GROUNDWATER NEED ASSESSMENT

ORASECOM

BY

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Africa Groundwater Network (AGWNET)

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List of Acronyms

ACRU:	Agricultural Catchment Research Model
AGWC:	Africa Groundwater Commission
AGWNET:	Africa Groundwater network
AMCOW:	African Ministerial Council On Water
ANBO:	African Network of Basin Organisations
AU:	African Union
DGS:	Department of Geological Surveys
DWA:	Department of Water Affairs
DWAF:	Department of Water Affairs and Forestry
FEFLOW :	Finite element subsurface flow system
GW:	Groundwater
HQ:	Head quarter
I& TWRM:	Integrated and Transboundary Water Resources Management
ISRAM:	International Shared Aquifer Resource Management
JPTC:	Joint project Technical Committee
L/sec:	Litre per second
L/RBO:	Lake/River basin organization
MCM/yr:	million cubic meter per year
Mm^3:	million cubic meter
ORASECOM:	Orange-Senqu River basin Commission
PMWIN:	Processing Mode flow Windows version
SADC:	Southern African Development Community
SAP:	Strategic Action Program
TBA:	Transboundary Aquifer
TDA:	Transboundary Diagnostic Analysis
UN:	United Nations
UNESCO:	United Nations Educational, Scientific and Cultural Organization
WRYM:	Water Resource yield model

1. INTRODUCTION

The Orange-Senqu River basin is located in the arid and semi arid part of Southern Africa where the groundwater resource has strategic role for rural water supply (domestic, livestock and irrigation uses) besides as a source for mining, irrigation and tourism in the basin States. Due to benevolent gesture of the countries to meet the growing water demand, foster an economic growth and the interaction between countries on water resource issues, ORASECOM has been officially established in Nov. 2000 with the Head Quarter at Centurion, South Africa. Of course, there were bilateral agreements between countries since 80's.

ORASECOM aims to develop the Orange-Senqu River basin for the benefit of all the respective states and is the first formal body established for the management of shared water resources since the Protocol on Shared Water course system became an instrument of international water law in SADC in 2000.

The ORASECOM, 2000 agreement reveals the following key points:

- General scarcity of water in the southern African region due to arid climatic condition
- Mutual benefit, peace, security, welfare and prosperity of people that would grow from the collaboration between the riparian countries.
- Upholding important aspects of international water law such as the 1966 Helsinki Rules on the Uses of the Waters of International Rivers and the UN Convention on the Law of the Non-Navigational Uses of International Watercourses of 1997.
- Upholding the spirit of the Protocol on Shared Watercourses in the Southern African Development Community.
- Desire to extend and consolidate good neighbourliness and friendly relations between parties through close and co-ordinated co-operation in the development of all resources in the Orange-Senqu River.
- Foster economic development through sustainable use of water.

Since its establishment, ORASECOM has carried out a lot of activities such as project development and management, coordinate water management activities across the basin, policy level dialogue on water related issuesin the basin. ORASECOM has placed all available information of the basin its website (.A total of five Google Earth layers were developed for the Orange-Senqu River basin including a layer of major dams, river network, stream order, sub-basins and land cover. These layers, along with layers already available for the region from Department of Water Affairs (DWA) South Africa, Ramsar and other agencies, were made available on the Orange-Senqu RAK CDROM and website (www.orasecom.org). These activities are inline with its mandate listed in BOX 1. ORASECOM has also put tangible effort on TBA diagnostic analysis which is an encouraging activity for the riparian countries. According to SADC (2009)[10] report,

ORASECOM has been the first river basin commission in SADC to establish a groundwater technical committee in 2007 to facilitate the dialogue between the respective basin States on transboundary aquifer management which was followed by the implementation of the Molopo-Nossob groundwater assessment.

Roles of RBOs

- Joint basin-wide planning, including development of basin master plans and coordination of planning with responsible national level organisations
- Generate information and knowledge required for planning and management and provide platform for information sharing
- Preparation and implementation of projects (only if RBO has executive mandate)
- Monitoring and coordination of ongoing projects and activities (national and transboundary) in the basin
- Liaise and coordinate with relevant organisations at national and REC level
- Facilitate in the resolution of disputes

BOX 1. Role of RBOs (Source: SOFRECO 2011.)

2. OBJECTIVES

The main objective of the work is to assess the present framework, experiences, and capacity for groundwater management in ORASECOM and identify shortcomings for integrated groundwater management as part of integrated and transboundary water resources management (I&TWRM). Furthermore, it is aimed to develop targeted and prioritized recommendations for enhancing the capacity of ORASECOM for integrated groundwater management in the basins.

The work links to the ongoing efforts by the basin states and the international community to strengthen the ORASECOM as main actors in national and transboundary water resources management in basin.

3. THE BASIN AND ITS WATER MANAGEMENT

3.1 Bio-physical condition

The Orange-Senqu River basin, with a total area of 896,368 km^2 and population of over 19 Million, is located in Southern Africa that includes Republic of Botswana, Kingdom of Lesotho, Republic of Namibia and Republic of South Africa (Fig.1). The two main tributaries are the Senqu River (originates from the Lesotho Highlands, ≈3000 m a.s.l) and the Vaal River (originates from central part of South Africa). However there are other tributaries such as Molopo, Kuruman, Nossob, Auob and Fish Rivers, which are important in sustaining the catchment hydrography. The Orange-Senqu River flows in a westerly direction for 2,200 km to the west coast and discharges into the Atlantic Ocean. The River forms part of the border

between South Africa and Namibia. It is regulated by more than thirty-one major dams. Two of these dams are situated in Lesotho, five in Namibia and twenty-four in South Africa. The largest five reservoirs are those formed by the Gariep, Vanderkloof, Sterkfontein, Vaal and Katse Dams with capacities ranging from 1950 Mm^3 to 5675 Mm^3 at full supply level (ORASECOM 001/2009 [24]).

The riparian countries cover a range of ecological zones with high rainfall mountainous areas of the Lesotho Highlands, through the savannah grasslands of the central plateau to the desert conditions in the western part of the basin (Bohenskey et al., 2004; ORASECOM, 2005 [1, 2]). The entire country of Lesotho falls within the Orange-Senqu River basin, with the river flowing into South Africa. The total runoff of the Orange-Senqu River basin is in the order of 11600 MCM/year (ORASECOM, 2005)[18].

3.2 Socio-economic conditions

In the SADC region, in general, no reliable statistics on groundwater use in the region are available. However, it is well known that groundwater is the largest water supply source for the domestic water supplies in the region, while it also plays a significant role in stock watering and other uses (Braune, E and Xu, Y. 2011[27]). South Africa is by far the largest water user of the Orange-Senqu basin and accounts for 97% of total water use in the basin; Lesotho accounts for 1%, Namibia 2% and Botswana <1% (ORASECOM Awareness Kit). Agriculture accounts for 61% of water demand from the Orange-Senqu basin and is the major user in basin countries with the exception of Lesotho. In Lesotho, industry and domestic water demands are higher than agricultural demands (ORASECOM Awareness Kit). It is important to underline the fact that to meet the demand, withdrawal is made both from the Orange-Senqu River and groundwater, however, groundwater reserve and use has not been quantified as source for various activities in the basin.

According to the ORASECOM Awareness Kit, the upper Orange-Senqu River includes the Orange–Senqu River in Lesotho and the Orange River in South Africa above the Vaal River confluence. The Lower Orange River includes the South African stretch below the Vaal River confluence, and Botswana and Namibia sections. In Lesotho, an estimated 70% of rural households produce vegetables in their home gardens and most of these gardens are rain-fed, supplemented with irrigation from household and/or community domestic water supplies. In the upper Orange River basin of South Africa, the main economic activity is livestock farming and there are extensive areas under dry land cultivation. In the lower Orange River basin, most of the agriculture is irrigated using water extracted from the river and from groundwater.

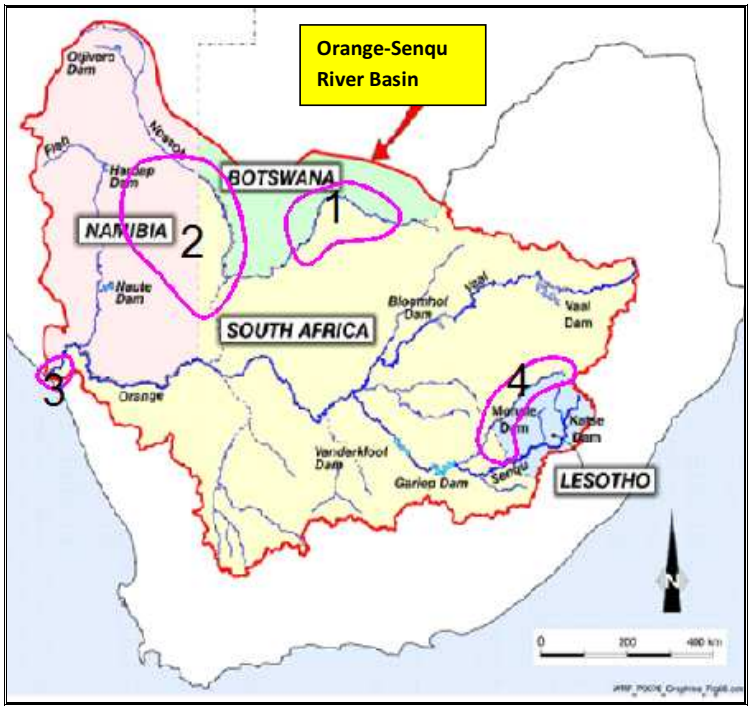

Fig. 1. Orange-Senqu River Basin (Updated from ORASECOM) 1: Ramotswa dolomitic aquifer, 2 Stampriet artesian aquifer, 3, Coastal sedimentary aquifer, 4, Fractured Karoo aquifer)

The environment of the Orange-Senqu River basin is characterized by vast dry land primarily in Botswana, Namibia and South Africa with limited highland terrain in Lesotho. The basin is congested with various mining activities: Gold, Diamond, Copper, Uranium, PGE minerals etc. besides large-scale irrigation and many conservation areas (national parks and protected areas). Regarding water use, groundwater takes prime position in the rural areas away from the main Orange River for all type of human activities.

3.3 Hydrogeological conditions

Groundwater occurrence in the Orange-Senqu River basin is limited to the weathered and fractured hard-rock formations (Precambrian crystalline rocks) with modest yields. However, higher yielding aquifer systems, occur in the coastal sediments lowland alluvial deposits and dolomitic formations which are locally very important.

The most important hydrogeological system in Orange-Senqu basin countries is represented by transboundary system, which requires profound attention for the sustainable resource development. Small hydrogeological basins in each country provide water for the

development of agriculture, industry, mining, domestic and tourism activities. Some of which are (ORASECOM 004/2007)[3] :

Botswana: Hydrogeology of the Molopo River Basin area**:**

- The fractured porous aquifer, represented by the Karoo sandstones, comprises 37% of the basin in the country and is the most common but saline.
- The porous aquifers, represented by alluvial and Kalahari bed aquifers, comprise 35% are generally saline or low yielding and occasionally fresh.
- The fractured aquifer includes the Archaean Basement and Proterozoic aquifers and Karoo Basalts, comprise 27%.
- The Karstic fractured aquifers, which are represented by the Transvaal dolomite units, comprise only around 1%.

