has resulted in the establishment of diverse entities such as the Water Advisory Council, the Water Regulatory Board, the Water Tribunal, Basin Management Committees, Water Point User Associations and Local Water User Associations.

The broadening of short-sighted water management to incorporate IWRM guiding principles such as integration and participation has been very successful in Namibia "on paper". However, practical implementation is still in process and not finished yet. Many of the above mentioned entities have not yet been implemented, i.e. are not yet functional and the process by which they have been created is often unclear.

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70 Cf. also HEDDEN-DUNKHORST 2005, which reports on this experience in South Africa.

71 OFFICE OF THE PRESIDENT 2004: 137

72 The diverse relationships between questions of land use on the one hand and those related to water use on the other are all too obvious in an area such as the model region which is characterised by constantly alternating floods and drought. This does not apply only to ecological implications, for example respective titles of ownership are often directly bound to one another (e.g. the right to use groundwater through the land title). This gives rise to potential conflict between land and water rights, since for example, the land title does not stipulate any conditions or similar regarding the nature and extent of groundwater use.

The integration of different sectors is an exception, as is the integration of the various institutions involved in the decision-making process. The existence of many parallel, apparently independently acting decision-makers, appears to be promoted rather than discouraged by the central hierarchical principle of the Namibian administration. This shortcoming is particularly clear in the realisation of a concept that stresses integration since the spectrum of relevant participants here goes far beyond those directly involved in water management.

There is too little reliable data on the quality and quantity of groundwater and on the technical side, too few options for the retention of surface water to permit the comprehensive implementation of IWRM processes. The status of water processing leaves room for new developments such as recycling waste water. In relation to the water infrastructure, there is an obvious need for capacity building and for the sustained use of wells. Surface waters are subject to significant pollution through raw sewerage. Household sanitation is often inadequate.[73]

The catchment area of a water body is of central importance to IWRM as the significant spatial unit for the management of its water and all other associated natural resources. The creation of Basin Management Committees serves not only the protection, development and control of the water resources in the respective river catchment area; the committees are also responsible for developing a plan of use for the water resources, for guaranteeing community participation and for the independent establishment of a cost-covering tariff system.

The process of implementing the principles stipulated in the Water Resources Management Act of 2004 began with the establishment of individual Basin Management Committees. The MAWF is currently working on the development of the Cuvelai Basin Management Committee with support from the GTZ. The MAWF and the GTZ have decided to establish a Basin Management Committee on the level of the Cuvelai-Iishana Sub-Basin on a pilot basis and then to successively transfer the experience to the other three sub-basins.

In accordance with its demand that a holistic approach have also to be followed in the spatial dimension, the IWRM focuses on the entire catchment area of a water body wherever possible. For the Cuvelai, this means inclusion of the upper reaches, which lie in Angolan territory. Finland has strongly supported plans to develop a bi-national Cuvelai River Basin Commission (CUVECOM) between Namibia and Angola. However, these are still in their early stages and the process is far too superimposed by strategic political considerations on both sides. The Angolan administration is making efforts to link the management of the Cuvelai water resources with those of the Kunene and so to implement a Cuvelai-Kunene River Basin Ma-

73 Cf. NAMIBIA WATER RESOURCE MANAGEMENT (NWRM) PROJECT 2005 and DEPUTY DIRECTOR WATER ENVIRONEMNT 2004

nagement. Namibia sees an improvement to its strategic position in the extension of the existing long distance pipeline network beyond the country's border to the Angolan city of Ondjiva. The momentary concentration of the GTZ supported IWRM efforts on the lower reaches of the Cuvelai may appear inadequate from a holistic perspective, however more is not possible due to restrictive positions both in Angola and in Namibia.

II.3 The Central Challenge for an Adapted IWRM: The Accomplishment of Integration Tasks

The current status of the realisation of IWRM in the model region and in Namibia generally shows obstacles in two central areas that require special attention in order to successfully continue a further development of IWRM: one is working on the level of the river catchment area and its interrelationship to neighbouring catchment areas, and the other is the realisation of cross-sectional functions and perspectives. In both cases, it is evident that the problem of integration has not been sufficiently resolved in the current IWRM processes to do justice to the general expectations of the concept.[74]

II.3.1 IWRM and the River Catchment Area Perspective

The river catchment area perspective is of central importance to the general concept of IWRM. As outlined (See Section I.1), the administrative borders of the Cuvelai-Etosha Basin were defined to simultaneously correspond to hydrological and political criteria, resulting in three levels of action for water management: the overall Cuvelai System, which is shared by Angola and Namibia, the Namibian part of the system referred to as the Cuvelai-Etosha Basin and the four sub-basins. The interdependence between these levels of activity is clear and must be reflected in the institutional structure. The current administrative structure is characterised by a strongly hierarchical delegation model (See Figure II-1). The "upward moving" processes in the diagram are not yet reflected in functioning structures although this is currently pursued (See also Section II.5).

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[74] Cf. also GLOBAL WATER PARTNERSHIP 2000 and KLUGE 2005

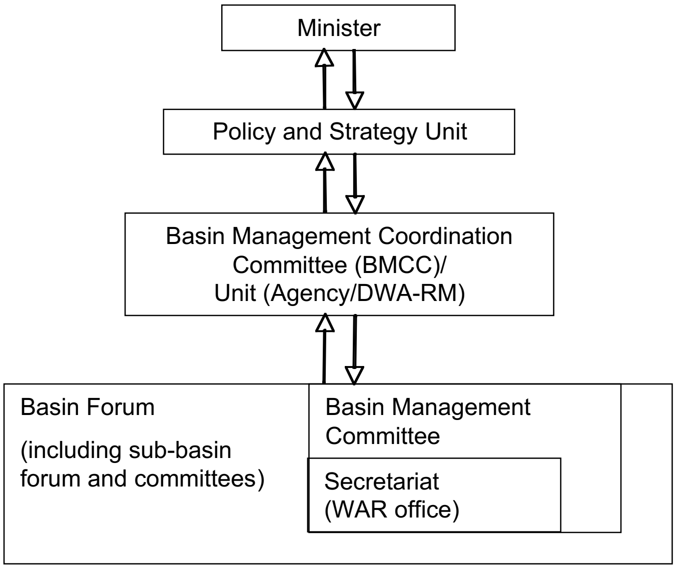

Figure II-1: Institutional integration of the Basin Management Committee in Namibia (According to MATROS, 2005)

This delegation model quickly confronts its limits when it comes to the management of resources in the entire Cuvelai catchment area and consequently in works undertaken in cooperation with Angola. This is also demonstrated by the faltering process for establishment of the CUVECOM (See Section II.2). The existing institutional structures and those currently in development and planning must be examined for their capacity for consultation and the integration of activities at the various levels of operation; additionally, they must be further developed accordingly.

The cooperation with the Angolan authorities, which is embedded in a politically volatile process of bilateral cooperation between Namibia and Angola that extends far beyond the focus on water resources, is proving to be problematic in current planning and is not yet explicitly incorporated into the institutional setting on the Namibian level.

A second critical point in establishing the river catchment perspective in the IWRM for the model region is the close interrelationship between the different catchment areas. Those living in the region and therefore being part of the population that "belongs" to the Cuvelai-Etosha Basin are increasingly dependent on water transported from the Kunene via the established and, according to planning, to be further developed long-distance water pipeline network. Both the hydrologically important upper reaches of this river and the source of water for the long-distance pipeline lie in Angolan territory placing Namibia in a position of vulnerable hydro-political dependency. This is intensified by the fact that efforts are being made to develop the regional economy of the South Angolan Kunene region.[75] Current plans to ex-

[75] A. Francisco, Vice Consul, verbal information, 18th March 2005, Oshakati/Namibia

tend the pipeline back to the capital city of the South Angolan province, Ondjiva (100 m^3/h, 47 km from the border) must be viewed from the perspective that it will also improve the Namibian negotiating position. From the perspective of supplying drinking water, this creates connections that may not have been sufficiently thematised by existing commissions (PJTC and CUVECOM) to date. This form of interbasin water transfer, the resulting interconnectedness of hydrological entities and the associated conflict potential[76] have not been adequately considered within the context of an integrated resource management. As such, an important integration perspective of resource management has been neglected: Under these conditions, increasing demands on use within the Kunene catchment area have a direct effect on the availability of drinking water in the model region. The development of alternative sources of water for household and industrial use in the model region could help to minimise competition for this resource. An integrative view of the development of water use patterns is a key issue for minimising potential international conflict.

The central focus of the proposed joint project should be integration and consequently the guaranteed capacity for coordination between the different levels of action. The first institutional structures for resource management in the Cuvelai-Etosha Basin have already been established. Under the integration perspective described here, it is proposed that these be further developed in cooperation with the decision-makers and stakeholders in the region. Model building, especially the development of scenarios will be of particular importance here. Given the difficult political experience in the bi-national negotiations associated with this project in the past, the following objective can be formulated on an international level: The mutual dependencies, potential advantages and other interrelationships resulting from a bilateral cooperation should be incorporated into the basis for negotiations (trust building measures) through the processing of data, information and knowledge for the development of models and scenarios.

