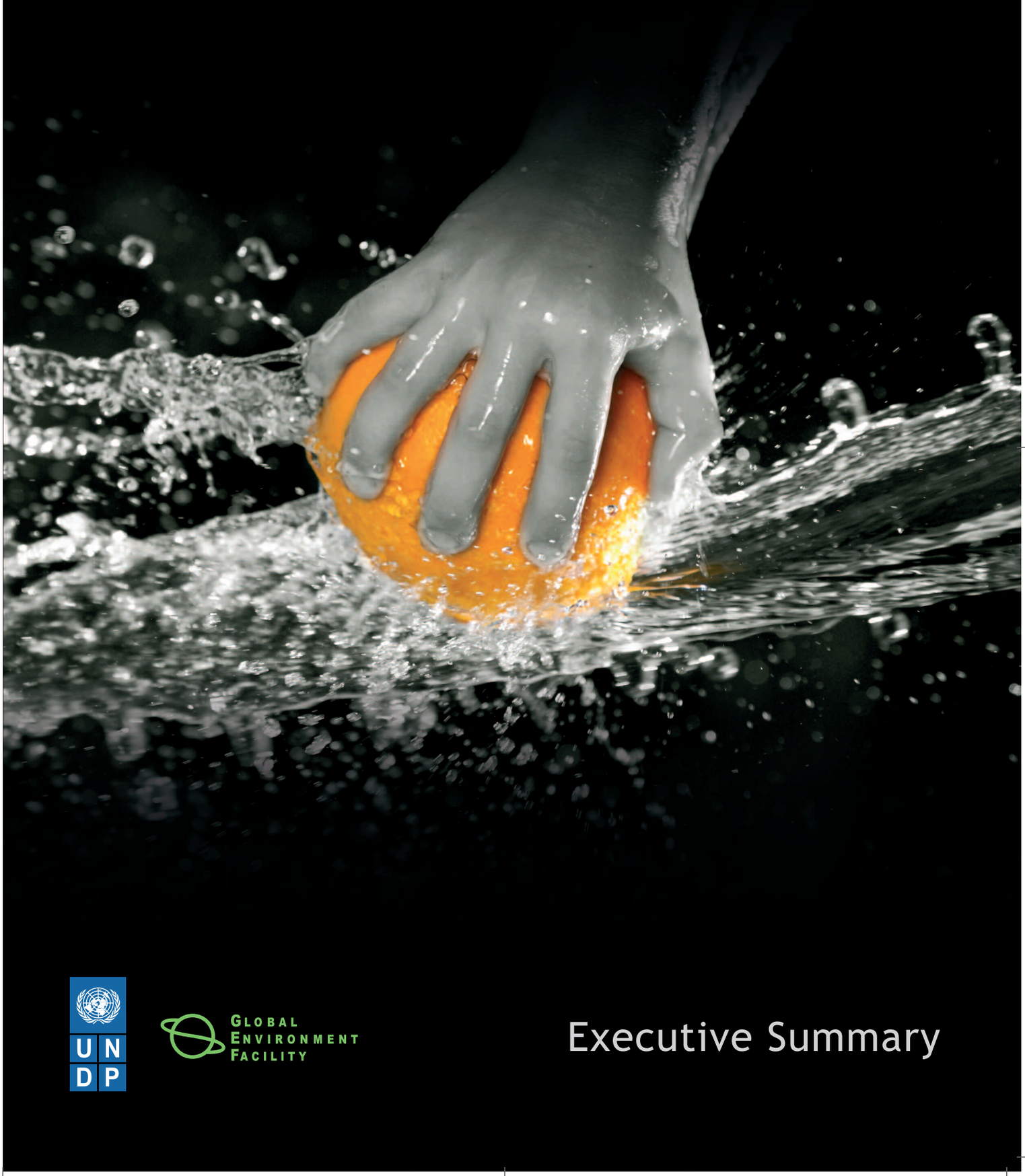
ORANGE-SENQU RIVER COMMISSION
BOTSWANA LESOTHO NAMIBIA SOUTH AFRICA
ORASECOM
Established 2000