Namibia: Important aquifer is the Stampriet Artesian Basin shared by Botswana, Namibia and South Africa. The main lithology is made of Kalahari sand and gravels. Isolated groundwater occurrence exists within the fractured basement rocks and sand dunes.

Lesotho: Groundwater resource has played a crucial role in water supply for both rural villages and urban centres in Lesotho, but more importantly for rural population. Main groundwater occurrence is in the Burgersdorp Formation (argillaceous 1.6 L/sec), Molteno Formation (sandstone 3 L/sec), Elliot Formation (interbedded sandstone, 1.3 L/sec), Clarens Formation (compact sandstones, 0.9 L/sec). These aquifers are part of transboundary system between Lesotho and South Africa.

South Africa: Groundwater has always been an important source of rural water supply. Dolerite dykes within the Karoo sedimentary rocks, weathered zones, alluvials are important host for groundwater even as a transboundary aquifer system. An important feature with regard to the groundwater resources of the Orange River Basin is the large dolomitic aquifers of the Upper Vaal. Tosca Dolomite Aquifer in the North West Province (recharge= 6.90 MCM/yr) which is a major aquifer in the area. The Karoo aquifers that cover virtually most of the area have generally only a moderate development potential. Low permeability, storativity and available aquifers storage are the limiting factors.

The Molopo-Nossob groundwater study (ORASECOM006/2009[20]) and review report on the groundwater resources in the Orange River basin (ORASECOM/004/2007[13]) provide important background information which need detailed study on the transboundary aquifers such as the extent, storage, recharge and current state of exploitations based on which water managers can give decisions.

3.3.1 Transboundary aquifers

Transboundary aquifer management will have major benefits to the four riparian countries and to the groundwater stakeholders. RBOs are expected to generate information

and knowledge required for planning and management of water resources and provide platform for information sharing in the riparian countries. Therefore, ORASECOM has undertaken TDA and SAP (UNDP/GEF, 2008[28]) in three countries (Molopo-Nossob basin study). The TDA identified that groundwater resources are limited and has yet to be established what contribution, if any, they could make to the water balance. SADC has planned a major TBA management study with GEF funding on Stampriet and Ramotswa aquifers (SADC, 2010[26]; Braune and Xu, 2011[27]) which did not happen up until this time.

According to Struckmeier et al. (2006[8]) and Cobbing et al. (2008[9]) the main transboundary aquifers in the ORASECOM countries are:

3.3.1.1 Ramotswa dolomitic aquifer: Botswana/South Africa

It is unique because of its dolomitic characteristic that has karst structures consequently it has high yield, high interconnectivity with surface water and high vulnerability to pollution. There are two primary aquifers, namely the Ramotswa dolomite and the Lephala formation. Both aquifers are considered to be hydraulically connected. The upper karstic zone receives recharge from the river and percolating rainfall. According to Cobbing et al. (2008)[9], the dolomitic transboundary aquifer between South Africa and Botswana requires attention in order to avoid over abstraction from South African side for agricultural use. Most of the aquifers have not been studied from transboundary perspective and need immediate attention from the riparian countries. In any case over-abstraction of these aquifers could have severe impact on the status of surface water resources through drying up of rivers.

Key issues relating to this transboundary aquifer analysis are (SADC, 2009)[11]:

Botswana:

- The Ramotswa dolomite aquifer is Botswana's most productive aquifer and has a major well field, serving as local water supply and as back-up supply for the capital, Gaborone, north of Ramotswa.
- Aquifer pollution from pit latrines.

South Africa:

According to SADC 2009[10] report, the South African side of the dolomitic transboundary aquifer has not been well developed, but there is considerable interest in it from national water planners, because of the rising demands in the area which includes Mmabato, the capital of North West Province. While, Cobbing et al, (2008 [9]) indicated the presence of an over exploitation in the dolomitic aquifer by commercial farmers. Thorough study (such as the proposal by SADC, 2009) is necessary to establish the current status of the aquifer and to recommend the way forward.

3.3.1.2 Stampriet Artesian Basin: Namibia/Botswana/South Africa

The basin contains two confined regional artesian aquifers in the Karoo sediments, overlain by the Kalahari sediments that often contain an unconfined aquifer system (Fig. 2). The study confirmed that extensive faulting resulted in a complex nature of this aquifer system. Recharge into the system in the north-western part of the basin is from structures such as faults, linked to sinkholes that serve as the main conduits for recharging the confined sandstones. The recharge mechanism in the Botswana/Namibia boundary area is however still unknown.

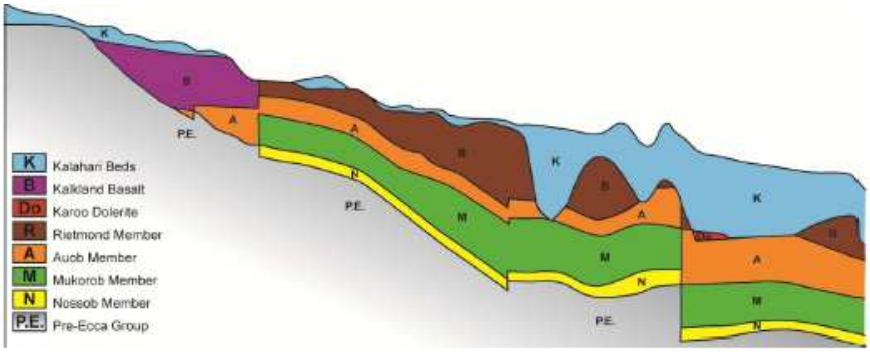

Fig. 2 Cross-section through Stampriet basin (Courtesy Greg Christellis, Namibia): (source SADC, 2010[26])

In Namibia, there is a comparatively good understanding of the geology and hydrogeology of the Stampriet Artesian Basin. Groundwater occurs in the Auob and Nossob sandstones of the Ecca Group as well as the overlying Kalahari Group sediments. In the South African part of the basin, mainly along the Molopo and Nossob Rivers, the known productive and potable aquifers are in the Kalahari Group and the inference is that being down-gradient from the hypersaline Stampriet / Nossob Basin, the water quality may not be good. The groundwater chemistry is mainly of good quality and poor groundwater quality with respect to salinity is generally confined to the south-eastern corner of the Stampriet Artesian Basin. However, thorough and integrated study is needed from Botswana and South Africa side by considering the Stampriet aquifer as a single system.

Key issues relating to this transboundary aquifer system are (SADC 2009)[11]:

Namibia

- Sustainable utilization of a significant aquifer, at this stage largely for commercial agriculture;

- Management of losses of water due to leakage from the artesian aquifers through regional fractures and through inadequately designed boreholes.

South Africa:

- Exploration for and development of freshwater in the saline aquifer environment for rural communities
- Establishment of public awareness and local management of the local resource
- Maintenance of arid zone ecosystems for farming and nature conservation purposes, including issues of bush encroachment and water point management

Botswana:

- Sustainable utilization of land and water resources in a tribal stock farming environment

3.3.1.3 Fractured Karoo Supergroup Sedimentary Aquifer: Lesotho/ South Africa

There is very good information on this aquifer from South Africa side, but less understood from Lesotho side. The Karoo supergroup that constitute the transboundary aquifer includes Burgersdorp, Molteno, Elliot, and Clarens formations that outcrops the main lithological sequence between South Africa and Lesotho. The 200 m thick Burgersdorp Formation found in much of the transboundary area is composed of low permeability mudstones and siltstones with minor sandstones. It is a semi-confined to confined aquifer with a mean transmissivity of 20 m^2/day supporting borehole yields <0.5 l/s, except where intruded by dolerite dykes that has high yield. Within the Burgersdorp Formation, many boreholes have been drilled into the dolerite ring dyke intrusions to supply water to farms and small rural communities(Cobbing et al., 2008[(9)]).

The Molteno Formation varies in thickness from 250 m in the south to less than 50 m in the north. It is the best aquifer where permeability is enhanced by intruded dolerite dykes or fracturing. This semiconfined aquifer with mean transmissivity of 20 m^2/day has been developed at Roma and Teyateyaneng, where wellfields with individual borehole yields of more than 3 l/s have been installed. Outcrops of the Molteno Formation also form an important spring line with individual spring discharges as high as 0.5 l/sec. The Elliot Formation varies in thickness from 200 m in the south to 100 m in the north, and is often in hydraulic continuity with the underlying Molteno Formation. Although good water strikes are recorded at the contact between these formations, the Elliot Formation is regarded as a poor aquifer due to its compact nature. The 130 m thick Clarens Formation supports the lowest mean borehole yield of 0.9 l/s and transmissivity of 5 m^2/day. The low transmissivities and consequent low borehole yields of the Karoo Supergroup rocks straddling the Lesotho/South

Africa border mean that the transboundary impact of groundwater abstraction is likely to be very small (Cobbing et al., 2008[9]).

In general, there is a very good understanding on the groundwater occurrence and control structures from South African side on this aquifer which can be up-scaled into Lesotho to draw valuable conclusion on recharge and storage in the area.

3.3.1.4 Coastal Sedimentary Aquifer: Namibia/South Africa

The main geology of the aquifer is made of Quaternary sedimentary rocks and sand dunes. The transboundary problem related to the aquifer in both countries is saltwater intrusion into the coastal aquifer system

The main water uses in all riparian countries are for domestic, livestock, irrigation, mining, tourism and industry while in addition surface water is also used for hydro power generation. However, the use of groundwater is enormous in all rural communities for domestic use, irrigation and livestock.

The review of groundwater resources in ORASECOM (ORASECOM 004/2007[14]) provides few information onthe transboundary aquifer assessment and has little contribution also to the ORASECOM Secretariat and riparian countries to develop groundwater as a strategic resource due to the lack of practical solutions based on monitoring results. The report contains very shallow information without significant hydrogeological information for professional users too. The SADC, 2009[27] report further describes capacity building activities, CD-ROM and Webpage in ORASECOM which is very important component of information dissemination. Groundwater monitoring activities (water level and quality) are active in South Africa, Botswana and Namibia but less in the transboundary basins as a common effort. ORASECOM 005/ 2009 [15] and ORASECOM 006/2009[20] has a comprehensive groundwater assessment report for the Molopo-Nossob River basin (Botswana, Namibia and South Africa). Still detailed characterization of the transboundary aquifer especially the Stampriet and the dolomitic aquifer did not take center stage. Detailed information on, storage, recharge, discharge and other relevant factor has not been addressed for specific aquifers to assist management decision. However, more general assessments have been done, maps have been prepared on yield, saturated thickness, groundwater quality, groundwater level and groundwater recharge on a regional scale. In order to validate the study results continuous monitoring is vital. Available national data base information in the Molopo-Nossob basin has been described in the report, which is very important starting point for the implementation of detailed transboundary aquifer projects in ORASECOM.