II.3.2 A Cross Section of the Perspectives in Integrated Water Resource Management

The basic institutional structure for water management illustrated in Figure II-1 (and the bi-national level referred to in Section II.3.1) should make it possible to fulfil the demands of the integration and cross-sectoral functions stipulated by the IWRM. The current status of institutional development only partially fulfils these demands. As previously mentioned, the operational level is not integrated into the procedural level. The principle of participatory scenario development (See also Section II.5) can support the process of institutional development on the one hand and on the other, can develop a decision support system that focuses in the long-term on both the operational level and on the nature of the cross-sectoral relationships. The latter is particularly important since the central focus of the current IWRM con-

[76] Cf. NIEMANN 2005

cept for the model region is on water. However, the related areas such as land management, regional development, combating poverty and ecology are not sufficiently integrated and therefore the competition between sectors of use can only be partially considered. The available documents and expert interviews reveal that the interdependence referred to is recognised but it is not yet sufficiently incorporated into the working processes.

The analytical study of the cross-sectoral relationships allows the development of perspectives for the model region that create synergy between the goals formulated in Vision 2030: the connection of questions of land distribution and aspects of water use allows the discovery of regional economic potentials, which for example, via (small scale) agricultural activities (financial and therefore also intellectual) retains capital within the region and contributes to the fight against poverty. The effect of the assignment of land titles, made possible by the land rights reform, on water was to be anticipated and appropriate social-ecological conditions could be applied (water-related criteria for the allocation of land titles). Alongside the positive effect of the creditability of land that makes investment possible, new means of handling water are also provided with a material basis. However, there are ecological implications that correlate strongly with the creation of conditions that encourage an expansion of agricultural activity. The aforementioned poor soil quality and the fragile local water balance are central here. Retention of the Oshana System with its perennial water courses and characteristic green land formations essentially means maintaining the functionality of the terrestrial water balance (relationship between fresh and salt water as well as ground and surface water) for the regional climate, which in turn is an important condition for agricultural activities, but also for water use in general. The conservation of the functionality of the Oshana System as well as the sustainment of the Etosha Pan with its ecological role is of central importance here, which is of great economic importance for the region due to its development as a tourist attraction.

A second issue concentrates on improvement of the health and hygiene situation: the extended provision of sanitation and waste water collection also means an improvement in water quality and the quality of life through minimisation of the (largely unintentional) discharge or infiltration of waste water into surface waters and groundwater. This makes it possible to reduce the risks for humans and animals consuming this water and to improve local water quality.[77] The changes in water use brought about by technical and social innovation have consequences for the relationship between water supply and demand. It must be emphasised that all supply-orientated measures are embedded in a demand management process so that the positive effects gained through the development and protection of water resources

77 Cf. DEPUTY DIRECTOR WATER ENVIRONMENT 2004

are not counteracted by an accelerate increase in demand.[78] In addition to the activities of the national authorities, aimed at covering the costs of the urban and rural water supply, a "positive valuation" of water must therefore be pursued in the various contexts of use.

II.4 Primary Goals of Further Development of IWRM

The weaknesses identified in the course of the preliminary study give rise to the following core goals for the further development of adapted IWRM processes in the model region: Central to the adapted IWRM concept is the provision of *support for improved integration* in the current IWRM process. This relates to both the integration of various users or sectors of water use (household: drinking and domestic use; agriculture: watering livestock and irrigation; industry, manufacturing, energy production, waste water disposal; nature) and also the integration of water and land management. It includes the integration of various institutions (cross-departmental cooperation) as well as the integration of different territorial entities. A high degree of integration is pursued within the framework of the IWRM concept with the aim of balancing the various demands for use but also of satisfying the requirements of sustainability.[79] Considering the diverse water uses with their different requirements of water quality on the one hand and the available water sources and qualities on the other, the implementation of further technological development should *strengthen the potential for using endogenous resources* and counteract the growing one-sidedness and dependence. Securing the region's water resources in the middle and long term and giving consideration to their interrelationships with other resources should *support the use of regional economic potential* and *thus combat poverty.*

These goals can only be achieved through an increased understanding of the situation and its potential for further development. The *promotion of capacity building* is therefore a central tool for the proposed initiatives. Knowledge and interaction should build a bridge between the various problem areas and provide appropriate access through independently conceptualised processes and independently designed options for action. This is linked to the sought-after improvement in integration and is closely interrelated with the *establishment of a decision support system,* which will assist the development of transparent and therefore comprehensible policies. The development of different scenarios, which enable the stakeholders to judge the possible consequences of their actions *ex ante,* is especially important here.[80]

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78 A similar development could be observed during the development of the long distance water supply in the model region during the 20th century. Water consumption increased greatly with the increased availability of water via the long distance pipeline (NIEMANN 2000: 171ff.).

79 Cf. also HUPPERT (2005)

80 A platform is intended to provide the communicative basis for exchange (e.g. national policy dialogue), but also to facilitate the transfer of knowledge about best practice examples and international experience.

II.5 Basic Concept for the Adapted Development of an IWRM in the Model Region

The primary goals described above identify the central aspects to be considered in the further development of the IWRM concept for the model region. Of central importance here is the issue of integration, which relates to the relevant spatial, institutional and content levels. It is necessary to have an implementation concept that on the one hand meets the characteristics of the model region and on the other gives consideration to prior scientific work on IWRM processes, derived from outside the model region but that are nevertheless applicable to the region. Particularly relevant to further development of the concept is dealing with uncertainty and the lack of knowledge in relation to (existing and future) complex social-ecological influences in resource management (reciprocal interaction between social and natural processes).[81] These conceptual aspects play a special role when it comes to the stabilisation of IWRM process structures in the model region, but also for IWRM processes as a whole. The stability referred to here is the resource management system's ability to respond adequately to influences that endanger structures and processes.[82] As prerequisite to the capacity to stabilise structures, the adapted IWRM concept places central importance on the promotion and maintenance of permanent, legal institutional structures through participation in the development of appropriate instruments for planning, approval and control.

This is supported and guaranteed by adapted knowledge management, the implementation of adapted technologies and capacity building. Knowledge management includes the conceptual combination of scientific knowledge, empirical studies and technological potential as well as modelling and scenario development. Technology transfer relies above all on the provision of techniques for the acquisition of water from alternative sources and changes to the patterns of water use. Capacity building focuses on developing a knowledge base, skills and abilities necessary to use, adapt and further develop the established technical and institutional structures.
Here, it is especially important to provide Namibia with a bottom-up process that can stand alongside the existing top-down hierarchy. This will make it possible to transfer local problems (occurring on a local or sub-basin level) into the national political strategies. This does not relieve the political or administrative functions from the obligation of developing parallel, independent structures (regulations, legislative framework, institutions) that will combine the top-down and bottom-up processes to establish a basis for the development of governance.[83]

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81 In the absence of integrating social processes, such as symbolic social action, social strategies for the supply economy or political concept, for example, the question of what different cultural behaviours/attitudes are there in the use of water and how this influences the patterns of use in households, agriculture, commerce and industry (cf. KLUGE 2005).

82 Especially here, consideration must be given to the potential for conflict and violence that can hinder or cause failure in the sensitive process of decentralisation and democratisation. Prof. Denis GOLDBERG, South Africa, reported similar experience at the KOSA Conference "New Strategies in the Pipeline? Commercialisation of the Water Supply in South Africa" in Bonn on 25-26 February, 2005.

83 Cf. also the experience from other countries in southern Africa (MANZUNGU 2004).

The methodological core of integration is modelling and the (participative) development of scenarios through which the diverse work on research and development is combined in order to to facilitate achievement of the central goals. On the one hand, the development of scenarios aims at identifying issues for planning while taking the various levels of action into consideration (identification of elements related to a problem). On the other, it aims to integrate knowledge bases of the diverse stakeholders at various levels (spatial, institutional and subject matter). In this manner, scientific, administrative and also everyday knowledge is combined to provide a forward-looking evaluation of the consequences of decisions. This is intended to provide the basis for developing a favourable supply structure for a multi-resource mix and to strengthen the potential use of endogenous resources. The importance of the further development and adaptation of water technologies must be considered in this context (For more detail, see Section II.7).

This requires that the processes on which the creation of scenarios are based are open to participation and negotiation and permit a long-term perspective. With the help of contrasting scenarios (e.g. baseline, trend and sustainability scenarios) both the decision-makers (local, national, Iishana Sub-Basin, Cuvelai Basin, Cuvelai-Etosha Basin) and those effected by the decisions (e.g. water users and consumers in the various sectors) have the opportunity to consider the advantages and disadvantages of possible futures. In this sense, the creation of scenarios is an integrative learning process with its own dynamic, which can be initiated and supported by the proposed project, but whose results cannot be premeditated by either the project or the individual participants. This necessitates options for adaptation and adjustment during the development of scenarios and also in the associated processes of negotiating goals, decision-making, planning and implementation. A linear control model that does not permit such reiteration is unlikely to lead to satisfactory or optimal results.[84]

Openness to participation makes it possible to collect not only "hard" data (e.g. from hydrology, pedology, economics) for the modelling process but also "soft" facts, i.e. general knowledge and practices that allow the integration of various user perspectives in model development. This enables the integration of various collections and types of data and allows deficiencies in data to be balanced out.