Orange-Senqu River Basin

Preliminary Transboundary Diagnostic Analysis

Adopted by ORASECOM in April 2008



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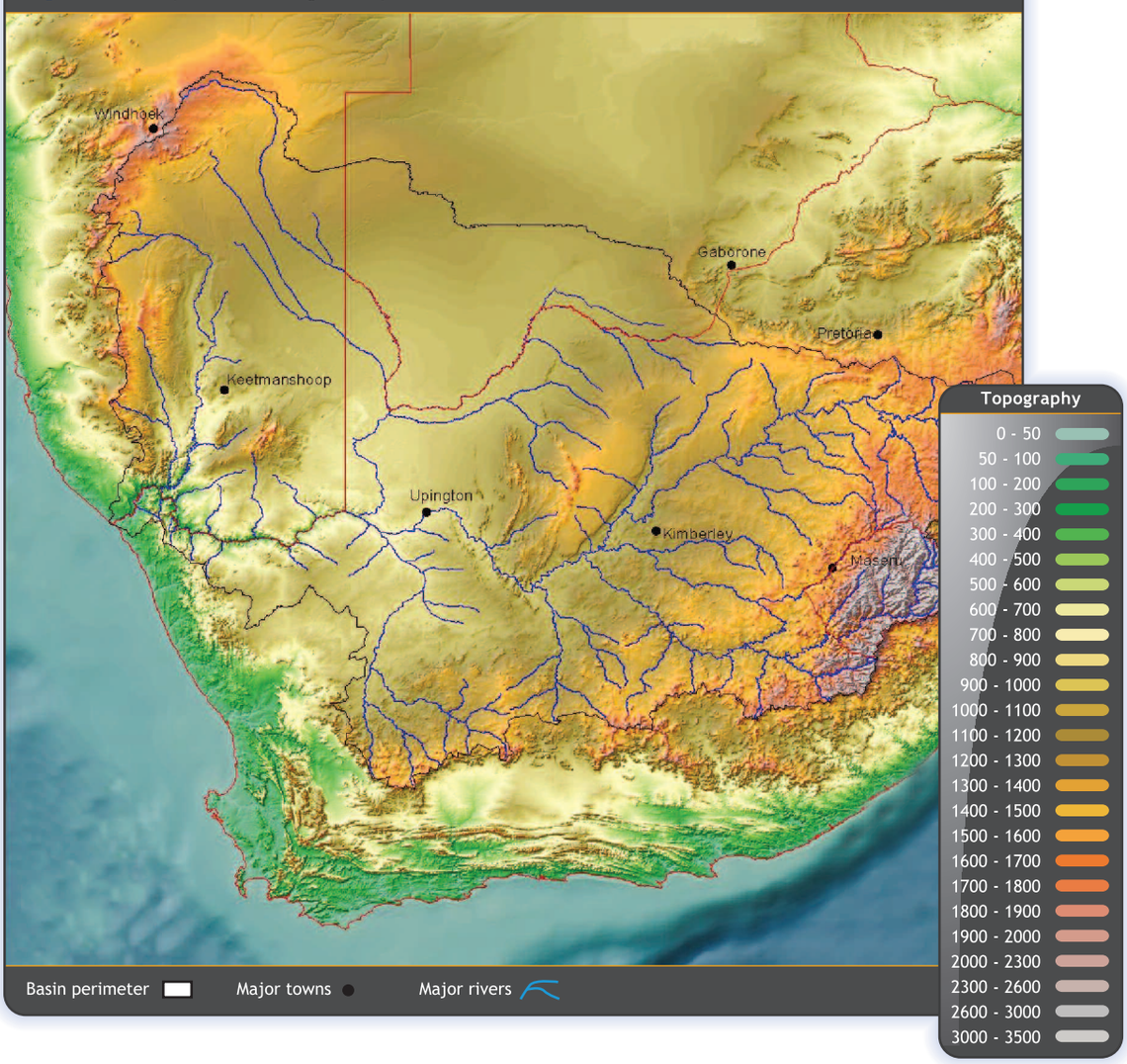
Executive Summary

The Orange-Senqu is an internationally significant river system, located in the territories of Lesotho, South Africa, Botswana and Namibia. These countries rely to varying degrees on the river as a source of water for industry (mining and manufacturing), agriculture, energy, tourism, conservation and residential uses. The basin is degraded environmentally and continues to be threatened by anthropogenic factors.

The Orange-Senqu river is important to regional cooperation as it crosses and forms some of the borders between the riparian states (figure 1) and provides the single largest water resource south of the Zambezi in a region which is classified as semi-arid and subject to increasing water stress. The highlands of Lesotho provide the only exception where the climate is temperate and annual rainfall exceeds evaporation. Elsewhere annual evaporative losses far exceed annual rainfall and to such a degree in the Lower Orange that the climate is classified as arid to hyper-arid.

Certain areas of the Basin are already densely populated, economic development is significant, and socio-economic expectations are high. This causes an inevitable high degree of competition for the finite water resources that are available. Add to this the fact that the urban and industrial demands are

Figure 1: Map of the Orange-Senqu basin



geographically concentrated in the upper parts of the Basin and these demands support activities that make a major contribution to the GDP of South Africa (the largest Basin state) creates a significant geographical imbalance in the utilization of available water resources. Water quality is impaired by seepage, runoff and point source discharges of municipal, industrial and agricultural effluents, and by high sediment loads resulting from land degradation in many areas of the catchment.

As past experience has shown, single sector oriented management of water resources does not solve the problems of transboundary water resources. Only integrated planning of water resources at the basin level can address the environmental and socio-economic development needs in the basin. Consequently, integrated, inter-country efforts are urgently required to comprehensively evaluate the degree of ongoing degradation of the Orange-Senqu and to take action to halt and reverse damaging trends where necessary.