Conflict: According to the information obtained from the ORASECOM HQ, it was noted that there was no conflict on water use among the riparian countries. However, there is a growing competition among local users due to fast economic growth in the region. Hence, excessive water use in the countries could potentially raise the tension on top of alarming climate change impact.

3.4 Water governance framework for ORASECOM

ORASECOM has an international and national legal character (ORASECOM 2000[7]). It is operating based on the agreement signed on 03 Nov. 2000 at Windhoek, Namibia, among Botswana, Lesotho, Namibia and South Africa. The ORASECOM 2000, agreement provides the establishment of the Council with the institutional structure as in Fig.3 which is the highest body of the Commission as a technical advisor to the Parties, as well as sets out objectives and functions of the Council, how it will conduct its day to day activities. All four states are signatories to the SADC Revised Protocol on Shared Watercourse Systems in 2000, which was initially adopted in 1995 and then revised in 2000, in order that its provisions were brought in line with those of the United Nations Convention on the law of the non-navigational uses of international watercourses (ORASECOM 011/2007)[5]. This provides a framework for ORASECOM to implement transboundary groundwater resources management.

The ORASECOM 2000 agreement provides for the establishment of the Council, which is the highest body of the Commission. The Council consists of one delegation per party that have ratified the agreement. The Council meets regularly once in a year. It serves as technical advisor to the Parties on matters relating to the development, utilisation and conservation of the water resources in the River basin.

The Secretariat is permanent body at ORASECOM HQ and is composed of two experienced experts that monitor and manage all water resource activities in the basin. All activities of ORASECOM and staffs are financed by four riparian countries.

The Task Team is a technical committee represented from the riparian countries who advices the Secretariat and Council on the technical aspect.The National focal points from which each countries get direction from Task Team members who represent the four countries at ORASECOM and belong to countries DWA (see Fig. 4). The national focal

points do not specifically address groundwater. Any decision proposed by Task Team and approved by Council/ORASECOM will be implemented by individual countries.

Each basin state has its own legal, policy and institutional framework governing the use of both national and international waters. There is encouraging activity, in this regard, at SADC, where there are groundwater activities in drought mitigation measure, but the detailed transboundary groundwater assessment and implementation is being conducted by ORASECOM.

The ORASECOM 2000 agreement does not explicitly indicate groundwater both as local and transboundary resource and did not emphasise the transboundary aquifer characterization and governance in the basin. However, article 7.4 describes data sharing on hydrology, hydrogeology, and water quality, meteorological and environmental condition of the river system. This gives important mandate for ORASECOM in organizing suitable platform for transboundary aquifer assessment, data sharing, and management among the states. The legal implication of each article in the ORASECOM 2000 agreement has been thoroughly assessed in ORASECOM 011/2007 Report [5] however, there is no any relevant article with respect to groundwater.

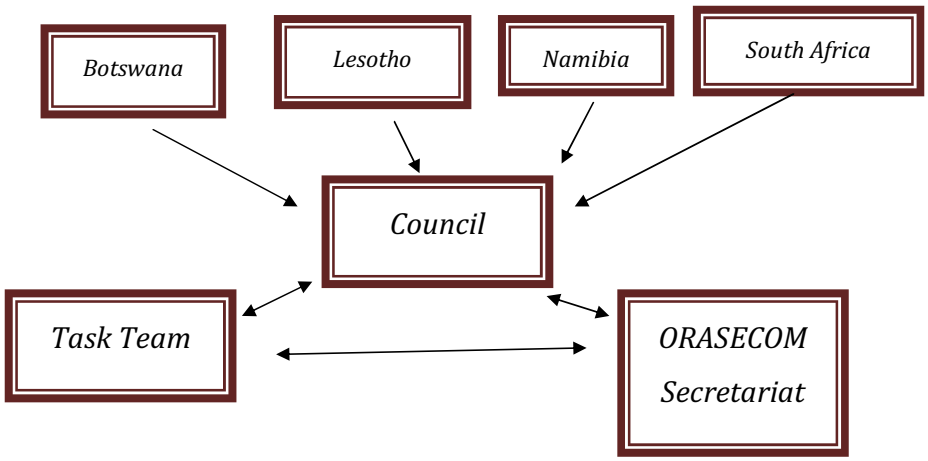

Fig 3. The ORASECOM operational structure.

On the country level:

Lesotho: The Department of Water Affairs is responsible for water sector administration, policy and data collection. All water uses (except domestic use) must be licensed, and

domestic uses have priority. Most of the population lives in the Lowlands and experiences frequent water shortages, despite the plentiful supply in the Highlands [10].

South Africa: Department of Water Affairs is responsible for the nation's water resources including well-organized database, reports and hydrogeological maps.

Botswana: The Department of Water Affairs (DWA) is responsible for hydrological data, water resources development, water supply to major villages and the design and investigation of supply to rural villages and the servicing and support of the Water Apportionment Board. The Department of Geological Surveys (DGS), however, is responsible for the administration, management, and research of groundwater resources under the Boreholes Act (SADC, 2009[10]).

Namibia: the Ministry of Agriculture, Water and Rural Development holds overall responsibility for the management of the nation's water resources. The Directorate of Resource Management is responsible for the implementation of measures to ensure sustainable use and protection of water resources, the control of abstraction and water allocation and carries out the functions of planning and regulation of the water sector. Geohydrology division is responsible for groundwater management in the country.

There is high level of understanding in the cooperation for sustainable utilization of water resources in the basin including groundwater in the riparian countries due to low rainfall, arid climate and rapid development trend in the region. ORASECOM collaborates with SADC, UNESCO and other RBOs in Africa and the world.

The detailed institutional analysis of the four countries has been presented in ORASECOM 010/2007[6] report where groundwater has important place as division in four riparian countries Department of Water Affairs structure. Even though it is not indicated in the institutional structure, the discussion made with hydrogeologists has confirmed presence of elevated role of groundwater in respective countries. However, there is no defined position for a Hydrogeologist at ORASECOM that can especially coordinate groundwater activities and maintain its continuities in regards to TBAs. ORASECOM has to strongly advise the riparian countries on the strategic role of groundwater and its sustainability for community development at the time when we face evident climate change impact in the region based on SADC, AMCOW and UN resolutions which will help in order to retain hydrogeologists in Government Departments, who can be involved in the transboundary aquifer analysis and management issues for common benefit.

Human resources: ORASECOM Secretariat has experienced permanent staff at HQ. However, there is no dedicated position for a groundwater expert that can deal with transboundary groundwater issues and database coordination at HQ. From the oral

discussion made with the relevant people in the riparian countries, it is noted that the Groundwater section in the Water supply authorities is understaffed and they rely on private consultants for groundwater investigation. The suggested way-out would be to strengthen the Geological survey Departments or Council for Geosciences, in the case of South Africa, to undertake the survey besides Universities.

3.5 STAKEHOLDER INVOLVEMENT

Article 5.2.4 of the ORASECOM 2000 Agreement indicates that Council can advise parties on "the extent to which the inhabitants in the territory of each Party concerned shall participate in respect of the planning, development, utilisation, protection and conservation of the River System". There is a wide recognition at ORASECOM that sustainable development of the basin primarily depends on how stakeholders in the four riparian countries participate in all the aspects of water resources development and management. Stakeholder participation is focused primarily on projects and building capacity rather than participating in policy dialogue at at more senior levels. This can also be regarded as being confidence-building within the basin (SADC, 2009[10]). Article 5 of the ORASECOM agreement indicates that the Council shall take "all measures required to make recommendations or to advise the Parties". This may require stakeholder participation to ensure that the recommendations are viable and implementable (SADC, 2009[10]).

The ORASECOM Stakeholder Roadmap (ORASECOM, 2007[12]) was developed with inputs from regional and international experts during a meeting in Cape Town in October 2006. This has built on the draft outline strategy and aims to provide guidance on the progressive involvement of stakeholders in the co-management of the Orange-Senqu basin.

The main objectives of the ORASECOM Stakeholder Roadmap were:

- To develop and strengthen institutional mechanisms for effective stakeholder participation in the management of the Orange-Senqu River basin.
- To build and strengthen capacity in Basin Forums to effectively participate in decision-making, planning and sustainable co-management of the Orange-Senqu River Basin.
- To develop and maintain open and effective horizontal and vertical communication between and among the structures of ORASECOM and basin stakeholders via the development of accessible, timely and good quality information and dissemination mechanisms to build trust, and improve participation and decision making in the

basin To develop and strengthen institutional mechanisms for effective stakeholder participation in the management of the Orange-Senqu River basin.

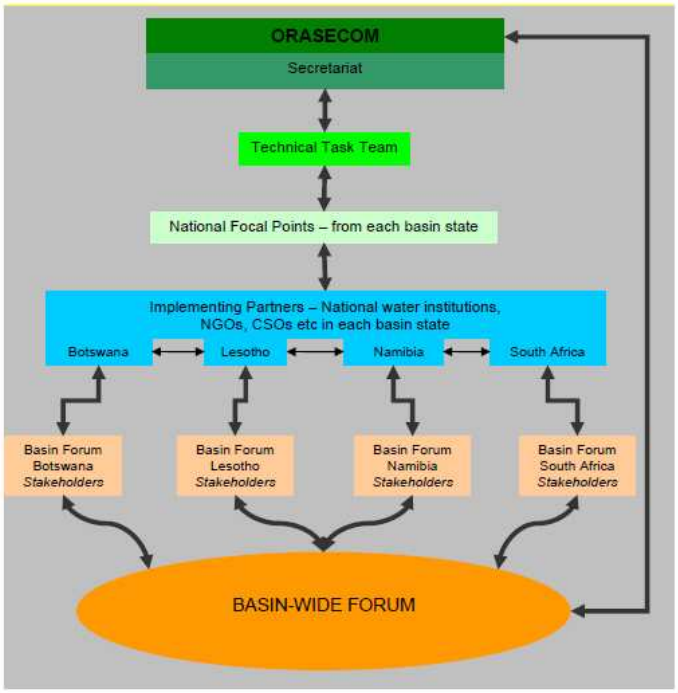

Fig. 4 Institutional interfaces for stakeholder participation in ORASECOM [12]

The Roadmap does provide some suggestions and options centred around four key focus areas, these being:

- Communication and information,
- Institution creation and development,
- Capacity building, and
- Institutional interfaces.

A number of key recommendations of stakeholder participation have been given in ORASECOM 008/2009[4]. However, attention should be given to the transboundary groundwater resource assessment and utilization. Stakeholder participation in transboundary organisations like ORASECOM, therefore, needs to include more than just participation in developing implementable recommendations, but also in the functioning of the organisation itself, albeit only be at an observer level (SADC, 2009[11]).

For effectiveness of the stakeholder involvement, ORASECOM has developed a stakeholder linkage (Fig. 4). The ORASECOM Secretariat monitors different stakeholder

participation activities that are implemented in the basin with a view to creating synergies and avoiding overlaps.