This approach places high demands on the participation process. A procedure must be developed that allows the various perspectives of the different stakeholders to be integrated with *equal consideration* so that the existing interest groups, power structures and gender relationships can be combined productively to produce an

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84 The considerations on regulation presented here are based on HUMMEL/KLUGE (2005), which presents a cybernetic-based of social-ecological regulation. There are possible connections to the experience in South Africa presented by HEDDEN-DUNKHORST (2005: 161): "The interaction between stakeholders, institutions and programs/projects are repetitive (on a temporal level) and lead to changes, which give rise to new points of departure again and again."

overall result that does not endanger the sustained economic management of water resources and secures the water supply for the population, i.e. can be further developed for various uses. However, at the same time, the depth of participation must be determined for the various planning objects. For example, the mode of participation in the development of pilot projects on a local level would differ greatly from those that aim to develop a negotiation basis for the management of shared Namibian and Angolan resources. Within the context of scientific monitoring attention must given to consistency and the communication between the levels since interdependencies can be expected between all areas of activity and planning levels. The sustainability and continued development of the knowledge base, i.e. the knowledge gained and the ability to develop it further, must be transferred to the day to day operations of the current institutions and of those in development. This point the makes the need for stable governing structures especially clear.

The scientific goal here is to document the development of methods in a manner that allows their transfer to other countries, especially in the SADC area. At the same time, the communicative development of scenarios results in the establishment of a new communication platform that can connect the various stakeholders and levels of action in the model region. In addition to the previously mentioned development of procedures for designing processes, the central challenge here is the transfer of this platform to an institutional structure making it possible to continue the communication process beyond the term of the joint project. The Basin Committees would naturally be suited to this function since they represent a new level of action that must be integrated into the existing institutional structure. Since they are still in the establishment process, the appropriate interfaces could be identified, tested and developed during the progress of the project. Such a communication platform could also take on the function of facilitating and coordinating national dialogue on water politics (policy dialogue). Further, such a platform could provide a means for the collection of best practice examples and for an exchange of international experience that would strengthen the transfer of knowledge into and out of the model region.

II.6 Status of Consultation on the Basic Concept with the Responsible Decision-makers on Location and Integration into Existing Activities

In view of the described lack of integration within the region, it is currently not possible to speak of an “decisive” agent in respect to IWRM matters, but rather of numerous agents with various institutional connections. The most significant agent in this respect is, without doubt, the State Ministry of Agriculture, Water and Forestry (MAWF). The adapted IWRM concept was therefore developed in particularly close consultation with this body, which showed itself to be involved into numerous government activities. The current Department of Water Affairs and Forestry (DWAF) efforts to establish Basin Management Committees and other IWRM relevant bodies will be supported through ISOE’s conceptual and empirical work in the future. This applies within the context of the bilateral cooperation between MAWF and GTZ and also pertains to projects applied for by the MAWF under the AKP-EU Water Facility. In the latter, ISOE is designated as a member of the working group, which includes the MAWF, the GTZ and the BGR as well as other institutions. It has been agreed that a detailed description and assignment of the work packages will follow as soon as questions related to financing the various planned activities and the institutional cooperation have been clarified.

In the interests of scientific integration, cooperation has been established with various Namibian institutions (DRFD), i.e. preliminary discussions have been conducted (UNAM, Faculty of Sciences), or the first steps have been taken towards establishing a basis for consultation on the respective activities (NRIS, NEPRU, Habitat Research and Development Center). Of utmost importance for the establishment of connections of activities and therefore the long-term effectiveness of ISOE activities, is the contact to the local population and institutions in the research region. Not only long-term, formal and informal contacts have been established through individual project members, but also very positive discussions with the regional representatives of the Department of Water Affairs and the Regional Councils were conducted within the context of the feasibility study in the Spring of 2005.

If the demands of IWRM expectations are taken seriously, the medium-term goal must be to extend the integrative activities of the project to the upper reaches of the Cuvelai, that is, to Angola. The first exploratory discussions with the Angolan Consulate in Oshakati were promising; both sides indicated great interest in a close cooperation. The viability and the nature of a possible cooperation with the (currently faltering) FINNIDA attempt to establish a cross-border water management initiative must be investigated.

II.7 Potential for the Development of Adapted Technologies

The aim of every technological change in the model region is to develop the potential use of endogenous resources and therefore to increase the access of the community, agriculture and business to new water sources. This is linked to a reduction of dependence on the long-distance water supply with the aim of supporting long-term, regional economic activities that can contribute to the fight against poverty. Insofar, further development of IWRM and demand-driven technological adaptions are closely linked. The latter might include small-scale agricultural activity such as the cultivation of vegetables for local markets and the recovery of mineral salts and humus for soil improvement and the generation of energy (methane gas as a substitute for wood).

The following were identified as societal demands on the implementation of adapted technologies: profitability, problem-free technology, ownership, avoidance of damage through misuse, prevention of theft and clarification of the general political conditions (also for investments). Given that it is planned to extend, i.e. to branch out the long-distance water supply network (to provide access close to houses) in the model region, that where it is available, waste water collection and treatment is often inadequate, and that an increased demand on water services is to be expected, appropriate new technologies are those that do not lead to (an increase in) water use conflicts.[85] The following provides a closer description of rainwater harvesting, decentralised desalination facilities, artificial groundwater enrichment and ecological sanitation/waste water recycling as suitable technologies.

II.7.1 Rainwater Harvesting

The technology of rainwater harvesting is of special interest for those areas that are not currently connected to the long-distance water supply line but it can also provide a good supplement to remote water on the household level. With an almost total absence of any sort of relief, the topography of the model region offers a relatively difficult starting point for rainwater harvesting. An exact evaluation of the possible transfer of techniques from other regions requires an initial investigation of the specific local conditions. However, it is clear that the relevance of this sort of procedure concentrates largely on the collection of roof runoff although there are also regional variations in potential for collecting water from other surfaces (e.g. roads). Against the background of increasing population density in the region's urban areas and the use of different roofing materials to those used in rural areas, there is undoubtedly increasing potential for the collection of runoff, the significance of which is hardly quantifiable at this time. It must be established whether an existing canalisation system is suitable for rainwater collection, i.e. what other means of collection are possible in urban and rural areas. Pre-purification procedures must be modified accordingly.[86] Should there be potential to use the existing canalisation for rainwater collection, household and industrial waste water must be channelled separately.

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85 The following areas of use must be mentioned here: drinking water supply, water for stock, irrigation, commercial water use and the water needs of nature. The status of research is firstly that above all any use that causes or intensifies an upstream/downstream problematic (e.g. the damming of Oshana water in (small) dams), is to be excluded. Some of the decision-makers at the location have great reservations in regard to the construction of small dams because they require too much space (loss of potential productive or forested areas), there is too little run-off and consequently increasing salinity can be expected in the area of small dams. It remains to be monitored during the course of the project, the extent to which, e.g. how far the existing disadvantages associated with canals can be balanced out and useful pilot projects installed. The principle difficulty of the unprotected, above-ground storage of collected water in tropical and sub-tropical regimes is however – in addition to the previously mentioned evaporation caused by high sunshine – the danger of a spread of malaria agents.

86 Various processes can be considered here and their technical but also their social applicability must be checked. Under consideration here are firstly filter technologies that are applied prior to the storage of the water (cf. WILHELM 2005, WACK 2005), but also techniques for the production of artificial rain lenses in the ground, in combination with the basic techniques of low-energy bank filtration.

The prerequisites for reservoirs (for rain and surface water) are created through chemo-physical procedures of soil liquefaction and compaction. A further possibility for storing rainwater is in the introduction of substances into the topsoil (e.g. natural granulate, polycarbonate), which prevents the rise of groundwater through capillary action.[87] The latter can be used to support the germination phase of millet and sorghum and as such can be a valuable starting point for the proposed initiatives.

Focusing on agriculture, it remains necessary to investigate whether improved cultvation techniques would increase crop return or reliability under some conditions and the extent to which a mixture of (saline) groundwater and pretreated rainwater could provide a basis for new irrigation techniques. A transfer of lessons learned in other regions to the consciousness of the residents, with their centuries of experience with local conditions, may contribute to a relaxation in the supply situation.

II.7.2 Decentralised Desalination

Due to high groundwater salinity in the region (See Section I.2) and the dispersed pattern of settlement in rural areas, decentralised groundwater desalination may be a viable option for providing the rural population with access to clean water. There are advantages in using solar powered equipment given the high solar radiation and the absence of electricity supply in parts of the Four O'Regions. Suitable solar powered technologies range from reverse osmosis to condensation technologies.