Awareness of this fact has promoted the development of a UNDP-GEF sponsored "Transboundary Diagnostic Analysis (TDA) of the Orange-Senqu River Basin" and Strategic Action Programme development project among four of the riparian nations. This project aims to ensure that the quality and quantity of the water throughout the Orange-Senqu river system meets the short and long-term needs of the ecosystem, the communities and economies relying upon the river and its associated resources. The project is expected to achieve its objectives by: encouraging regional cooperation; increasing capacity to address water quality and quantity problems; demonstrating water quality/quantity improvements; initiating required policy and legal reforms; identifying and preparing priority investments; and developing sustainable management and financial arrangements.

The GEF IW TDA/SAP "best practice" approach underpins the methodology used in the development of the Orange-Senqu River Basin TDA. Consequently the methodology for the TDA consists of the following steps:

- **Identification and initial prioritisation** of transboundary problems
- Gathering and interpreting information on **environmental impacts** and **socio-economic consequences** of each problem
- **Causal chain analysis** (including root causes)
- Completion of an **analysis of institutions, laws, policies and projected investments.**

It focuses on transboundary problems without ignoring national concerns and priorities and identifies information gaps, policy distortions and institutional deficiencies. The analysis is cross-sectoral and examines national economic development plans, civil society (including private sector) awareness and participation, the regulatory and institutional framework and sectoral economic policies and practices. Causal Chain Analysis (CCA) is one of the most useful aspects of the TDA for the development of future corrective actions. The causal chain should relate the transboundary problems with their impacts, immediate physical causes and their social and economic underlying root causes.

Image 1: Workshop

During the compilation of this preliminary TDA, a number of workshops were held and consensus reached on the key transboundary problems, their root causes and the three pilot projects needed to guide future development.

Basin profile

The climate below the Alpine belt in Lesotho is temperate but at higher altitudes can be severe with June and July temperatures falling below -10o C at night. Temperatures increase westwards with the hottest areas recording temperatures in the mid 40o C. At the summit of the Drakensberg escarpment in Lesotho, the mean annual precipitation is 1,600-1,800 mm, decreasing sharply westwards to 45mm at Oranjemund at the Orange River Mouth. Rainfall is highly variable in the western areas which also have the highest evaporation rates. This results in an average water deficit per year of about 1.9 m in the middle reaches of the Orange basin to about 2.6 m in the western parts of the lower Orange.

The highlands of Lesotho support Alpine vegetation that consists of climax heather communities composed mainly of low woody species interspersed with alpine grasses at the highest altitudes. Grassland habitat dominates the remaining high-lying areas while at lower altitude, mixed sour grassveld occurs westwards to False Upper Karoo. A series of karooid vegetation types characterize the middle

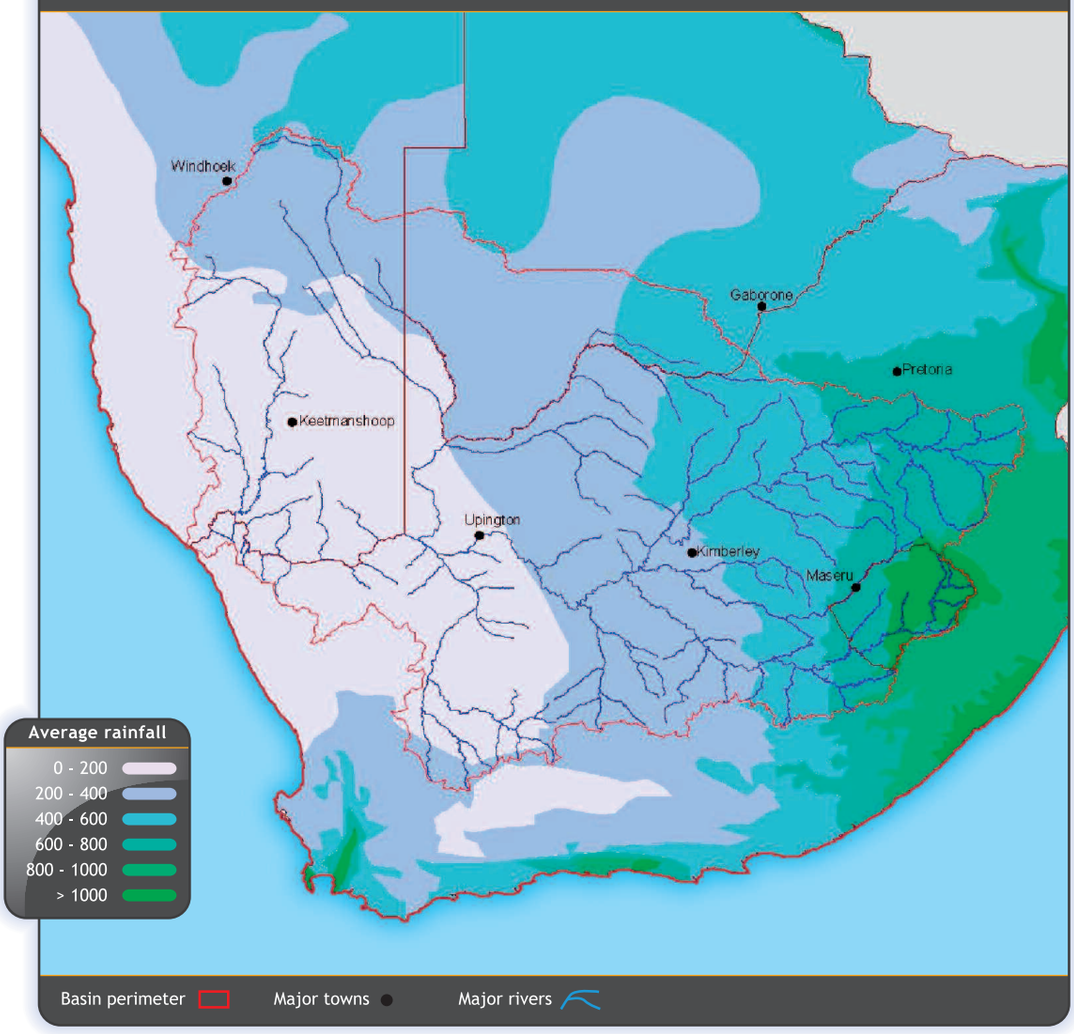
Image 2,3,4: Orange-Senqu basin landscapes