3.6 GROUNDWATER RESOURCES MANAGEMENT

3.6.1 Supply and demand management

An important vehicle for the implementation of the groundwater management is the SADC Drought and Groundwater Management Programme, supported by the Global Environmental Facility (GEF and World Bank). Its objective was the development of a SADC regional strategic approach to support and enhance the capacity of its member States in the definition of drought management policies, specifically in relation to the role, availability (magnitude and recharge) and supply potential of groundwater resources (SADC, 2009[11]). In order to meet the growing water demand, supply is sought from transboundary aquifer system. Based on the discussion made with the respective hydrogeologists in the riparian countries, it was learnt that one of the International Shared Aquifer Resource Management (ISARM) related project proposed by SADC was the Stampriet Artesian Basin that is shared by Namibia, Botswana and South Africa and the dolomitic aquifer shared between Botswana and South Africa (SADC, 2009[11]). Even though, it was a feasible transboundary proposal, the project has not yet been implemented for various reasons. It is known that SADC is the one who has sound technical background and institution to undertake the transboundary aquifer studies, but the involvement of ORASECOM in management and follow up aspect is crucial for successful implementation of the projects and results.

3.6.2 Groundwater resources assessment and monitoring

Attempt to address transboundary aquifer management, analysis through SADC has been made by Botswana, Namibia and South Africa. However, the contacted experts from Lesotho have indicated that no attempts were made from their side yet due to capacity limitation. As it is indicated earlier, through SADC there was an attempt to address the Stampriet and the dolomitic transboundary aquifers. In terms of groundwater management and protection within ORASECOM there are joint initiatives on the Groundwater and Drought Management Plan which was completed as Phase II, that will include the above mentioned ORASECOM transboundary aquifer systems. This ISARM project will focus on aquifer protection as well.

The report did not contain valuable aquifer information. The transboundary aquifers of the region did not attract special attention in the report (ORASECOM report 004/2007[13]) which are vital for the community developments. Only little information on abstraction and use has been presented on local aquifers. Based on the discussion made with the riparian countries some monitoring activities on water level and water quality are still active based on the country program especially in Botswana, Namibia and South Africa.

3.6.3 TECHNICAL CAPACITY, DATA

3.6.3.1 Analytical tools

In the four riparian countries, qualified hydrogeologists with BSC Honours, MSc and PhD level (DWA South Africa, has got a PhD holder) are involving in Groundwater divisions who can carry out groundwater assessment and data collection. However, most of the expertise exists in the private sector with large number of private consultants residing in South Africa. High level of technical capacity with sufficient number at all levels is lacking in most countries except in South Africa, especially in regards to groundwater. Close collaboration with the Geological Surveys and systematic incentive for groundwater professionals may mitigate the problem.

The ORASECOM 009/2007[25] report described particular technical tools for surface water experts based on surface water numerical models.

Numerous hydrological and water resources system models are widely used in the four basin states by various specialists as well as government personnel among which are ACRU Rainfall – Runoff Model, WRYM – Reservoir Simulation Model, FEFLOW, PM WIN and many more..

3.6.3.2 Capacity Building, database and data sharing

There is a need for capacity building aimed at different targets in ORASECOM (the Secretariat), as well as representatives and administration in the riparian States. Awareness building for the decision-makers and community. is also needed. One important issue is the development of a common level of understanding among four states, the creation of opportunities for discussions, negotiations and joint management of groundwater resources primarily for the vast rural population and irrigation.

As part of capacity building training, courses are designed, where there is a specific training course on “surface hydrology” that has groundwater as one component with specific consideration on surface and ground water interaction, principles and techniques of recharge estimation. Groundwater quality and pollution issues are also part of the training parcel. However, transboundary aquifer characteristics (quantity and quality) based on shared data

base structure needs particular attention. At the ORASECOM level, hard science training in groundwater may not be necessary which is a duty of Universities, however, key findings on specific aquifers to assist management and stakeholders are necessary. At ORASECOM, there is no on-going or planned capacity building program in groundwater with specific reference to transboundary aquifer systems.

From the discussion that was undertaken at the ORASECOM HQ, it was noted that ORASECOM has data base for completed groundwater projects e.g. Molopo-Nossob. On a country level, however, the level of database development is variable as presented below.

Botswana: DWA and DGS maintain separate groundwater databases and most of the time duplicate each other's efforts. Hydrogeological maps and different groundwater reports are available.

Namibia: 40,000 records of Borehole Completion Forms of water wells-numbered boreholes are available in Namibia. The Department of Water Affairs owns the data sets. Some 90,000 water chemical analyses of mainly major ions plus some bacteriological data is also available. Many operational analyses from distribution networks and chemical data from numerous groundwater schemes are also available from DWA. Hydrogeological map is available. In Namibia, water levels are monitored in the Stampriet Artesian Basin (south of Gobabis and east of Mariental). Hydrogeological maps and different groundwater reports are available.

Lesotho: Groundwater is used extensively within rural population, both as a source of domestic water supply and for irrigation. Groundwater database is available at DWA and DRWS. However, the data base is incomplete in most cases. Hydrogeological maps and reports are available.

South Africa: Groundwater data, reports and maps from DWA are available without any significant costs (only maps). Time series hydrogeological data is readily available through the Internet (http://www.dwa.gov.za/Groundwater/NGIS.aspx), Electronic and hard copies of reports are available at minimal cost and can be obtained from DWA. High-level scientific reports on groundwater research results are available from the Water Research Commission (WRC) both as downloadable format (http://www.wrc.org.za) and hardcopy from WRC office, Pretoria.

It is very useful to mention the presence of online hydrogeological information in SADC countries on www.sadcgwarchiev.net and the SADC Hydrogeology Map and Atlas on http://www.sadc-hgm.com/.

Even though the riparian countries have large collection of national groundwater data base, up to now the available data have not been shared among the countries for transboundary aquifer assessment. The information sharing within ORASECOM is guided/governed by the SADC Protocol on shared water resources and the ORASECOM agreement. There are many platforms through which data/information is shared through task team, council meetings, Intranet system. There is a disparity in the level of development of the countries in the basin; some have less processed data than others. There is a GIS based database on groundwater development potential in the Molopo-Nossob sub basin.

Monitoring of transboundary groundwater system has not been implemented yet within the basin. Possibilities exits through ORASECOM Secretariat, which will facilitate joint monitoring activities by member states technical people, similar exercise as the water quality joint basin survey carried out in 2007 (ORASECM, 010/2010[(22)]). The feasible way forward is that there should be an ORASECOM driven TBA aquifer project in the basin which must include monitoring of groundwater use, quality and level within the strategic TBA's in the basin. There is a good will and understanding of the problem by the Secretariat on TBA's.

4. Interviews

The interview process has focused on three key sectors:

1. Personal interview/discussion with the core personnel at ORASECOM HQ (Centurion, South Africa),
2. Telephone interview with the country representatives
3. Discussion with the senior government groundwater managers

After brief discussion on groundwater related issues in the Orange-Senqu River basin with the secretariat, relevant information was obtained on country representatives at ORASECOM ("Many thanks to ORASECOM Secretariat for the kind cooperation"). Based on the contact address obtained, numerous attempts were made to track down concerned representatives. Besides the contact details obtained from ORASECOM HQ, the consultant has used earlier contact in the riparian countries through professional connection. Most of the country representatives such as in Botswana, who were not able to avail themselves both through telephone and repeated emails and South Africa where the country representative did not show an interest to take part in groundwater discussion, others have provided relevant information on groundwater related issues in the basin.

Table 1. People who have been interviewed for the groundwater need assessment: Oct-Nov, 2011: ORASECOM

Title	Name	Surname	Position	Interview schedule	Representation	Email	Telephone
Mr/Eng	Lenka	Thamae	Executive Secretary, ORASECOM	1	ORASECOM HQ	Lenka.thamae@gmail.com	+27126636826
Mr/Eng	Rapule	Pule	Water Resources Specialist, ORASECOM	1	ORASECOM HQ	Rapule.pule@orasecom.org	+27126636826
Mr	Leshoboro	Nena	Hydrologist, DWA	2	Lesotho-DWA	nena@dwa.gov.ls	+26622317991
Ms	Maria	Amakali	Deputy Director and ORASECOM Technical Task Member	2	Namibia-DWAF	amakalim@mawf.gov.na	+264612087167
Mr	Greg	Christelis	Hydrogeologist, DWAF	3	Namibia-DWAF	christelisg@mawf.gov.na	+264612087089
Mr	Othero	Mulele	Hydrogeologist, DWAF	3	Namibia-DWAF	muleleo@growas.org.na	+264612087123
Ms	Matsolo	Migwi	Hydrogeologist, DWA	3	Lesotho- DWA	migwimatsolo@gmail.com	+26622313602
Mr	Thato	Setloboko	Hydrogeologist, DWA	3	Botswana-DWA	tssetloboko@gov.bw	+26771490378
Dr	Eddy	Van Wyk	Hydrogeologist-DWA	3	South Africa-DWA	vanwykE2@dwa.gov.za	+27828011740

1. ORASECOM HQ, 2. National ORASECOM GW Focal Point; 3. National GW Mgt. Authority

5. SWOT analysis

The most important hydrogeological system in Orange-Senqu basin countries is represented by transboundary system, which requires profound attention for the sustainable resource development. However, small hydrogeological basins in each country provide water for the development of agriculture, industry, mining, domestic and tourism activities (ORASECOM 004/2007[13]).

From the discussions held with ORASECOM Secretariat and Task Team members, as well as from various literature sources, it is clear that the commission deals primarily with surface water. It is noted that there is good understanding of SADC groundwater activities while AMCOW resolutions were not efficiently communicated to different stakeholders. The Molopo-Nossob groundwater assessment is an encouraging work. Most of the hydrogeologists claim that there is a dependency on SADC transboundary activities in the basin. Professionals prefer to see ORASECOM as a key role player in ORASECOM areas.

a. *GW governance in ORASECOM*

ORASECOM oversees groundwater management in the riparian countries besides advising the states on groundwater related issues. There is no successful activity on the transboundary groundwater basins in the commission. Groundwater governance is the task of each state and allocations are issues by the water apportionment Board.

b. *Collaboration with riparian states*

There is very good collaboration based on the ORASECOM agreement. However, most of the effort goes to surface water resources.

c. *GW data management/sharing*

There is a disparity in levels of development in some riparian countries and some have less processed data than others do. This shows that there will not be equal level of data sharing among the riparian countries and needs capacity development to address the issue. Data is kept by respective countries and when a need arises it is made available to those requiring it up on request. However, data sharing is not well developed.

d. *Capacity building*

- Lack of Hydrogeologists in the Government Departments and ORASECOM HQ
- There is a lack of understanding of the process of surface and ground water interaction in the transboundary aquifer areas

- data base management and sharing at ORASECOM and with the riparian countries is limited
- There is lack of continuous training and information exchange on groundwater related issues
- There is a departure of groundwater experts from Government offices into the private sector.