Condensation procedures serve the sole purpose of water recovery and require relatively little maintenance. The condensation/convection procedure can be constructed in modules and can therefore be flexibly adapted to accommodate different volumes as required.[88] Solar-coupled thermal desalination, can be combined with equipment for raising groundwater and also electrical appliances requiring little power (i.e. light, radio, etc.).[89]

All procedures produce totally desalinated water, however, residual amounts of brackish water remain. The mineral concentration in this residual water is critical. It can be run through the equipment again to produce clean water. This results in residual water with a successively higher concentration of minerals and the disposal becomes increasingly problematic (in terms of ecology and health). In order to avoid undesirable side effects, experts recommend that rather than producing the maximum amount of clean water, the amount of clean water produced should ensure that the residual water is of a quality that can be used for purposes that require only

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87 Cf. HAMAIDEH 2005

88 Cf. KUNZE 2005

89 Cf. HOLZ 2005

low quality water. This is also consistent with the principle of adapting quality standards to the context of use.

II.7.3 Artificial Groundwater Enrichment to Stabilise Freshwater Lenses

A further possibility for securing the local water resources is the artificial enrichment of freshwater lenses using groundwater infiltration wells. Infiltration wells serve the rapid penetration of surface or rainwater underground.[90] They offer the best possible protection, an additional barrier against pollution (multi-barrier principle), more hygienic and improved water composition and a large, flexible and manageable storage volume (balances supply and demand over several weeks or months). The minimum prerequisite is the initial removal of as much turbidity-causing material as possible since if introduced to the aquifer, this material rapidly creates layers of residue, which impair its function.[91] A further advantage of infiltration wells is that they break through the clay lenses that prevent the natural infiltration of groundwater. Diverse pump systems can be used to raise the water out of the artificially filled aquifer. The water accessed in this manner can be used to water livestock or to irrigate market gardens. Additional filter technologies can be implemented to make the water suitable as drinking water (e.g. membrane technology, water pumping and purification system[92], solar disinfection).

II.7.4 Ecological Sanitation and Decentralised Waste Water Technologies

The combination of ecological sanitation (EcoSan) systems with concepts for using waste water to generate energy (methane gas) and nutrient salts (especially nitrogen, ammonia and phosphorous) represent a useful form of technological support for the IWRM process in various areas of the model region since it allows the integrated development of water and land use. Human excrement contains exactly the amount of nutritional material that is required for the production of food (measured in grains). The relationship of approx. 7.5 kg nitrate, phosphorous and potassium for 250 kg of grain can serve as an orientation here.[93] The extraction of nutrients using anaerobic processes or also the production of humus supports the project idea of strengthening small-scale agricultural activity involving the cultivation of marketable products. The extracted substances increase the efficiency of these agricul-

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90 Infiltration wells are well suited to the model region. Due to the high evaporation rate they are better than surface injection basins. There are proven techniques here (i.e. Sink-holes, covered percolation ditches) that minimise evaporation (water loss) and (soil) salification.

91 Rainwater that is introduced to the groundwater in this manner can also disperse the saline groundwater from water extraction plants producing groundwater with a better composition, especially for drinking purposes.

92 This system was developed by the Freiburg Company Solar-Fabrik AG in cooperation with the Freiburg Fraunhofer Institute and makes it possible to supply water for drinking and general use for village communities of up to 50 persons. The processing occurs via microfiltration and is powered by solar energy. Compare: http://www.solar-fabrik.de/ger/3.htm.

93 Cf. WERNER et al. 2004

tural activities (improved soil quality) and under suitable conditions, the extraction can be complemented through the use of grey water.

The generation of energy and the reclamation of nutrients from waste water is usually based on the (semi-)decentralised collection of effluent. However a reasonable population density in the collection area (minimisation of the transport distances), the possibility of installing decentralised collection and recovery facilities (minimisation of fixed costs, assured adaptability), the exclusion of rainwater from the system (inefficient dilution of the waste water), and the elimination of hygiene risks in the use of the reclaimed product (e.g. irrigation water) are prerequisites for the economic feasibility of these facilities. The separation of rainwater and waste water using semi-decentralised waste water collection permits a reduction of the hydraulic pressure in the waste water purification. Psychrophilic, anaerobic based purification plants that also produce renewable energy (biogas) can be implemented with lower investment and lower operating costs than those of the Western European standard solutions.[94]

Consequently, these technologies are especially suitable for use in urban areas where the extracted products can be used in urban agriculture in the immediate vicinity. The extent to which existing systems (especially canalisation) can inexpensively integrated into alternative waste water systems through reconstruction must be investigated on a case by case basis. The EcoSan options must be evaluated, especially in rural areas. In these areas the focus lies on the avoidance of waste water and the realisation of potential resource use on a household level.[95] The potential technologies are then implemented on a smaller scale. Above all, they serve to balance out existing competition in water use.

II.7.5 Market Chances and the potential of the investigated technologies

In its “Action Concept for a Sustainable and Competitive Water Resources Management” (2001), the BMBF stated that the German water industry had a generally high technological level, but that there were great deficits in the adaptation of technologies and concepts for export to international markets. This research project includes potential applications – through the development of an adapted concept and appropriate technologies – that utilise the strengths of the German water industry and as such, provide the basis for its establishment in the African market i.e. for generally improving its position in markets in arid zones.

For rapidly developing settlement areas (in the process of urbanisation), it is necessary to develop appropriate, adapted concepts because traditional, centralised systems are too inflexible and quickly confront their limitations. This is an important factor for the support of technology transfer in arid-zone countries. Concept devel-

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94 Cf. TRÖSCH 2005

95 Cf. WERNER 2005 and OTTERPOHL 2005

opment also provides a basis for the identification of necessary technological (further) development. User groups for the results of this research project are operators, consultancy companies, facility construction and equipment companies that conduct projects in (semi-)arid regions and areas undergoing the process of urbanisation.

The technologies investigated demonstrate considerable potential, especially in regard to decentralised (solar-coupled) water desalinisation plants, new decentralised waste water technologies (generation of energy and nutrients) and rainwater harvesting technologies (collection systems, filters, soil compaction). Germany occupies a leading position here, both from a development perspective and in terms of the level of technology achieved. At the moment, the successful placement of these technologies on the market relies largely on functioning best practice examples in the form of pilot plants.

These technologies have considerable market potential in the SADC region in particular but also on the world market generally because on the one hand, the continuing urbanisation process in developing countries demands sustainable solutions such as, e.g. innovative decentralised waste water solutions, and on the other, climate induced changes to the water cycle tend to reduce the availability of these resources and the new, decentralised waste water solutions coupled with rainwater processing technologies (with increased management of the circulation of drinking water) represent appropriate adaptations to the modified conditions. The current barrier to movement from a niche position to broad application lies in the previously mentioned lack of support in the form of demonstration plants. This is especially true in respect to desalination, as there are no appropriately adapted solutions for the various cultural groups. The overall potential for developing this market is high.

As indicated, it is necessary to conduct feasibility studies in the research area aimed at clarifying which system, or combination of systems is appropriate for which location and what are the appropriate spatial and temporal dimensions. The feasibility study should include a comparative evaluation of solar-coupled desalination systems, the newer waste water technologies (the chain of use coupled to them) and also rainwater collection and processing technologies, and should indicate under which (economic, ecological and social) conditions a technologically optimal, local implementation is possible. Both infiltration wells and rainwater harvesting have high potential for use within the region (increasing the available water resources with drinking water quality).

The investigation process itself is embedded in a participative process during the planning phase, which is expected to take approximately two years: In the first phase of the proposed project, it is planned to use a participative process to select the most effective and therefore also the most marketable technologies at the location. In addition to securing the acceptance and functionality of the system, procedures of this nature promote self determined development in the model region and facilitate information and knowledge based decision-making at the location ("Informed choices" on the basis of alternatives). Establishing an information exchange platform will be of particular relevance here.

As demonstrated by experience in technical and financial cooperation, each aid contribution must be adapted to the specific situation at the location. Of special significance here are the hydrological and ecological requirements, the initial economic and social conditions, existing traditions and cultures and institutional capacity.[96] This perspective makes clear the fundamental need for research and development in relation to the situation-specific adaptation of scientific, hydrological and technological concepts.

Consequently, appropriately differentiated preliminary investigations, evaluation methods and different forms of participation are necessary. An uncritical transfer of what currently exists could only be successful in the minority of cases, if at all. This has also been demonstrated by the expert interviews on location: There is a great deal of sensitivity towards "imposed" project and implementation ideas, so that a high level of networking and cooperation is required on location. An integration concept that can coordinate these activities is also necessary for the success of the project.

Another important prerequisite for the success of technological innovation is the creation of an owner or an owner's association for the plants. The experience of leading German companies is that only in the instance of ownership is there a commitment to sustaining the plant. This can be promoted, for example when the upkeep and maintenance of the plant can be financed through the price charged for redistributed water (whether investments can be refinanced in this manner depends on the individual case). It can be useful to initiate maintenance networks for specific plants or plant types, which can combine and pass on special knowledge at the location. Low interest loans that can be repaid later through the sale of water have also proved successful for first investments. Financing models for such networks and appropriate public-private partnership models must be investigated, e.g. via the KfW.