The Orange-Senqu basin includes spectacular and highly varied landscapes, including the Lesotho highlands (left), the Gauteng highveld (middle) and the arrid west (right).

and lower Orange River catchment, including the Fish River tributary in Namibia, ending ultimately in the Succulent Karoo from the Richtersveld to the coast.

The skewed distribution of rainfall (see Figure 2), the geographical concentration of demand in the upper half of the system, the significant agricultural demands in the drier parts of the catchment and the provision of the storage and transmission infrastructure to meet these, is the essence and driving force of the ensuing transboundary issues.

Figure 2: Map showing average annual rainfall in the Orange-Senqu



The water quality in the Orange-Senqu Basin is highly variable due to a combination of natural and anthropogenic factors. The catchment includes the main urban and industrial conurbations of South Africa, the main gold mining areas of the country, parts of the Highveld coal fields, some of the country's power stations and significant areas of dryland and irrigation agriculture. Although the arid western part of the catchment is less developed, irrigation agriculture occurs extensively along the lower reaches of the river.

The demand for water in three of the basin countries in Mm^3/a are shown in the table below. There are no detailed demand figures for Botswana.

	2005	2010	2015	2025
South Africa	5389	5531	5647	5729
Namibia	76	134	197	244
Lesotho	21	23	24	26
Total	**5687**	**5867**	**5997**	**6168**

95% of all water demand is from South Africa of which approximately 60% is from the irrigation sector. Growth in demand in South Africa is predicted at 1% per annum principally in the Urban, industrial and mining sectors. Higher demand growth rates are expected in both Namibia and Lesotho, but particularly in Namibia where an expansion in irrigation is anticipated. Available water resources are currently sufficient to meet demand however demand growth and the need to meet ecological flows means that a combination of new water resource development and demand management, particularly in the irrigation sector, is required in the relatively short-term.

Image 5,6,7: Irrigation for food production

Irrigation is a major user of water from the Orange-Senqu river. This sector is likely to use more water in the future as the need to grow food becomes even more acute. The above images show irrigated lucerne (left), dates (middle) and grapes (right).

For Namibia, the Orange River is a key resource for the southern region of the country, where commercial agriculture and mining activities depend on the river as a reliable resource. In Botswana the basin is very flat and arid and has not contributed water to the main stream in recent history. Nor is the Orange a very practicable resource for south-eastern Botswana, because the existing demand canters are far from the river.

In the case of Lesotho the national water demands are relatively small and the downstream impacts of abstractions would therefore be quite minor and not present a significant downstream conflict risk. However, the development of the Lesotho Highlands Water Project (LHWP) in Lesotho, transferring water to the Vaal System, does have a significant impact on the river in Lesotho and South Africa.

The basin had an estimated population of 19 million people in 2004 (Earle et al., 2005). South Africa has by far the major proportion of the basin's people, with high population densities in its Gauteng province but significantly fewer people in the arid west. All four countries have undergone significant urbanization

but population growth rates have slowed because of decreasing fertility and high mortality due to the very high HIV/Aids prevalence rates.

The South African economy is overwhelmingly dominant with 93% of the total gross domestic product (GDP) for the four countries. GDP per capita is highest for South Africa and lowest for Lesotho. Between 1975 and 2004 economic growth rates have declined in Botswana and Lesotho but increased in South Africa and Namibia. Inflation rates have been low and have declined further in recent times. The following four sectors dominate:

- agriculture forestry and fishing,
- mining and quarrying,
- manufacturing and utilities, and
- services (which includes government).