The SWOT analysis has been done based on inputs primarily from the ORASECOM HQ, and secondarily from the riparian member states.

5.1 Strengths

What are the internal strengths of the ORASECOM that can enhance the integration of GW into the mandate of the ORASECOM?

1. *Good political support*
2. *Presence of strong commission driven by riparian countries*
3. *Good cooperation among countries and financial availability*
4. *Collaborative link with SADC and donors in the information exchange of common interest areas.*
5. *The ORASECOM* basin states have incorporated IWRM into their water laws, which makes transboundary cooperation easier.

5.2 Weaknesses

What are the major inherent deficiencies in the ORASECOM in addressing appropriately GW in its mandate?

6. *Lack of position for an expert hydrogeologist at ORASECOM who can exclusively handle transboundary groundwater issues in the basin*
7. *Traditional prioritization of surface water over groundwater in the basin*
8. *Groundwater is recognized at a program level only, without any monitoring activity and modelling follow up subsequent to the completion.*
9. *Insufficient understanding of transboundary aquifer systems: extent, potential, quality, vulnerability and recharge*
10. *Lack of capacity building in groundwater sector*
11. *Lack of activity between ORASECOM and National groundwater authorities on groundwater monitoring*
12. *There is no legal provision for groundwater regulation at ORASECOM level especially to address the issue of TBAs which could be the main challenge, however, riparian countries have got water laws and bylaws that govern groundwater.*
13. *Lack of external sponsors on transboundary aquifer projects*
14. *Lack of consideration of transboundary groundwater resources during water allocation process*
15. *Disparity in the level of assessment and diagnosis on the suggested transboundary aquifers*

5.3 Opportunities

Which present opportunities or drivers exist to support the GW mandate of the ORASECOM?

16. *Profound interest of International donors and development partners in the region*
17. *The dependence of rural population on groundwater which strengths its strategic role as supply and Interest of rural communities and large scale activities (irrigation, industry) as a prime groundwater users*
18. *The link with SADC is a key platform to address transboundary groundwater issues where* an ISARM-SADC is active since 2005 and has done a lot of groundwater activities in the region.

5.4 Threats

What are the major external threats that inhibit the ORASECOM from taking upon it sustainable GW mgt.?

19. *Limitation on funding hinders the level of transboundary groundwater project formulation and implementation.*
20. *Disparity in the level of groundwater data/information capture in the basin states*

6. Conclusions

- The level of understanding of the importance of groundwater within the basin is excellent due to arid climatic condition. However, still the level of integrating groundwater in the common management is very poor.
- There exists a positive political will and understanding at ORASECOM HQ and riparian countries on the strategic importance of groundwater in the basin for various activities.
- Good general understanding of water professionals, ORASECOM secretariat and country representatives on the importance of surface and ground water interaction and common management within the transboundary aquifer system
- There exist, traditionally, prioritization of surface water resource over groundwater in all aspects: planning, budgeting, management which hinders the level of groundwater management.
- Department of Water Affairs of all riparian countries are understaffed with respect to Hydrogeologists.
- No post for groundwater expert at ORASECOM.
- No common database structure (centralized format) on transboundary aquifers, except the Molopo-Nossob study results and GIS based database at ORASECOM which is on a catchment level that addresses different aquifers.
- Disparity in the understanding of the extent and usefulness of transboundary aquifer across the basin, some have good understanding, some have low.
- In terms of national groundwater allocation, ORASECOM approval is not required in all riparian countries which requires ORASECOM's involvement on TBAs.
- First experience with TBA assessment through the Molopo-Nossop study where surface water is scares. Options for the development of the groundwater resource were identified and have been recommended to the basin state (Namibia, Botswana and South Africa).

7. Recommendations

Since groundwater sustains the livelihood of vast majority of population, ORASECOM should bring groundwater resource assessment and management to the prime agenda of the basin states. Transboundary aquifer management is not a matter to be left to the riparian countries. In order to facilitate TBA management, the followings points are suggested:

a) Monitoring, data and knowledge generation

- Centralized database should be built for each transboundary aquifer at ORASECOM HQ and centralized groundwater technical team with necessary project support based on the location of the aquifer: e.g between -Lesotho and South Africa
  -Botswana and South Africa
  -Botswana, Namibia and South Africa
  -Namibia and South Africa
- Basin level time series data collection and monitoring on groundwater availability, quality change and abstraction in selected and critical areas in the basin States which should be coordinated by ORASECOM.
- On transboundary aquifer management that involves groundwater allocation, ORASECOM is required to play central role in deciding the shares based on monitoring results.
- Harmonization of groundwater database of four countries and experience sharing on data generation, storage and dissemination should be handled by ORASECOM on a continuous basis
- Detailed hydrogeological maps, models and databases are necessary on each identified TBAs for users and decision makers.

b) Institutional/legal aspects

- Level of recognition of TBA project should be elevated to the project office level.
- Basin level policy recommendation on common groundwater related issues
- Include groundwater during water resource allocation and management through legal provision, not only surface water which is vulnerable to climate change impacts, pollution and is basically scarce in the basin.
- Find out the way to update the ORASECOM agreement to emphasize the role of groundwater in community development for its protection, monitoring and sustainable utilization.
- Increase the level of groundwater from program into at least project office level at ORASECOM HQ.

c) Financial aspects

- The transboundary groundwater assessment projects of ORASECOM deserve a sponsorship from International development partners, which aims at common database for individual TBAs, common monitoring (use, quantity, and quality) and common policy formulation with improved and systematic monitoring scheme on users, water availability, water quality and environmental situation.
- Good will of the riparian countries has guaranteed the financial flow to the ORASECOM activities and the staffs development

d) Capacity building aspects

- Typical characteristics of transboundary aquifers such as areal extent, storage, abstraction, discharge (natural, environmental), recharge, dependency by users and ecosystem, state of pollution should be assessed.
- Necessary amendments and improvements are necessary on the SADC groundwater information, especially maps, in order to maximize it application on a detailed scale.
- Hire expert hydrogeologist at HQ to coordinate the TBA activities.
- Build capacity on transboundary groundwater sector through continuous and tailored trainings at all level
- Optimize the use of wide expertise in the local and transboundary groundwater assessment of SADC
- Pilot projects and implementation of the TBA managements should take place under ORASECOM umbrella with appropriate capacity building in the groundwater sector, where AMCOW's decision on the inclusion of groundwater in the river basin scale can be implemented.
-
- The wide groundwater experience and technical capability of South Africa can be exhaustively utilized in order to cover the transboundary aquifer issues in the riparian countries. The rich groundwater database and monitoring results at DWA/SA help to understand the TBA dynamics along the borders with Lesotho, Namibia and Botswana. Historically, South Africa was at a better position to acquire long time data and information even in Namibia, Lesotho and Botswana which can be shared technical people.

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Appendix 1.Table of basic data for ORASECOM

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River Basin	**ORANGE-SENQU**
Major tributaries	**Senqu, Vaal, Molopo, Kuruman, Nossob, Auob and Fish rivers**
Riparian states	**1. Botswana 2. Lesotho 3. Namibia 4.South Africa**
Upstream riparian states	**Botswana, Lesotho, Namibia, South Africa**
Downstream riparian states	**Namibia, South Africa**
Total basin area (km^2)	**896,368 km^2** [18, 19]
Mean annual runoff (mill. M^3/year)	**11600** [18]
Total population (mill.)	**15 738115 (2001)** [17] **, 19 million (2002)** [19]

Riparian state	Share (%) of basin area **(Refer. 23)**	Share (%) of population **(Refer. 17)**	Mean annual runoff (million M^3/year) **(Refer, 18, 19)**	Average rainfall in riparian basin part (mm/yr) **(Refer, 14,18, 19, 21)**	Primary land uses/cover in basin part **(Refer.20)**	Primary water uses in basin part **(Refer, 14, 18, 19, 20)**	Major cities in basin part (Mill. pop.) **(Refer, 17)**	Protected areas, national parks in basin part **(Refer. 20, 22)**	Major water transfer schemes between states **(Refer, 18, 19, 20)**	Transboundary conflicts over rivers
1. South Africa	**64.2%**	**29.8**	**6550**	**100 mm-1000mm**	**-Urbanization** **-irrigation** **-mining**	**-hydropower** **-domestic** **-Irrigation** **-mining**	**-Johannesburg (3.3)** **-Mangaung (0.65)** **-Emfuleni (0.66)** **-Matjhabeng**	**-Richtersveld National Park** **-Kgalagadi Transfrontier Park** **-Ai-Ais/Richtersv**	**Lesotho Highland Water Project** **Between Lesotho and South Africa**	**Never happend**

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						-livestock -tourism -Industry	(0.41) -Maluti a Phofung (0.36) -Klerksdorp (0.36) -Mafikeng (0.26) -Highveld East (0.22)	eld Transfrontier National Park -Augrabies Falls National Park -Golden Gate Highlands National Park -Vaalbos National Park	[2,3] 780 Mm^3/a into South Africa [5]	
2. Lesotho	3.4%	100	4000	800 mm-1150mm	-Farming -Forest	-domestic use -irrigation -livestock -tourism -mining -hydropower -Industry	-Maseru (0.45) -Leribe (0.36) -Berea (0.3) -Mafeteng (0.24) -Mohale's Hoek (0.21)	-Sehlaba-Thebe National Park -Masitise Nature reserve - Letšeng-la-letsie protected area - Maloti-Drakensberg Transfrontier Conservation and Development area - Bokong Nature Reserve - Tšehlanyane National Park - Liphofung Reserve		Never happend

Appendix 1.Table of basic data for ORASECOM

								- Muela Nature Reserve		
3. Botswana	7.9%	2.8	337	200mm -600mm	-pastoral farming, - commercial farming -livestock	-domestic use -livestock - mining -tourism -Industry	-Tsabong (0.046) -Mmathethe (0.048) -Goodhope (0.034)	-central Kalahari game reserve - Gemsbok National Park -Khawa Wildlife Management Area -Inalegolo Wildlife Management Area -Corridor Wildlife Management Area		Never happend
4. Namibia	24.5%	8.9	494	50mm-600mm	-Pastoral farming -wildlife	- domestic - livestock -irrigation -mining -tourism -Industry	- Keetmanshoop (0.074) -Mariental (0.073)	-National Diamond Coast Recreation Area -Hardap Recreation Resort -Naute Recreation Resort -Ai-Ais Hot Springs Huns Mountains park		Never happend