Beyond this, a pattern of use that concentrates entirely on German component manufacturers would appear inadequate in the long-term considering the global challenges and the MDGs. It is important that demonstration plants be produced, but however, this alone does not automatically guarantee a broad development of the market. The return on investment can be secured through basic know-how and technology licences in the hands of German providers/research organisations, how-

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96 Cf. EDIG/EDIG 2005

ever, expansion of the market requires the transfer of the culturally adapted uses to local manufacturers in order to generate local income and to lay the foundation for self-determined development. Such an economic-technical and know-how transfer oriented cooperation is planned in connection with the pilot plants.

III. R&D Concept for Supporting the Implementation of IWRM in the Model Region

The previous sections of this report described the special characteristics of the research region in North-Central Namibia as well as its potential and the core elements for the further development and implementation of IWRM. This section builds on this information and presents the concept for an R&D project that uses transdisciplinary principles to address the diversity of regional demands and creates the conditions necessary for the development and implementation of problem-related solutions.

III.1 Objective and R&D Requirements

The institutional landscape of Namibia's water sector finds itself, as described in Section II, in a time of upheaval. In recent years, the National Water Policy White Paper (2000), Vision 2030 and the Water Resources Management Act, 2004 (the Namibian water legislation) have provided important formal steps towards the integrated management of water resources. Nevertheless, the realisation of this self imposed obligation is still at the outset and considering that the starting point, described in the previous sections, is characterised by a complex network of problems, this represents a great challenge. To this come the demands arising from international agreements concerning water and the fight against poverty. Of central significance here are the World Summit on Sustainable Development action plan and the UN Millennium Development Goals (MDGs).

With the perspective of the long-term, sustainable accomplishment of this challenge, the R&D project described in the following is organically embedded in, and supports and expands the processes that have already been initiated. The adapted concept forms the core of IWRM in the model region. It pursues integrative principles that on one hand are based on knowledge, technology and participation and on the other simultaneously provides direction through a goal and process orientated approach. "Water" is understood as a cross-sectional issue. It gives rise to the superordinated objective of the R&D project:

> The R&D project aims at the conceptual further development and practical implementation of Integrated Water Resource Management (IWRM) that is embedded in existing processes and adapted to the specific political, social and ecological conditions of the region. The central task is to use knowledge management, tech-

> nology transfer and participation to achieve optimal water allocation between the various sectors, and to make a significant contribution to the fight against poverty and the avoidance of crisis. This involves achieving an ongoing, secure means of livelihood for the population and an expansion of the possibilities for creating and using long-term, stable development potential.

This goal and the complex, interwoven structure of problems provide the basis for the proposed R&D initiatives for the model region. These link into the topics identified in the presentation of the IWRM concept and are grouped into three main areas. A fourth, which is not classified as a direct R&D focus, is capacity building, which will be addressed separately in Section III.2.

Integration in the current IWRM process:
Integration of the various levels of activity – national, bi-national, interbasin and intrabasin – currently finds itself at different, but in all, very early stages of development. In addition, these are linked through highly sensitive administrative and institutional structures. An adapted IWRM must therefore link into the described spectrum of tensions between the various levels of action and the special characteristics of existing structures and include these conceptually. This demands an empirically based differentiation of the various stakeholders and population groups. The long-term support of “good governance” must also be regarded as an important task in the necessary integration process.

Integration of the inherent cross-relationships between the various sectors (e.g. the question of water and land management, links to the energy sector) and between the various disciplinary perspectives (ecological, economic, social) on water-related questions is not well developed and has only limited and sporadic input into the decision-making process. A systematic combination of sectors and disciplines, ascertainment of specific levels of knowledge, interests and conflicts and finally their inclusion in the decision-making process are tasks of great importance and urgency.

Minimising exogenous dependencies and the promotion of endogenous potential:
The dependence of the model region on a long-distance water pipeline network that begins from the Kunene in Angolan territory presents a not to be underestimated social, economic and also strategic risk in view of the current difficult political conditions and the active dynamic in the regional demographic development. Possibilities for promoting the potential use of endogenous resources are sought with the aim of reducing the risks associated with this dependency. Equally, there is demand for appropriate knowledge management, adapted technologies, “intelligent” financing models and the establishment of support structures and responsibilities. Under the given difficult, natural conditions resulting from low, seasonally limited and highly variable rainfall patterns and the problem of salinity, innovative technological solutions are of particular importance. In terms of the stabilisation of processes,

precedence must be given to the role of developing institutions through suggestions for regulations and laws and organisational safeguarding. Finally, existing regional economic potential must be strengthened and expanded because this can contribute to the development of a counterbalance to dependencies across national boundaries.

Adapted further development, implementation and generalisation of the IWRM concept:
The sustainable implementation of Integrated Water Resource Management requires a sound scientific conceptual basis. This study provides a decisive and important first step towards the development of that basis. However it is necessary that the concept be made more concrete and its details defined. Because participation is a central component, the concept offers a high level of design flexibility, which is intended to be adapted to the given general conditions.

In view of the active processes in which the IWRM is embedded, there continues to be a need for an instrument that evaluates the future consequences of current decisions and activities. Due to the importance of social factors, consultation and support for the participants in the decision-making process and an appropriate means of handling uncertainties and limited knowledge play a special role. The concept has implications and influence beyond its immediate regional application, both in terms of the neighbouring regions of the SADC area and in terms of its possible transfer to other regions that experience analogous constellations of problems.

III.2 Need for Training – Capacity Building

In view of the semi-arid conditions, the great importance of water resources for all stakeholders is beyond question. To handle the current, intense process of change and pursue the need for sustainable use of endogenous resource potential requires research into practices, which would provide the foundation for training and further education initiatives at all levels of activity and decision-making. The various institutional structures and hierarchy levels and the various groups within the population are addressed with the appropriate respective weight and focus.

On the institutional and administrative level, the focus of such training and further education measures lies primarily on the creation of an overview that goes beyond the respective individual areas of responsibility and develops a deeper understanding of the intersectoral and interdisciplinary interrelationships. A notable example here is the relationship between water, waste water, land use and energy and also between ecology, society and the regional economy. In conjunction with the establishment of a decision support system and the consideration of alternative scenarios of the future, a adapted capacity building process satisfies an important requirement for the implementation of a successful IWRM concept. For the population, the second target group of training, the focus of training and further education lies in the three areas of water infrastructure, decentralised water extraction (rainwater harvesting, desalination) and waste water disposal (use of waste water, EcoSan). The statements of local experts give a clear and unmistakeable indication of the need to promote an understanding of water on a household level so that the availability of clean drinking water is understood to be of economic value. This would promote the acceptance of water costs and consequently support the economic viability of the NamWater long-distance pipeline system. Important impulses can be provided for developing the potential use of endogenous resources, whereby promoting the acceptance of technical alternatives also plays an important role here.

The principles of decentralisation are of marked importance in the pursued balance of endogenous and exogenous resource use. Appropriate measures must be implemented to resolve the difficulties associated with the powerful autonomy of small-scale settlements as well as those associated with the technologies used. In the first instance, this includes training and further education measures on two levels: the ability to appropriately deal with newly developed resource potentials must be strengthened through the provision of practical technical skills and must be assured in the long term through the establishment of self supporting structures and competences. Guaranteed maintenance of the various systems, adapted cost models and the development of a so-called *willingness to pay* form the core elements of the proposed structures. This is closely related to the establishment of suitable political conditions in the sense of Good Governance.

Capacity building and the associated increase in public awareness of local and regional water-related problems form an important basis for the successful implementation of the principles of participation. As part of the general IWRM concept and the Namibian Water Act, the demand here is for an implementation that is adapted to the conditions and needs of the area.

III.3 Outline of a Joint Project

III.3.1 Integration in a transdisciplinary research and development process

The definition of targets and the formulation of the R&D requirements make clear the many levels of demands on a suitable R&D project for the development and realisation of IWRM in the model region. The following outline of a joint project takes up these challenges by explicitly integrating the various fields of knowledge and action within the context of a transdisciplinary research process and transporting them into a research and development process.

As illustrated in Figure III-1, the incorporation of problems from both the societal and scientific-technological spheres is central to this process. The background to this is the fundamental assumption that scientific and technological developments must be adapted to the specific societal needs and potentials and simultaneously, however, that the development of societal options for action and societal structures is closely linked to the availability of scientific knowledge and technological options. For the R&D project, this means that the integration of areas of knowledge and technology as well as fields of action must be considered equally from the very beginning and not first in the compilation of the results. As such, integration must be understood to be part of the overall research and development process.

The core of the transdisciplinary research and development process is represented by the grid structure displayed in Figure III-1, in which scientific disciplines and integrative issues overlay the various disciplines, science and society. This highlights the need for clearly defined and limited areas of competence on the one hand and their interconnection through strong relationships and mutual exchange on the other.