The majority of the populations in the basin countries can be described as poor. Health indicators for the basin tend to have similar patterns to those for human development, employment and poverty. Compared with the rural areas, the urban areas have lowest infant mortality rates and better medical services and facilities. The human development index rose between 1970 and 1990 but has since declined in all countries. Similarly, life expectancy between 2000 and 2005 is much lower in all countries than it was between 1970 and 1975. Other indices such as adult literacy, and access to improved water sources, reflect general improvement over time, in line with the economic growth trends. In South Africa the general level of human development is highest in the urban centre of Gauteng, and lowest in the arid west, where traditional, small-scale rainfed land-uses are typical. The incidence of HIV/AIDS is very high, being 35.8%, 23.6%, 22.6% and 20.0% in Botswana, Lesotho, South Africa and Namibia, respectively (Ashton & Ramasar 2001). The social and economic impact of this pandemic is currently dire, and will become even more so in future.

The high level of use of the water resources of the Orange – Senqu Basin particularly in the Vaal River has reduced the total annual flows of the lower Orange River to a fraction of their natural levels along with corresponding perturbations in their inter-annual variability. The seasonal pattern of the flow regime is now just a token of what it was, with no discernible flood season in many years and only large flood episodes being evident when there is spillage from Vanderkloof, though the flood hydrographs are very much attenuated and maximum discharges and flood durations much less than formerly. The smaller flood events are captured in the reservoir storages, the overall effect being diminished distinctions between the seasons and constant regulated flows for months on end. The environmental consequences are potentially very severe in the long term and could lead to the collapse of the natural riverine ecosystem and its ability to function. Already, the Orange River Mouth has deteriorated to the extent that its integrity as a functional Ramsar site is in jeopardy, as a result of a number of factors, perturbations in flow being just one.

All Orange-Senqu River riparian states have, or are on the process of developing, water policy and legislation that reflects international trends in water management, particularly the implementation of Integrated Water Resource Management (IWRM). Once all legislation is in place the four countries are, from a legal perspective, largely in the position to implement IWRM nationally while taking into account

Image 8 & 9: The effect of dams on the natural flow of the Orange-Senqu

A number of dams (left) have severly altered the natural flow of the river and the lower Orange (right) now only receives a fraction of its former volume.

the obligations set forth by applicable international law. It needs to be acknowledged though that all countries, to different degrees, are faced with serious (human and financial) capacity constraints to effectively implement the applicable policies and laws in practice. Whereas the required capacity is arguably highest in South Africa, all countries experience significant capacity challenges and a detailed assessment of capacity gaps needs to be undertaken.

In order to use the resources of the River System in an "equitable and reasonable" manner, the equitable share of each country needs to be determined. Only once that has been done the respective national authorities are able to accurately include international obligations (as far as water resources allocation is concerned) into their planning and thus comply with international law. The determination of the "equitable share" requires the joint acceptance of a resource definition as well as of the applicable criteria to be considered for the determination of the "equitable share". International water law provides guidance as to the criteria to be used for the determination of each country's equitable share.

From climate records of the past 50 years, elements of climate change for derivatives of rainfall, temperature and hydrological responses can already be detected in certain regions within southern Africa. Not all areas display equal change, and in some areas no change can yet be detected. The following predictions have been made with regard to water resources:

- In South Africa, the projected increase in potential evaporation is estimated to be 10-20%. This increase will be accompanied by enhanced evaporation losses and increased irrigation demands.
- Soils will become drier more often which may result in reduced runoff per mm rainfall, agricultural land-use changes, reduced crop yields and higher irrigation demands.
- Fewer, but larger rainfall events which may result in more groundwater recharge.
- Climate change will be accompanied by changes in land-use in the four countries, which will be superimposed on already existing complex land-use impacts.

Vulnerable communities in southern Africa already have to cope with multiple stresses, of which climate variability is but one. Climate change impacts, including water resource availability, within the Orange-Senqu basin require adaptive strategies and adaptation policies - co-ordinated between all basin States.

Priority transboundary concerns

The twenty-three common GEF transboundary issues were assessed by the members of the Technical Task Group (TTG) in order to determine their relevance and transboundary nature in the context of the Orange-Senqu River Basin. The group was asked to brainstorm and identify the major water-related transboundary problems. Consequently, the GEF list was narrowed down to 5 major transboundary issues in the Orange-Senqu River Basin that required further detailed analysis:

- Stress on ground and surface water resources
- Changes to hydrological regime
- Deterioration of water quality
- Land degradation
- Alien invasives.

When examining the transboundary issues the authors were asked to consider biodiversity and climate change as cross-cutting issues.