Appendix 1.Table of basic data for ORASECOM

								-Fish River Canyon Park **-Sperrgebiet National P.**		
Year of formal recognition of Basin Org.	**Windhoek, 03 November 2000**									
Primary mandate of Basin Org.	**Integrated development and management of the water resources of the Orange-Senqu River to the mutual and equitable benefit of all parties** **-Develop a comprehensive perspective of the basin** **-Study the present and planned future uses of the river system** **-Determine the requirements for flow monitoring and flood management**									
Type of Org.	**X River Basin Commission** [7] □ **Technical Committee** □ **Lake/River Basin Authority**									
Name of treaties or legally recognized agreements governing water mgt. in the basin	**1. 1978: South Africa and Lesotho, Joint Technical committee to investigate feasibility of the Lesotho Highland Water Project** **2. 1986: South Africa and Lesotho, Agreement signed** **3. 1999: South Africa and Lesotho, Highland Water Commission** **4. 1987: South Africa and Namibia, Joint Technical committee** **5. 1992: Permanent Water Commission** **6. SADC Revised Protocol, 2000 Between: South Africa, Botswana, Lesotho and Namibia** **7. ORASECOM Agreement, 2000 Between: South Africa, Botswana, Lesotho and Namibia** **(Reference # 8, 9, 19)**									

Appendix 1.Table of basic data for ORASECOM

River Basin	**ORANGE-SENQU**										
Major shared aquifers in the basin	**1. Ramostwa Dolomitic Aquifer: Botswana/South Africa** **2. Stampriet artesian basin: Namibia/Botswana/South Africa** **3. Coastal sedimentary aquifer: Namibia/South Africa** **4. Fracture Karoo Supergroup sedimentary aquifer: Lesotho/ South Africa** **(Reference #4, 13)**										
Aquifer no.	Shared between which riparian states	Approximate area (km^2)	Geological formation of aquifer (e.g. sandstone, karst, limestone, volcanic, sedimentary) **(Refer. 3, 9, 14, 15)**	Depth location of aquifer: Shallow (0-20 m), Intermediate (20-100m), Deep (>100m) **(Refer. 3, 9, 14)**	Estimated storage (mill. M^3)	Estimated annual recharge volume (mill. M^3)	Primary recharge mechanism (rainfall, irrigation, river/lake, pre-historic) **(Refer. 14, 21)**	Principal use/users of aquifer (Give order: agriculture, domestic, industry, mining) **(Refer. 9, 14, 20)**	Primary GW management issue(s)	Are there already known transboundary conflicts over this aquifer?	Level of TBA mgt. Note: A, B, C, D, E, F^a acc. to what has been achieved
1. Ramotswa Dolomitic Aquifer	**Botswana/ South Africa**	**No info.**	**Ramostwa dolomite basin (Pomfret/Vergelegen)**	**- Low gw potential** **-7.20 m^3/hr (2.0 l/s)** **-Deep**	**No info.**	**1.65-1.71 mm/m [21]**	**-Rainfall**	**-Commercial farm** **-domestic**	**Over abstraction [9]**	**No information**	**A, C** **(8, 9, 12, 16)**
2. Stampriet artesian basin	**Namibia/** **Botswana / South Africa**	**No info.**	**SW Kalahari /Karoo aquifer (Aeolian sand)**	**-Yield <1.0m^3/hr to 8.6m^3/hr** **-Low gw potential** **-Deep**	**No info.**	**No info.**	**-Fossil gw** **-Rainfall**	**-livestock** **-domestic** **-Mining**	**-Recharge estimation [11]** **- Hydrogeological map [11]** **-**	**No information**	**A, C**

Appendix 1.Table of basic data for ORASECOM

									Groundwater monitoring -Data base [11]		(8, 9, 12, 16)
3 Coastal sedimentary aquifer	Namibia / South Africa	No info.	Coastal sedimentary basin	-Intermediate	No info.	No info.	-Rainfall -	-irrigation -domestic -livestock	-Salt water intrusion [8]	No information	A (8, 9)
4. Fractured Karoo Supergroup sedimentary aquifer	Lesotho/ South Africa	11628.56 [8] in Lesotho	Karoo sedimentary aquifer -Burgersdorp Formation: argillaceous: 1.6 L/sec, -Molteno Formation: sandstone: 22 L/sec (well field), >3L/s (single well) -Elliot Formation: sandstone: 1.3 L/sec -Clarens Formation: sandstone: 0.9 L/sec	-50-200m thick -0.9->3 L/sec -Intermediate	195.88 [8, 9, 14] in Lesotho	No info.	-Rainfall	-domestic -irrigation	-Low yield	No information	A (8,9)

[a]A. Identification, B. Delineation, C. Diagnosis, D. Conceptual/numerical model, E. Allocation principles, F. Implementation of joint infrastructure projects

Appendix 2. Transcripts of interviews

Reply from ORASECOM HQ

Appendix 2. Transcripts of interviews

Questionnaire for **ORASECOM**
Name: **Mr. Eng. Lenka Thamae**
Institution (if different from RBO): _____
Function - please let us know your job title, role and main responsibilities:
Title: **Executive Secretary**
Role and responsibilities:
Managing the ORASECOM programme of work; coordinating actions decided upon by the Commission, fundraising, Secretarial functions for the Commission.
How many years in present position: **4 years**
Background education: **MSc Water Resources Engineering**
Country: **South Africa**
E-mail address: **lenka.thamae@gmail.com**
Gender: Female:___ Male: X
Telephone number for possible follow up phone call: **+27 12 663 6826**
Date of Interview: **13th Oct. 2011**
Interview performed by: **Prof. Tamiru Abiye**
Place of interview: **Centurion, South Africa**
Or if done by telephone: _____

Questions:

1. **Governance:**
   a. What is the principal and legal role/mandate of ORASECOM with respect to groundwater:
      i. To allocate GW: Yes □ No □
      ii. To oversee GW mgt.: **Yes X** No □
      iii. To monitor TBAs in basin: Yes □ No □
      iv. To advise riparian states on issues related to GW: **Yes X** No □
      v. To implement joint GW development projects: Yes □ No □
      vi. Other. Specify:
      _____
   b. Does ORASECOM have a staffed permanent Secretariat?
      Yes
   c. Does the constitution/agreement establishing ORASECOM specifically/explicitly address GW and groundwater issues?

      YES
   d. If yes, how?
      Ground water is viewed as part of the overall water resource base of the river basin.
   e. Which water management instruments/schemes do you use? (e.g. management plans, action programs, monitoring and information systems, etc.)
      All of the above
   f. To what extent is groundwater already considered in your water management structure and what actions/initiatives/programmes are you using to foster

groundwater management within your organisation? (e.g. groundwater working group at ORASECOM)

ORASECOM undertook a study to investigate the potential for groundwater development in the Molopo Nossob sub-basin where surface water resources are extremely scarce. Options for development of the resource were identified and recommended to basin states (Botswana, Namibia and South Africa). ORASECOM is supporting a SADC/UNESCO project that seeks to follow up on some of the recommendations of the ORASECOM study through a GEF funded project. ORASECOM also established a Hydrogeology Committee as a formal structure of the Commission to advice of groundwater related management issues.

g. Do you collaborate with organisations/programmes/institutes/projects that have a groundwater component (African networks e.g AGWNET, WATERNET; policy decision makers (e.g. AU, AMCOW, AGWC, etc.) and international donors)?

We currently collaborate with SADC and UNESCO on the project listed under f above.

h. Are you aware of the AMCOW work plan? If yes: Are there any activities you have taken on board due to the AMCOW work plan?

Yes. we are aware of the groundwater working group but we have not yet initiated specific activities within this framework.

i. Do you know about the existence of the UN resolution on transboundary aquifers?
Yes

2. **Society/collaboration/inclusion:**

a. What are the major uses of groundwater within the basin?

Community water supply, livestock watering, limited irrigation.

b. What are the main water challenges your basin/lake is confronted with? (e.g. groundwater pollution, (ground-) water shortage, institutional, etc.)

Water scarcity, potential groundwater pollution due to mining, extensive commercial farming and some industrial activities. Ground water mining and natural (and elevated) salinity is also a risk in dry parts of the river basin.

c. Are there great disparities between the water conditions and challenges in the riparian states? Also in the level of groundwater development and management?

Yes

d. Also in the level of groundwater development and management?
Yes

e. How is the exchange of knowledge/data and cooperation between the L/RBO and the riparian states' water mgt. structures?

Good. But due to disparities in levels of development some riparian states have less processed data than others, especially related to ground water management, research, extend and recharge.

f. Do you find the commitment of the riparian states to include GW on the political agenda sufficient?

Yes.

g. Does this influence your functionality?

Our functionality is not negatively impacted.

h. What are you doing to strengthen the participation of the riparian states? (e.g. are formal structures, like stakeholder forums, in place with clear roles and responsibilities in water resources management and in the decision making process, are regular meetings taking place, etc.)?

Regular meetings of ORASECOM structures are taking place as scheduled from technical official meetings to Commissioners meetings and even meetings of Honourable Ministers responsible for water in the four basin States. Other stakeholder platforms outside government structures have not yet been formalised.

i. Do you exchange knowledge, experience with other RBOs?

Yes. From Africa and other parts of the World.

3. **Science/data/capacity building:**

a. Is there a good understanding to which extent groundwater-surface water interaction determines water balance and water quality in your basin and across riparian territories?

Not fully, because of limited exploration of ground water bodies, especially across boundaries.

b. Where are you in the process of managing TBAs (also fill in Table 4 for individual TBAs)?

i. Identification **X**
ii. Delineation □
iii. Diagnosis □
iv. Conceptual/numerical model □
v. Allocation principles □
vi. Implementation of joint infrastructure projects□

c. Which data, if any, do you collect related to groundwater in the basin?

Data and information on development potential on the Molopo Nossob aquifer system was collected as part of 2008-2009 study (once off).

d. What data bases, information portals, and monitoring networks exist in your organization, where groundwater is (or could simply be) added?

We have a GIS based database on groundwater development potential in the Molopo- Nossob sub basin.

e. What is the process/mechanism for data sharing with the riparian states' national groundwater dept.?

Not sure.

f. How many hydrogeologists, or staff with hydrogeological background, are working in your organization? Are all allocated posts filled?

2 (two) But we do not have specific posts titled "groundwater or hydrogeology".

g. Do you find your present capacity (in terms of human and financial resources) sufficient to address groundwater management appropriately?

Yes, within the mandate of ORASECOM as specified by the agreement.

h. How is prioritisation made in your organisation to meet the limited resources (e.g. human, financial, technical resources)?

Priorities are set jointly by Officials of the 4 basin States and endorsed by Council and ultimately approved by Honourable Ministers when they meet once a year.

i. What capacity building on groundwater is ongoing or planned?

Non specifically at this stage.

j. What in particular is lacking regarding capacity on GW management

Better understanding of Transboundary aquifer systems, extend, potential, quality, risks, recharge etc.

NOTE:

At the moment Mr. L. Thamae (Executive Secretary) is responsible for human resources, legal, capacity building aspect at ORASECOM HQ.