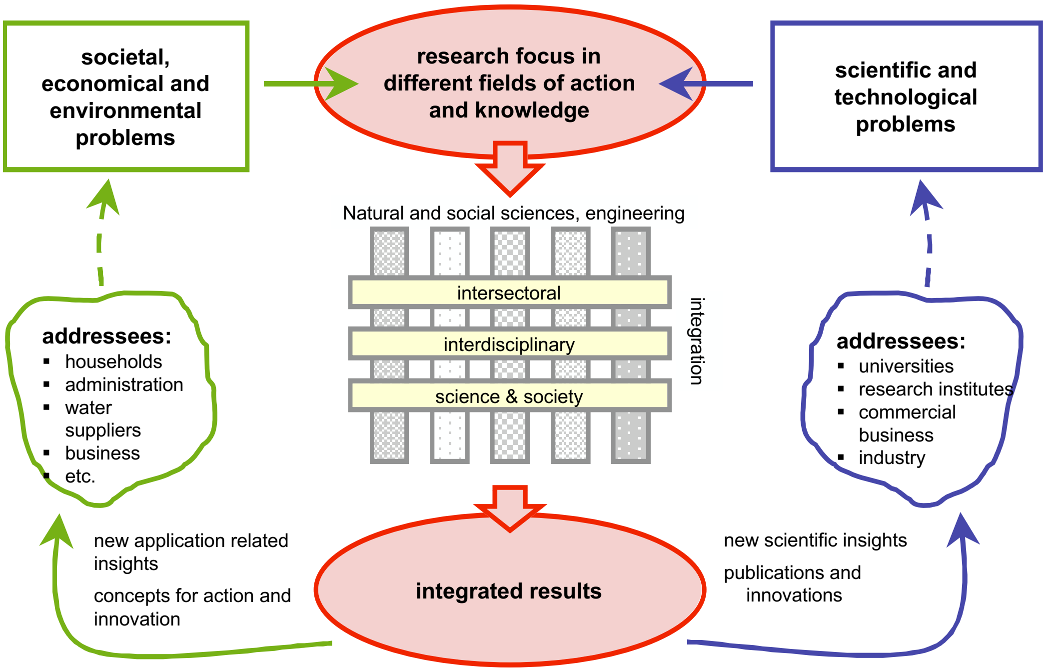

Figure III-1: The transdisciplinary research and development process as the basis for further development and implementation of IWRM in the model region.
Both paths, the societal (left) and the scientific-technological (right) dimension of problems relate to one another in several steps, each of which has independent integration processes/movement (1) through their combination in a research focus that includes the various fields of knowledge and activity; (2) through development of the research focus within the context of the relevant disciplines of engineering, natural and social science and under consideration of transverse integrative perspectives and (3) through the transfer of the results to an integrated problem-solution with new application-related perspectives and integrated knowledge and technologies with new and innovative scientific and technological insights.

III.3.2 Focus and Goals of the R&D Project

The R&D project is structured along the lines of the grid formation at the core of the transdisciplinary research and development process. Knowledge of the area's specific problems and needs was used to identify seven working areas and these were translated into subprojects.

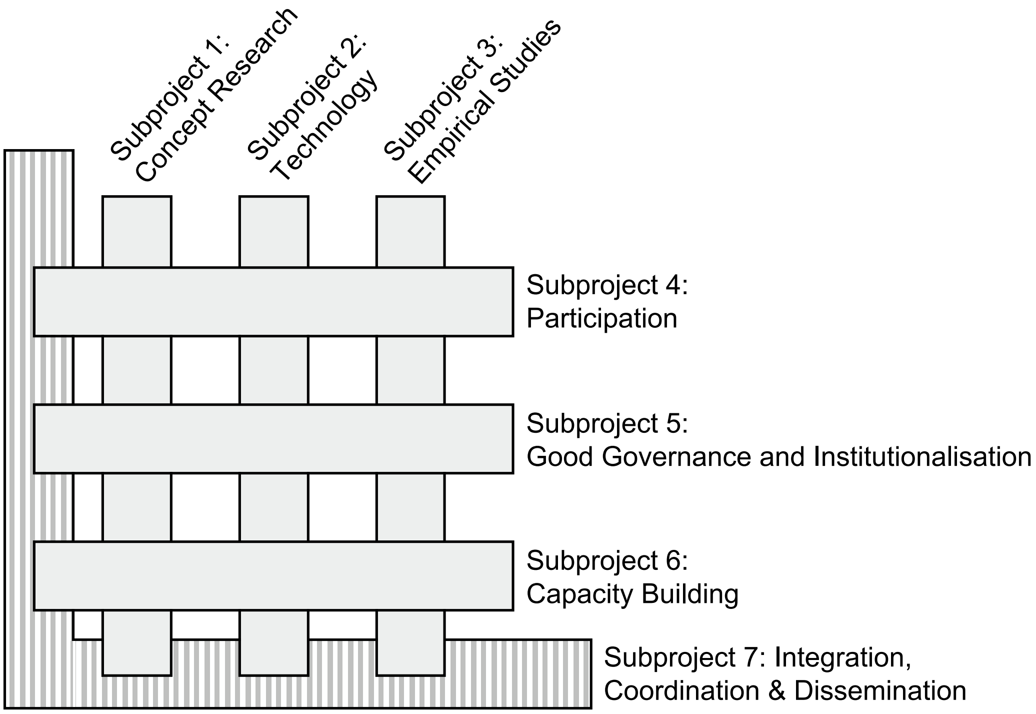

Figure IV-2: The R&D project consists of seven subprojects (SP) each with a specific thematic focus.

The subprojects are organised in the displayed grid structure in which the pillars of the various scientific-technical spectrum of tasks (SP1-3) are penetrated by the social-institutional orientated spectrum of tasks on the horizontal axis. The subprojects are intermeshed to a high degree and supplement one another although the "umbrella" subproject for integration, coordination and dissemination of all activities is of special significance.

The vertical basis structure is formed by the three scientific subprojects "Concept Research", "Technology" and "Empirical Studies" (Subproject 1-3). Horizontal to these, lie the subprojects with stronger social-institutional characteristics "Participation", "Good Governance & Institutionalisation" and "Capacity Building" (Subproject 4-6). Participation is an especially important component in the realisation of IWRM and as such forms a subproject in its own right. The previously formulated understanding of integration as an independent working area finds expression in the subproject "Integration, Coordination & Dissemination" (Subproject 7) – which has a particularly high level of interaction with all the other subprojects. The work of the subprojects is intensively interwoven. For example the relationships between Concept Research, Technology and Empirical Studies involve intensive exchange. The demands and requirements, technological potentials and limits and regional social and natural conditions must be balanced here. The involvement of stakeholders, their interests and their specific competences is of equal importance as the creation of structural, institutional and cognitive requirements for the long-term stabilisation of the current processes for development of IWRM in the model region. Annex 1 provides a description of the subprojects and addresses their individual interrelationships.

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Abbreviations

BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources)
BMBF	Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research)
CUVECOM	Cuvelai River Basin Commission
DRFN	Desert Research Foundation of Namibia
DWAF	Department of Water Affairs and Forestry (Department of MAWF); till March 2005: DWA – Department of Water Affairs
EcoSan	Ecological Sanitation
EPZ	Export Processing Zone
FINNIDA	Finnish Department for International Development Cooperation Finnische Agentur für Entwicklungszusammenarbeit
GTZ	Gesellschaft für Technische Zusammenarbeit
IGB	Fraunhofer Institute for Interfacial Engineering and Biotechnology, Stuttgart (Fraunhofer-Institut für Grenzflächen- und Bioverfahrenstechnik, Stuttgart)
ISOE	Institute for Social-Ecological Research (Institut für sozial-ökologische Forschung)
IWRM	Integrated Water Resource Management
KfW	Reconstruction Loan Corporation (Kreditanstalt für Wiederaufbau)
MAWF	Ministry on Agriculture, Water and Forestry; till March 2005: MAWRD Ministry on Agriculture, Water and Rural Development
MDGs	Millennium Development Goals
NEPRU	Namibian Economic Policy Research Unit
NRIS	Natural Resource Information Service
PJTC	Namibia-Angola Permanent Joint Technical Commission on the Kunene River
RM	Directorate of Resource Management (Department of the DWA)
RWS	Directorate of Rural Water Supply (Department of the DWA)
SADC	Southern African Development Community
SWAPO	South West Africa People's Organisation
TDS	Total Dissolved Solids
UNAM	University of Namibia
UNITA	National Union for Total Independence of Angola (Uniao Nacional para a Independencia Total de Angola)
WHO	World Health Organization

Annex 1: Proposed Subprojects of the joint project

Subproject 1: Concept Research

The subproject "Concept Research" aims to develop a scientifically based, technologically supported concept for implementation of an IWRM that is adapted to the regional conditions. Special consideration is given here to the question of integration within the complex network of relationships between nature and the society, to the need for a holistic perspective in handling intersectoral problems such as water and land management and, finally, to the problem of dealing with limited knowledge and uncertainty. A great challenge for IWRM in Namibia, as it is worldwide, is the dynamic of changing territories in relation to the management of natural resources. In order to incorporate these processes, investigations and conceptual development will be conducted in close association with the junior research team of the project "demons" of the University of Frankfurt and ISOE (See Section III.6). The focus here, from the perspective of interbasin water transfer in the model region, is on the structural, economic and hydro-political relationships between different river catchment areas, which indirectly result from and are driven by the phenomena of increasing population density.