Key findings and recommendations

The key findings of the **water resource and hydrological regime** studies are:

- Surface water resources of the Orange-Senqu Basin are highly utilized to the extent that the residual flows to the mouth represent only 25% of the natural MAR at the mouth;
- The DWAF/Namibian Water Resource Planning Model developed under the LORMS study and which models the whole basin, indicates that there is already under a significant deficit in the Lower Orange which may grow to over 400Mm3/a by 2025. This calculation excludes demand from Botswana and assumes that the current Ecological Water Requirement (EWR) of 1,000 Mm3/a remains;

Image 10: Flowing Orange-Senqu

- The strategy for new infrastructure development is not yet defined with options including LHWP phase 2, expansion of Thukela- Vaal transfer scheme, a re-regulating dam at Vioolsdrift, and an upper Orange dam, and therefore the yield cannot be defined with any certainty. The earliest implementation date for LHWP is 2018 at which time the deficit in the Lower Orange is forecast to be 374Mm3/a;
- Improved resource management in the Vaal and Orange systems could yield up to 223 Mm3/a and maintain a surplus in the Vaal system until 2015, however, this includes utilisation of spillages from the Vaal system and there may be double counting;

- Water demand management in the irrigation sector has a forecast potential saving of 226 Mm3/a deliverable in 5-10 years. There are limited available figures for demand management savings in the domestic, industrial and mining sectors or estimate of potential transfer and distribution savings. A detail demand management strategy needs to be established;
- Significant improvements are required in the hydrological flow monitoring network, particularly the low flows;
- The Lower Orange and the mouth currently has a category D ecological status and the provisional EWR is estimated to be 1,000 Mm3/a. From existing data and information it is difficult to establish whether this requirement is being met. It has been estimated that raising the ecological status of the mouth to category C will require a further 500 Mm3/a, which will increase the deficits in the lower Orange accordingly;
- The potential impact of climate change on the supply and demand side of the water balance is not taken into account in the calculation of the water resource balance;
- Groundwater resources are limited and it has yet to be established what contribution, if any, they could make to the water balance.

The key recommendations and conclusions of the **water resource and hydrological regime** studies are:

- To enable the decision makers to clearly understand the issue, a detailed water resource balance for the whole basin needs to be prepared, based upon agreed planning criteria (assurances, EWRs etc.), consistent component demand forecasts and climate change scenarios, against which potential water resource development options and demand management targets can be superimposed to determine the geographical planning surplus and deficits over a twenty year planning period.

Image 11: Irrigation using water from the Orange-Senqu

- To undertake an assessment of Ecological Water Requirements in the Lower Orange and mouth and establish an agreed methodology which can be applied in other key points of the Basin.
- Establish a ‘vision’ for the Orange-Senqu River Basin water resources in the national larger economic planning frameworks of the four countries. The vision should indicate the level of environmental

protection the river should be afforded. Can protection be increased from category D to category C?

- Develop and agree criteria for establishing equitable sharing of water resources between the four countries in order to set bounds on development demand.
- Establish a decision framework for future water allocation based on economic water evaluation criteria.
- Improve implementation of regulatory functions and responsibilities in all four countries and strengthen regional coordination through ORASECOM.
- Agreed climate change scenarios need to be incorporated into the water balance calculations - perhaps with different scenarios for different sub-basins - and develop adaptation strategies.

The key findings of the **water quality** studies are:

- The Vaal catchment is highly polluted which has implications for water resource availability and transboundary impacts. The water quality of the Upper and Lower Orange is said to be good; however there are insufficient data for certain categories of contaminants to make any conclusive statements.

Image 12: Pollution of the Orange-Senqu

- There are concerns along all the rivers which flow through towns and villages throughout the catchment regarding localized micro-biological pollution from untreated and partially treated sewage entering the rivers;
- The increase in Total Dissolved Solids (TDS) in the Vaal and Lower Orange catchments and the concomitant increase in constituents such as chloride and sulphate, has had major implications for domestic, industrial and agricultural water use;
- The transboundary impacts of POPs, heavy metals and radio-nuclides are unknown due to a lack of monitoring data and detailed studies, but some level of transboundary transfer of these pollutants is suspected;
- Eutrophication is a severe problem in the Vaal catchment and in isolated pockets in other parts of the Basin.

The key recommendations and conclusions of the **water quality** studies are:

- Establish basin-wide Receiving Water Quality Objectives (RWQOs) and agree and develop sectoral short- and medium-term targets to meet the objectives. RWQOs are being set in isolation in priority catchments; whilst integration of the RWQOs for the Vaal River is being addressed in the Integrated Water Quality Management Plan (IWQMP) that is being developed by the South African DWAF, there are no objectives agreed for the whole of the Orange-Senqu basin.
- Undertake a water quality assessment of the major aquifers in the basin. There are concerns regarding the quality of groundwater resources and their protection, however there is insufficient data to make any conclusive statements in this regard;

Image 13: Monitoring water quality of the Orange-Senqu

- Improve compliance monitoring and enforcement in all four countries. Lack of institutional capacity to effectively manage water quality in their respective countries is a major constraint;
- Improve the water quality monitoring network throughout the region. In Lesotho and Namibia, the water quality monitoring networks are poorly developed and there are no formal sampling networks or water quality databases. South Africa has a more sophisticated and extensive monitoring system, but there are still a number of deficiencies in the data sets, the extent of the network - especially along the Lower Orange and in some of the more polluted sub-catchments of the Vaal River.
- Undertake an assessment of Persistent Organic Pollutants, heavy metals and radio-nuclides in the Vaal and Lower Orange catchments for which there is a general lack of information in the catchment.