Appendix 2. Transcripts of interviews

Reply from ORASECOM HQ

Questionnaire for **ORASECOM**
Name: **Mr. Eng. Rapule Pule**
Institution (if different from RBO): _____
Function - please let us know your job title, role and main responsibilities:
Title: **Water Resources specialist**
Role and responsibilities: **Advice executive secretary on IWRM in the basin and information and communication issues**
How many years in present position: **2 years**
Background education: **Hydrologist**
Country: **South Africa and Lesotho**
E-mail address: **rapule.pule@orasecom.org**
Gender: Female:_____Male:___**X**___
Telephone number for possible follow up phone call: **+27722304669**
Date of Interview: **13th Oct. 2011**
Interview performed by: **Prof. Tamiru Abiye**
Place of interview: **Centurion, South Africa**
Or if done by telephone: _____

Questions:

4. **Governance:**

a. What is the principal and legal role/mandate of ORASECOM with respect to groundwater:
   i. To allocate GW: Yes □ No □
   ii. To oversee GW mgt.: Yes □ No □
   iii. To monitor TBAs in basin: Yes □ No □
   iv. To advise riparian states on issues related to GW: **Yes x** No □
   v. To implement joint GW development projects: Yes □ No □
   vi. Other. Specify:

b. Does ORASECOM have a staffed permanent Secretariat?

Yes, tenure of office for staff is 15 years

c. Does the constitution/agreement establishing ORASECOM specifically/explicitly address GW and groundwater issues?

Not quite, but article 7.4 does talk about parties exchange available information regarding hydrogeology.

d. If yes, how?

e. Which water management instruments/schemes do you use? (e.g. management plans, action programs, monitoring and information systems, etc.)

Action programmes (6 thematic areas). Basin wide plan is currently being developed.

f. To what extent is groundwater already considered in your water management structure and what actions/initiatives/programmes are you using to foster groundwater management within your organisation? (e.g. groundwater working group at ORASECOM)

Regular feedbacks from ISRAM/SADC Hydrogeology committee. Review done in Molopo- Nossob sub basin. To determine part of Botswana IWRM plan.

g. Do you collaborate with organisations/programmes/institutes/projects that have a groundwater component (African networks e.g AGWNET, WATERNET; policy decision makers (e.g. AU, AMCOW, AGWC, etc.) and international donors)?

SADC/ISRAM HYDROGEOLOGY COMMITTEE collaborates with ANBO.

h. Are you aware of the AMCOW work plan? If yes: Are there any activities you have taken on board due to the AMCOW work plan?

Not quite yet. Do collaborate with AMCOW through.

i. Do you know about the existence of the UN resolution on transboundary aquifers?

Yes, even though not yet in quite details.

5. **Society/collaboration/inclusion:**

a. What are the major uses of groundwater within the basin?

Livestock and human watering in Molopo-Nossobo sub basin and parts of Lesotho and Republic of South Africa.

b. What are the main water challenges your basin/lake is confronted with? (e.g. groundwater pollution, (ground-) water shortage, institutional, etc.)

Acid mine drainage contributing to groundwater and groundwater pollution, water shortage, No existing database at basin level, limited control on drilling activities and proper siting of waste disposal sites (landfill)

c. Are there great disparities between the water conditions and challenges in the riparian states? Also in the level of groundwater development and management?

Yes. E.g. High level of groundwater abstraction vs recharge rates. Limited monitoring and management of boreholes being used for water supply.

d. Also in the level of groundwater development and management?

Yes

e. How is the exchange of knowledge/data and cooperation between the L/RBO and the riparian states' water mgt. structures?

Not quite good yet, however, in plans.

f. Do you find the commitment of the riparian states to include GW on the political agenda sufficient?

Yes

g. Does this influence your functionality?

No

h. What are you doing to strengthen the participation of the riparian states? (e.g. are formal structures, like stakeholder forums, in place with clear roles and

responsibilities in water resources management and in the decision making process, are regular meetings taking place, etc.)?

Currently only official meetings are regular. Discussions are on going for creating stakeholder forums. Road map towards stakeholder participation was developed in 2007 for the basin.

i. Do you exchange knowledge, experience with other RBOs?

Yes, with SADC RBOs. More still need to develop.

6. **Science/data/capacity building:**

a. Is there a good understanding to which extent groundwater-surface water interaction determines water balance and water quality in your basin and across riparian territories?

More studies still need to be done. E.g. through implementation of basin wide plan.

b. Where are you in the process of managing TBAs (also fill in Table 4 for individual TBAs)?

i.	Identification	**x**
ii.	Delineation	□
iii.	Diagnosis	□
iv.	Conceptual/numerical model	□
v.	Allocation principles	□
vi.	Implementation of joint infrastructure projects	□

Even though, the first choice was done through other studies, ORASECOM driven studies still need to be undertaken.

c. Which data, if any, do you collect related to groundwater in the basin?

Potential of groundwater in Molopo-Nossob sub basin does exist mainly on quality.

d. What databases, information portals, and monitoring networks exist in your organization, where groundwater is (or could simply be) added?

Water information systems. Five year joint basin surveys mainly focussing on water resources quality.

e. What is the process/mechanism for data sharing with the riparian states' national groundwater dept.?

Protocols being developed. Online data availability like DWA-RSA case

f. How many hydrogeolgists, or staff with hydrogeological background, are working in your organization? Are all allocated posts filled?

Currently executive secretary and water resources specialist do have training and work experience in groundwater. However, dedicated position for groundwater would be ideal.

g. Do you find your present capacity (in terms of human and financial resources) sufficient to address groundwater management appropriately?

Not quite. Need eg. technical advisors for beginning hopefully creating permanent positions dedicated to gw issues.

h. How is prioritisation made in your organisation to meet the limited resources (e.g. human, financial, technical resources)?

Basin wide plan would also help to plan priority level of groundwater.

i. What capacity building on groundwater is ongoing or planned?

This to be discussed in detail as part of development and implementation.

j. What in particular is lacking regarding capacity on GW management

Plan (motivation), human, financing, resources, etc..

Appendix 2. Transcripts of interviews

Reply from Country Representatives: Lesotho

Questionnaire for ORASECOM
Name: **Leshoboro Nena**
Institution (if different from RBO): **Department of Water Affairs Lesotho/ORASECOM Technical Task Team**
Function - please let us know your job title, role and main responsibilities:

Title: **Hydrologist**
Role and responsibilities: **Assessment and Monitoring of Lesotho's Surface Water, Representative in ORASECOM**
How many years in present position: **4 years**
Background education: **Water Resources Management**
Country: **Lesotho**
E-mail address: **nena@dwa.gov.ls/ldnnena@yahoo.com**
Gender: **Male**
Telephone number for possible follow up phone call: **+266 22317991 or 58444483/ 59939783**
Date of Interview: **20th Oct. 2011**
Interview performed by:
Place of interview: _____
Or if done by telephone: **Maseru**

Questions:

a. What is your position in the principal government water management structure(s) in the riparian state where you reside?
Hydrologist and Head of the Hydrology Division

b. Are decisions taken within these structures first ratified by the ORASECOM board at HQ before they are implemented?
ORASECOM plays an advisory role to the Member States, it does not make decisions.

c. Do you find that groundwater management is strongly and adequately addressed and integrated into overall water management of your country?
The transboundary groundwater management is the new phenomenon in terms of transboundary water resources management. Mostly, the focus has been on the management and development of the water resources of the Orange-Senqu River. However, in Lesotho, the ground water management has been adequately addressed and integrated in water resources management.

d. What is the level and effectiveness of cooperation between ORASECOM and the national groundwater management authorities?
Groundwater is managed by the Department of Water Affairs, any information, opinion sought from Lesotho in relation to Groundwater is always provided to ORASECOM.

e. Is there an operational protocol between ORASECOM and the countries for GW data/information sharing?
No, not to my knowledge. However, information sharing within ORASECOM is guided/governed by the SADC Protocol on shared water courses and the ORASECOM Agreement

f. What are the procedures and costs involved in groundwater data sharing between the national groundwater management authority and ORASECOM?
There are many platforms through which information is shared within ORASECOM, e.g Task Team/Council Meetings, Intranet System (OSIS)

g. Do you acknowledge/value the work done by ORASECOM in terms of groundwater management?
Yes, there have been some studies on shared aquifers between RSA, Namibia and Botswana and those that are currently underway. This studies are very important in terms of the equitable utilization and management of the resource

h. Are there cooperative activities between ORASECOM and national groundwater authorities, for instance monitoring activities?

Yes, such as experience sharing

i. What are your key concerns with regards to transboundary groundwater issues?
They are not yet addressed in the same manner with the surface water resource. There is a need to also prioritise groundwater management within the basin

j. How important, in your professional opinion, is the interaction between surface water and groundwater in terms of i) transboundary water balance and ii) transboundary water quality?
Groundwater is very important to sustain the flow of the Orange Senqu River even during the drought periods. In terms of the water quality, the ground water is very sensitive to pollution, and pollution is one of the main problems in the basin, therefore it is very important to take to elevate groundwater management l in the basin.

Appendix 2. Transcripts of interviews

Reply from ORASECOM Country Representatives in the Riparian States: Namibia

Questionnaire for **ORASECOM**
Name: **Mrs. Maria Amakali**
Institution (if different from RBO): **Namibia DWAF**
Function - please let us know your job title, role and main responsibilities:
Title: **Deputy Director and ORASECOM Technical Task Member**
Role and responsibilities: **Water resources management (national and transboundary)**
How many years in present position: **7 years**
Background education: **Water and Environment Resources Management**
Country: **Namibia**
E-mail address: **amakalim@mawf.gov.na**
Gender: Female:___x_____Male:_____
Telephone number for possible follow up phone call: **+264-61-2087167**
Date of Interview: **14th Oct. 2011**
Interview performed by: **Prof. Tamiru Abiye**
Place of interview: _____
Or if done by telephone: **Windhoek**

Questions:

a. What is your position in the principal government water management structure(s) in the riparian state where you reside?

I am a Deputy Director (Divisional Head) responsible for Water environment management in Namibia, with responsibility for integrated water resources management both for national and shared water basins.

b. Are decisions taken within these structures first ratified by the ORASECOM board at HQ before they are implemented?
Yes. ORASECOM has its own program and depending on the topic support for National water department with implementation is sought.

c. Do you find that groundwater management is strongly and adequately addressed and integrated into overall water management of your country?

Yes, as such Geohydrology Division is responsible for groundwater management in the country and they are also involved in transboundary aquifer management, especially through SADC.

d. What is the level and effectiveness of cooperation between ORASECOM and the national groundwater management authorities?

There was an Effort in the past to include groundwater issues in the ORASECOM program and a sub-committee on groundwater has been established in DWAF to participate in the program.

e. Is there an operational protocol between ORASECOM and the countries for GW data/information sharing?

No. But when it comes to ORASECOM studies that require groundwater information countries are obliged to share that information.

f. What are the procedures and costs involved in groundwater data sharing between the national groundwater management authority and ORASECOM?

No cost for information provided by countries to ORASECOM.

g. Do you acknowledge/value the work done by ORASECOM in terms of groundwater management?

Yes, the studies made some good recommendations on groundwater management and use I suppose.

h. Are there cooperative activities between ORASECOM and national groundwater authorities, for instance monitoring activities?