An important element of the fundamentally transdisciplinary research processes is the involvement of stakeholders within the context of an appropriately designed participation process. Participation is understood here as the involvement of various stakeholder groups in essential aspects of concept development and in the translation of the concept into "products" that will support the decision-making process.

As such, the subproject "Conceptual Research" is characterised by two supporting pillars: the foundation provided by knowledge – which includes the natural and social sciences but also technological, engineering expertise and empirical knowledge – and the orientation on the stakeholders. Consequently, the scientific findings and insights into processes of action are to be conducted in the sense of a transdisciplinary research approach by the results of this subproject. This finds expression in the two central products: an IWRM concept that is adapted to regional conditions and – therein integrated and taking the local levels of action into account – a system that supports the decision-making process. The establishment of a decision support system represents a central instrument for integration for the entire course of the R&D project. Its development includes the use of qualitative and quantitative methods to produce a model-based description of all relevant social-ecological processes, the participative development of scenarios and the integration of the results of technological research and empirical studies. As such, this development serves the conceptual consultation of stakeholders as well as the management and transfer of knowledge.

The long-term viability and potential transferability to other model regions with similar problems will be taken up within the products themselves and also by an independent analysis.

Products:

- Conceptual development of an IWRM concept that is adapted to the region
- Cornerstones for a generalised IWRM concept
- Scenarios and model-based decision support system

Subproject 2: Technology

The subproject "Technology" aims at the development of endogenous and primarily semi-decentralised resource use potential and the creation of market access for German technology companies. The promotion of a multi-resource mix should create greater regional autonomy and a new balance with less dependence on exogenous factors. The development and strengthening of endogenous potential includes water extraction techniques such as rainwater harvesting, solar-coupled desalination and artificial groundwater enrichment as well as techniques for new ways of handling industrial and waste water, e.g. EcoSan and concepts for waste water reuse.

With the aim of establishing a successful and long-term technology transfer, the first project phase requires the initial investigation and evaluation of the available technical systems. Special attention will be given to the conditions in the model region and the possible potential for their further development or adaptation requirements. Building on this, the commercial technology providers will provide simulations of technical systems. This is followed by the pilot implementation of the selected technologies in the second phase. The experience derived in this manner will provide the basis for the introduction of innovative and sustainable new technologies in the model region during the third phase. The R&D project will support the implementation with accompanying initiatives and analyses the ongoing process within the framework of cooperative monitoring.

Prerequisite to achieve the objective of this subproject, is the close cooperation with engineering experts, German technology companies and local experts. Simultaneously, all relevant regional stakeholders must be involved and special consideration given to the prevailing structures and levels of action within the context of a participative assessment and decision-making process. This requires close connections to the concept of "Informed Choices" developed by subproject "Participation", and the accompaniment of educational and further training measures through the subproject "Capacity Building".

The subproject "Technology" is intended to create the conditions necessary for a long-term expansion of the market for German companies involved in the above mentioned technologies.

Products:

- Technologies adapted to the conditions in the model region
- Technology market; structures and abilities for dealing with technology appropriately

Subproject 3: Empirical Studies

The subproject “Empirical Studies” serves to confirm and complete data within the context of primary and secondary surveys. The aim is to document the status quo, development trends and development potentials in the areas social structure, patterns of action and use, demography, economy, ecology, natural resources and societal needs. As far as possible existing data sources held by administrative authorities, national or regional institutions and also the results of other projects, research groups and regionally active organisations should be accessed through secondary surveys. It may also be necessary to conduct further (literature) research on similar regions in the SADC area, in Africa or worldwide.

Due to the great importance of well-founded knowledge of the patterns of action and use and of societal needs, supplementary primary surveys that have been adapted to the special cultural and social conditions, will be conducted in the region. The methodological approach extends beyond the usual questionnaire procedures and partial explorations by involving, among other things, the participation process and therefore the efficient use of synergies. The focus here does not lie with water-related areas of action and use alone, but goes beyond this to include allied areas such as agriculture, land use and energy.

In consideration of ecological compatibility in the realisation of IWRM, the current escalation of interference with the ecosystem and with the functioning of the water system, empirical research on natural resources and their interaction with human activity has been included as a further focus of this subproject. Special cross-sectional issues are water quality, over-grazing, soil degradation and the overuse of aquifers.

The ultimate task of this subproject in accompanying the surveys, is the preparation of data for inclusion in the development of the IWRM concept. The combination of a GIS with text-based analysis has created a significant basis for the development of scenarios and a decision support system.

Products:
- GIS-based platform for access to quantifiable data
- Text-based format for qualitative analyses

Subproject 4: Participation

The subproject “Participation” primarily serves to support all the subprojects of the R&D project in the consequent realisation of the principle of participation and secondly to provide a conceptual and self-reflective foundation for the principle of participation within the context of the adapted further development of the IWRM.

A concept of participation will be developed that is incorporated in the IWRM implementation process, and that enables, promotes and strengthens long-term participation structures. The core methodological elements of participation are the organisation of workshops, possibly simulation exercises, the development and realisation of a participation concept for decision-making processes ("Informed Choices") and the development of appropriate (target group specific) communication and information structures. Reference to national issues is in the foreground here; at the same time, however, the North-South dialogue and the exchange within the SADC region should be strengthened. When taking into account the ethnic, cultural, social and structural conditions in the model region, special attention will be given to the strongly hierarchical nature of structures, the co-existence of state and traditional institutions, the different population groups and include consideration of the gender dimension.

All activities within the subproject "Participation" have strong cross-sectional character. Alongside the identification and development of potentials, the research also focuses on current barriers to participation in the model region. The results provide an important foundation for the subproject "Concept Research" and "Technology". The approaches generated by the subprojects "Good Governance & Institutionalisation" contribute significantly to the long-term approach of participation and, inversely, the identification of limitations indicates areas in which structures of governance apparently require strengthening. Finally, the close consultation of the subprojects "Empirical Studies" and "Capacity Building" serves the creation and efficient use of synergy effects.

Products:

- Long-term participation, communication and information structures

Subproject 5: Good Governance & Institutionalisation

The subproject "Good Governance & Institutionalisation" aims to promote permanent legal institutional structures that ensure the implementation of IWRM and link the related technologies in the model region in the long-term, well beyond the duration of the R&D project. Of special importance for long-lasting results, is the joint development of integrated, forward looking planning, approval and control instruments to ensure efficient planning, implementation and legal certainty. To this end newly established institutional structures that are still at the outset need to be strengthened and supplemented with participative elements; responsibilities need to be established at the various levels of action and, finally, there must be incentives and the procedures set in place for an comprehensive legal framework (preparation of plans, suggestions for regulations and changes to legislation). Generally applicable regulations for planning processes, technical procedures etc. could be generated through the participation process and combined to provide guidelines, handbooks and policy.

Close consultation with the subproject “Capacity Building“ is of great importance for two reasons. On the one hand, it leads to more certainty in the planning, implementation and operation of the technical facilities. On the other, a self-stabilising momentum should be established through new and sustainable options for dealing with the water resource and new technologies that are economically and socially beneficial, and that support institutional-legal initiatives through the transfer of knowledge. Water-related services and forms of actions should experience an increase in value and become embedded in self-supporting structures with appropriate cost systems.

Alongside the establishment and stabilisation of structures and therein incorporated specific responsibilities, guidelines are also created within the context of the subproject “Good Governance & Institutionalisation“. This represents an integral part of the IWRM concept (See Section III.5) and serves the regulative support of the institutional and legal foundation of the concept.

Products:
- Strengthening of permanent structures of legal certainty
- Establishment of responsibilities
- Guidelines

Subproject 6: Capacity Building
The subproject “Capacity Building“ targets the education and further training of the stakeholders: this is intended to increase and reinforce their ability to respond flexibly to the processes of change and new technologies, to perceive water as a resource within a superordinate system of values, to avoid and to manage conflicts, to act and communicate successfully within the institutional pluralism and to promote communication structures for the exchange of data and information. Capacity building is not confined to limited groups but is applied to the overall social setting. Learning through the transfer of knowledge and interaction are important core elements, which form a bridge between the various sectors and between the various levels of the hierarchy and which provide important access to key issues such as water, sustainability and the quality of life.

This claim is closely related to the participation of the stakeholders in the conception and realisation of an adapted IWRM concept. In addition to workshops, campaigns and target-group specific offers, increased attention through the media and the representatives of state and traditional institutions is also very important. The development of an exchange platform (See Section III.5) provides a basis for the intrabasin, interbasin and international transfer of information and data. On the one hand, this is pursued on the level of capacity building but on the other, it also creates an independent platform for communication of the results of the R&D project.