The key findings of the **land degradation** studies are:

- Land degradation poses a risk to ecosystem integrity in fragile highland and dryland environments, defined in terms of the health, connectivity and stability of both the biotic and abiotic components of ecosystems and the interconnectedness between them. Ovestocking, caused by communal land tenure systems and the uneven distribution of water, is a major factor in rangeland degradation throughout the basin;
- The Lesotho highlands are particularly sensitive to land degradation which causes critical impacts to run-off (e.g. damage of the water sponges) and sediment loadings;
- In the Lower Orange, land degradation due to overgrazing and overstocking is widespread but its economic impact on water resources has not been determined;
- Deforestation in the riparian belt and/or invasion by alien species can cause disruption to the hydrological cycle, but it is unclear to what degree this is prevalent in the Orange-Senqu River Basin due to a lack of any basin-wide studies in this regard;
- Lack of alternative livelihoods and access to market and financial facilities lock the rural populations into unsustainable range management practices;
- Poor land-use policies and historical tenure systems have exacerbated the land degradation problem;

Image 14: Land degradation in Lesotho

Poor land use in the catchment will always result in poor water quality, and thus reduced options, lower down in the system.

- There is an urgent need for community-based natural resource management initiatives across the basin, particularly for rangeland managed areas (under livestock, wildlife or both), involving integrated approaches in communal and freehold areas.

The key recommendations from the **land degradation** studies are:

- Undertake an assessment of the scale and scope of land degradation in the Orange-Senqu Basin particularly in the Upper and Lower Orange.
- Undertake a more detailed assessment of the water resource implications of existing and potential future land degradation; the linkage between land-use and water resource management is fragmentary which makes the development of a strategy to address the problem difficult; there is a tendency for generic solutions.

- Strengthen monitoring and evaluation systems need and the dissemination of information and knowledge to the local level to help develop adaptive management strategies.
- Demonstrate various governance models at the community level which will deliver best practice integrated rangeland and water resource management in various biomes.

The key findings of the **invasive species** study are:

- Increases in the distribution and occurrence of alien invasive species across the basin are contributing to the environmental degradation of riparian and aquatic ecosystems in the Orange-Senqu Basin.
- The upper catchments of the Basin within Lesotho, and the Eastern Free State and Gauteng provinces of South Africa show significant riparian infestations of alien species, such as Silver wattle, Black wattle, Grey poplar, Blue gum, Syringa and Jacaranda. These species are significant water users, and compound degradation of riparian ecosystems.
- The Vaal River contains sections of dense infestations of aquatic plant species, especially Water hyacinth. This species disturbs aquatic habitats, alters the flow of the river and blocks water abstraction, conveyance and irrigation equipment.

Image 15: Alien invasive plant species

Water hyancinth is a good example of an alien species that is now regarded as out of control, and a major threat to the integrity and management of various river systems in Southern Africa.

- The drier middle to lower sections of the Orange River Basin are impacted mostly by growing infestations of Mesquite. This woody shrub species is commonly encountered in riparian areas, and is responsible for significant river yield losses, as well as land degradation.
- The eradication programmes are fragmented in approach and, with the exception of South Africa, donor driven.

Key recommendations of the **invasive species** studies are:

- Integrate eradication efforts should across the basin to control common invasive species and where applicable incorporated them into the national and regional IWRMs.
- Strengthen monitoring of alien invasive species throughout the basin and establish a database.
- Undertake an assessment of the water resource losses due to invasive species in the Orange-Senqu and evaluate the economic cost.

The compilation of a TDA requires a Stakeholder Analysis (SHA) based on GEF International Water Projects (IWP) Best Practices. The SHA included interviews with 36 stakeholder groups in the basin countries in February and March 2007. The stakeholders included employees of departments dealing with environmental affairs, tourism, water affairs, meteorology, forestry, agriculture, national water managers and parastatals, agronomic boards, mining industry, scientists, NGOs, tour guides, river communities, officials of ORASECOM, and international organizations working on other ORASECOM projects, including French GEF, and GTZ. The interviews were followed by a telephonic/face-to-face questionnaire survey of more that 400 stakeholders from 36 groups across the region.