Products:

- Increased attention and increased scope for action and decision-making for all stakeholders
- Platform for interbasin and bi-national information and data exchange

Subproject 7: Integration, Coordination & Dissemination

The subproject “Integration, Coordination & Dissemination“ intersects the activities of all other subprojects and serves internally their coordination, assures their integrated interaction and, finally, the consolidation of their results to an overall contribution of the project to the formulated need for R&D in the model region.

The main focus lies on the establishment of internal communications structures such as integration workshops and the clear definition of responsibilities, which guarantees an integrative approach. Externally, the subproject “Integration, Coordination & Dissemination“ serves the consultation of and connection to existing on-site projects and work of other local institutions and also the coordinated communication with local stakeholders. The inherent responsibility for this linking process lies largely with the subprojects “Participation“ and “Capacity Building“.

Further, the subproject “Integration, Coordination & Dissemination“ serves to ensure the scientific utilisation of the results through distribution within the context of conferences, workshops and publications. Quality control and international transferability play a decisive role here.

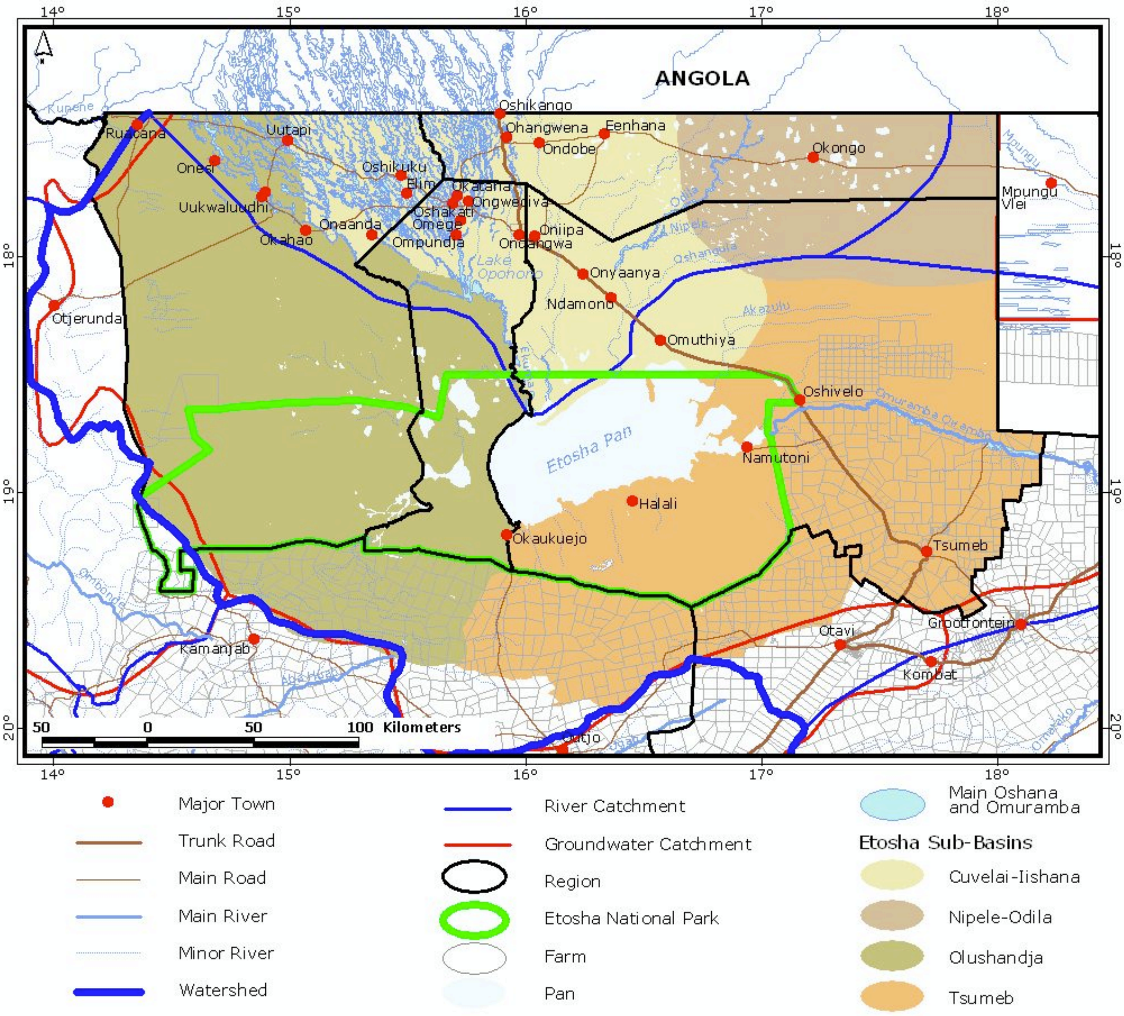
Products:

This subproject has the task of guaranteeing the integration and coordination of the entire R&D project and therefore delivers no independent products of its own. The successful realisation of the set of objectives manifests itself in the success of the overall project, participation in conferences and publications.

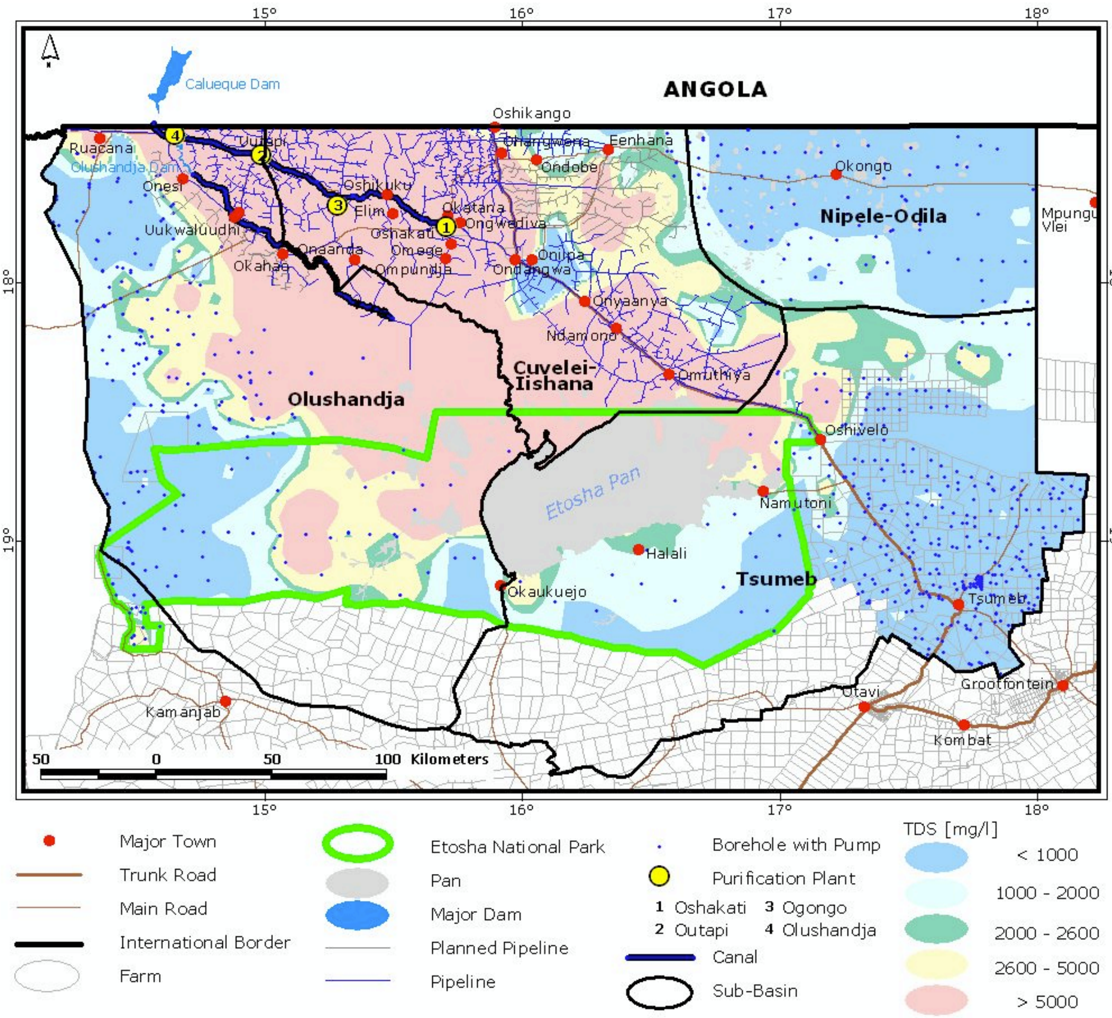
Annex 2: Maps

Source of all maps: Bittner Water Consultant (2004)

Etosha Sub-Basins, Groundwater and River Catchments within the Etosha Basin



Groundwater Salinity and Water Supply within the Etosha Basin



Population Density within the Demarcated Water Basins