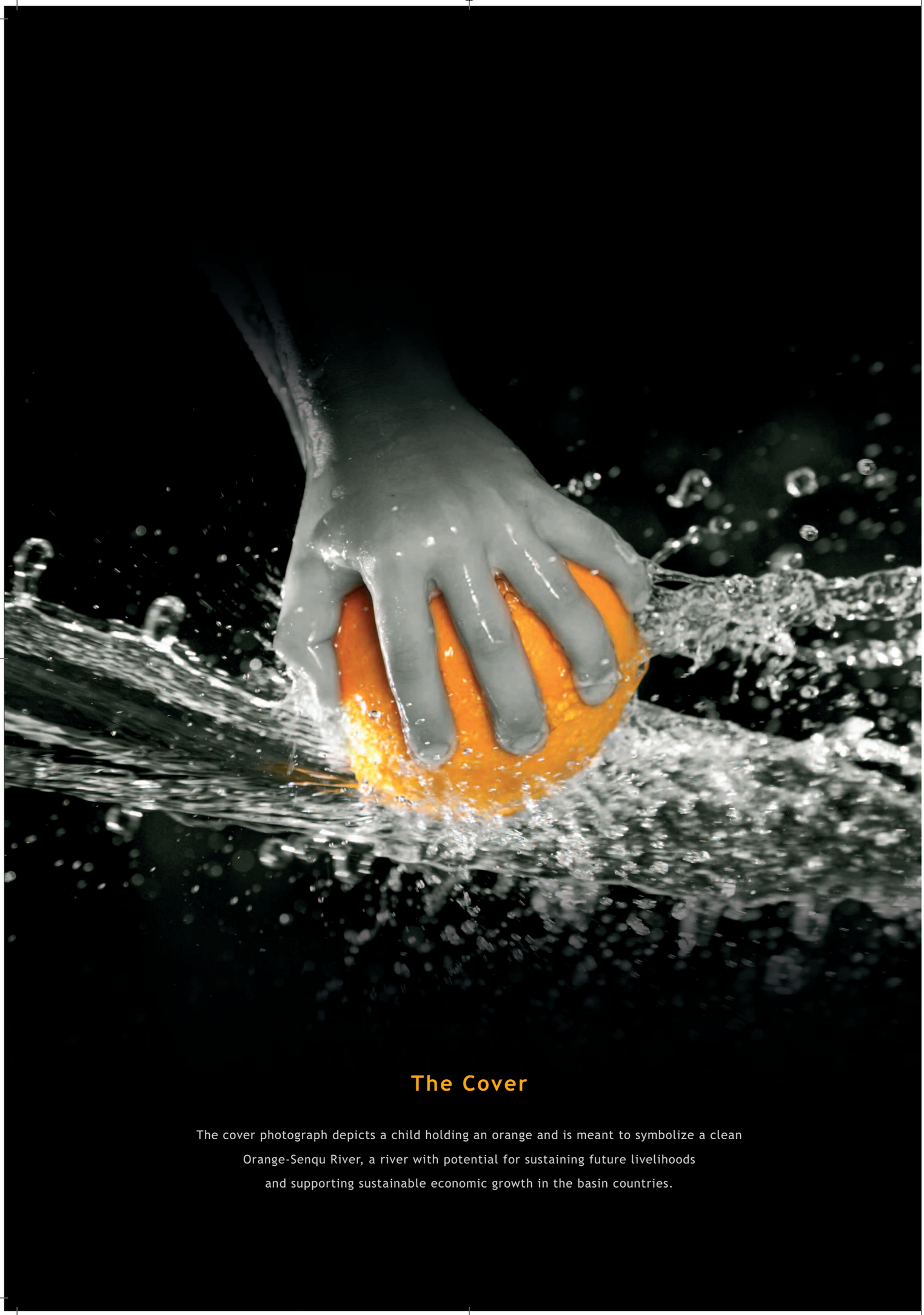
The Stakeholder Analysis showed that there is concern about the following major issues:

- Water quantity;
- Impacts of climate change on water regime including quality, quantity and ecosystems;
- Water regime influences on biodiversity;
- Water quality;
- Other social and economic issues impacting project design and implementation.

As a result of the SHA the following recommendations have been made for inclusion in ORASECOM's Stakeholder Roadmap.

- Develop and roll out a concerted national and regional awareness raising and building campaign, which acknowledges the scarcity of water and the need to implement water use conservation measures as part of a wider demand management strategy.
- Develop inter-sectoral capacity building measures to increase awareness and understanding of the concepts of sustainable development, IWRM, and environmental economics.
- Take steps to decouple the perception of a trade-off between sound environmental management and economic development.

The findings and recommendations of this TDA will be revisited as part of the UNDP- GEF full-size project and will feed into the development and negotiation process for the Strategic Action Programme.



The Cover

The cover photograph depicts a child holding an orange and is meant to symbolize a clean Orange-Senqu River, a river with potential for sustaining future livelihoods and supporting sustainable economic growth in the basin countries.