Not yet. Possibilities exist but it may mean that ORASECOM facilitate the joint monitoring activities by member states technical people, similar exercise as the water quality joint basin survey.

i. What are your key concerns with regards to transboundary groundwater issues?

Uncertainties with regards to the extent of groundwater availability and whether groundwater can be used additional to surface water.

j. How important, in your professional opinion, is the interaction between surface water and groundwater in terms of i) transboundary water balance and ii) transboundary water quality?

Very important especially when there is not enough water available for all member state in the river system (as Orange-Sengu River basin). See response in i).

Appendix 2. Transcripts of interviews

Reply from Department of Water Affairs Chief Hydrogeologist: Namibia

Questionnaire for **ORASECOM**
Name: **Greg Christelis**
Institution (if different from RBO): ***Ministry of Agriculture, Water and Forestry: Geohydrology Division***
Function - please let us know your job title, role and main responsibilities:
Title: ***Chief Hydrogeologist***
Role and responsibilities:
Responsible for coordination of the National Groundwater Monitoring Network
How many years in present position: **+26 years**
Background education: ***Hydrogeologist***
Country: ***Namibia***
E-mail address: ***christelisg@grows.org.na***
Gender: Female:_____Male: ***x***
Telephone number for possible follow up phone call: ***+264-61-208 7089***
Date of Interview: ***17 October 2011***
Interview performed by: ***Prof. Tamiru Abiye***
Place of interview: _____

Or if done by telephone: ***Windhoek***

Questions to Chief Government Hydrogeologist or GW focal point in the Riparian States:

a. Do you share national groundwater data with the ORASECOM? Does the ORASECOM also share groundwater data from the other parts of the basin with your department?
Not much
b. What are the procedures and mechanism of data sharing and funding?
Not yet implemented
c. Are there joint programs and activities with the ORASECOM in terms of groundwater management and protection?
On the Stampriet and Kalahari transboundary aquifer
d. In terms of national groundwater allocation, at what level are you required to obtain ORASECOM approval?
Not really

e. Is the linkage to surface water flows, surface water quality and environment considered at all when you allocate groundwater both internally and in the transboundary situation?
It will be considered when we do allocation
f. What is the formal relationship between your groundwater department and the country representative of the ORASECOM?
Consultation in this regard does take place.

Appendix 2. Transcripts of interviews

Reply from Department of Water Affairs Hydrogeologist: Namibia

Questionnaire for **ORASECOM**
Name: **Othero Mulele**
Institution (if different from RBO): **Ministry of Agriculture, Water and Forestry: Geohydrology Division**
Function - please let us know your job title, role and main responsibilities:
Title: **Hydrogeologist**
Role and responsibilities:
Responsible for coordination of the National Groundwater Monitoring Network that includes groundwater quality as well as quantity
How many years in present position: **2 years**
Background education: **Bsc honours (Hydrogeology)**
Country: **Namibia**
E-mail address: **muleleo@growas.org.na / muleleo@mawf.gov.na**
Gender: Female:_____Male: **x**
Telephone number for possible follow up phone call: **+264-61-208 7123 mobile +264-81 408 3679**
Date of Interview: **17 October 2011**
Interview performed by: **Prof. Tamiru Abiye**
Place of interview: _____

Or if done by telephone: **Windhoek**

Questions to Chief Government Hydrogeologist or GW focal point in the Riparian States:

a. Do you share national groundwater data with the ORASECOM? Does the ORASECOM also share groundwater data from the other parts of the basin with your department?
   Not currently
b. What are the procedures and mechanism of data sharing and funding?
   Not yet implemented
c. Are there joint programs and activities with the ORASECOM in terms of groundwater management and protection?
   Except for limited sampling undertaken during 2010 within 2 areas within the Transboundary Stampriet Kalahari Karroo Aquifer, no other activities were undertaken
d. In terms of national groundwater allocation, at what level are you required to obtain ORASECOM approval?
   A transboundary groundwater project proposal was drafted and this has been included as part of Phase 2 of the SADC Groundwater and Drought Management project that will probably commence within 2012. Once this study has been completed then we may be in a position to draw up allocations between the countries.

e. Is the linkage to surface water flows, surface water quality and environment considered at all when you allocate groundwater both internally and in the transboundary situation?
   It will be considered when we commence with allocations

f. What is the formal relationship between your groundwater department and the country representative of the ORASECOM?
   Consultation in this regard does take place.

Appendix 2. Transcripts of interviews

Reply from Department of Water Affairs Hydrogeologist: Lesotho

Questionnaire for **ORASECOM**

Name: **Ms. Matsolo Migwi**

Institution (if different from RBO): **Department of Water Affairs, Lesotho**

Function - please let us know your job title, role and main responsibilities:

Title: **Hydrogeologist**

Role and responsibilities: **Assessment and management of groundwater resources within the country**

How many years in present position: **11 years**

Background education: **BSc. (Honours) Hydrogeologist**

Country: **Lesotho**

E-mail address: **migwimatsolo@gmail.com**

Gender: Female:__**x**_____Male:_____

Telephone number for possible follow up phone call: **+266 2231 3602**

Date of Interview: **20th Oct. 2011**

Interview performed by: **Prof. Tamiru Abiye**

Place of interview: _____

Or if done by telephone: **Maseru**

Questions to Chief Government Hydrogeologist or GW focal point in the Riparian States:

a. Do you share national groundwater data with the ORASECOM? Does the ORASECOM also share groundwater data from the other parts of the basin with your department?

To my knowledge ORASECOM has dealt mainly with surface water but not with groundwater because management of transboundary aquifers was not included succinctly in ORASECOM agreements

b. What are the procedures and mechanism of data sharing and funding?

No data sharing, No funds

c. Are there joint programs and activities with the ORASECOM in terms of groundwater management and protection?

None

d. In terms of national groundwater allocation, at what level are you required to obtain ORASECOM approval?

Appendix 2. Transcripts of interviews

None

e. Is the linkage to surface water flows, surface water quality and environment considered at all when you allocate groundwater both internally and in the transboundary situation?

Nationally, surface water quality and environment are included to a certain extent but in transboundary situations, this does not happen

f. What is the formal relationship between your groundwater department and the country representative of the ORASECOM?

Groundwater Division is within Department of Water Affairs (DWA). DWA has representation in ORASECOM especially in the technical committee of ORASECOM

Appendix 2. Transcripts of interviews

Reply from Chief Government Hydrogeologist: Botswana

Questionnaire for **ORASECOM**
Name: **SETLOBOKO Thato Seth**
Institution (if different from RBO): **Department of Water Affairs/ ORASECOM TTT member, Botswana**
Function - please let us know your job title, role and main responsibilities:
Title: **Hydrogeologist**
Role and responsibilities:
Groundwater resources monitoring, modelling, provide technical advice to all groundwater user's, assess and evaluate groundwater resources, produce wellfield status report
How many years in present position: **Six (6) years**
Background education: **MSc hydrogeology**
Country: **Botswana**
E-mail address: **tssetloboko@gov.bw;setlobokothatoseth@yahoo.com**
Gender: **Male**
Telephone number for possible follow up phone call: **+267 3607231 or +267 71490378**
Date of Interview: **16th Oct. 2011**
Interview performed by: **Prof. Tamiru Abiye**
Place of interview: _____
Or if done by telephone: **Gaborone**

Questions

a. Do you share national groundwater data with the ORASECOM? Does the ORASECOM also share groundwater data from the other parts of the basin with your department?

There is a platform within ORASECOM where parties can and do share information. Beside ORASECOM there is also the data from joint country projects.

b. What are the procedures and mechanism of data sharing and funding?

Data is kept by the respective state and when a need arise it is made available to those requiring it.

c. Are there joint programs and activities with the ORASECOM in terms of groundwater management and protection?

ORASECOM has carried out studies such as Molopo-Nossob TBAs . There are many data gaps that still needs to be filled in the entire basin

d. In terms of national groundwater allocation, at what level are you required to obtain ORASECOM approval?
At the moment groundwater allocations are issued by the Water Apportionment Board.

e. Is the linkage to surface water flows, surface water quality and environment considered at all when you allocate groundwater both internally and in the transboundary situation?

There is virtually little or no surface water flows in the Molopo-Nossob basin.

f. What is the formal relationship between your groundwater department and the country representative of the ORASECOM?
It is good

Appendix 2. Transcripts of interviews

Reply from Department of Water Affairs Chief Hydrogeologist: South Africa

Questionnaire for ***ORASECOM***
Name: ***Dr. Eddie Van Wyk***
Institution (if different from RBO): ***Department of Water Affairs, South Africa***
Function - please let us know your job title, role and main responsibilities:
Title: **Dr.**
Role and responsibilities:
Scientific Manager in Directorate Hydrological Services. Coordinating all groundwater assessment and monitoring programs, evaluation of research products and investigation groundwater-rainwater interaction. National advisor on hydrogeological processes and aspects in South Africa.
How many years in present position: ***12 years***
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Date of Interview: **01/11/2011**
Interview performed by: **Prof. Tamiru Abiye**
Place of interview: **Pretoria**
Or if done by telephone: _____

Questions

a. Do you share national groundwater data with the ORASECOM? Does the ORASECOM also share groundwater data from the other parts of the basin with your department?

Yes, all the RSA DWA data is available on our National Water Resources data bases; for groundwater the National Groundwater Achieve specifically. From ORASECOM side, yes on request.

b. What are the procedures and mechanism of data sharing and funding?

Groundwater data, reports and maps from RSA are available without any significant costs (only maps). Time series hydrogeological data is readily available through the Internet media, Electronic and hard copies of reports are available at minimal cost and can be obtained from DWA. High-level scientific reports on groundwater research results are available through the Water Research Commission.

c. Are there joint programs and activities with the ORASECOM in terms of groundwater management and protection?

Yes, the Groundwater and Drought Management Plan was recently completed and Phase II, that will include two ORASECOM transboundary aquifer systems, is currently planned. This ISARM project will focus on aquifer protection as well.

d. In terms of national groundwater allocation, at what level are you required to obtain ORASECOM approval?

Groundwater allocation is done on National-Regional level in RSA; although the applications come from local, individual users. The assessment process is

done on national level. No ORASECOM approval is therefore required. Cases where transboundary groundwater issues (quality/quantity) occurs, such issues are still addressed on the respective countries department's level.

e. Is the linkage to surface water flows, surface water quality and environment considered at all when you allocate groundwater both internally and in the transboundary situation?

Internally: Yes, depending on the impact of the use, an environmental impact assessment process is required to foresee any surface-groundwater impacts. This process specifically covers the impact. Dolomitic aquifer systems are protected against large abstractions by a special verification process.
Transboundary: Officially, no collaboration exists between groundwater resource sharing countries (to be addressed in the Groundwater and Drought Management Program – Phase II).

f. What is the formal relationship between your groundwater department and the country representative of the ORASECOM?

Good, although operating on a higher level than the normal science-technology level currently present between RSA DWA and the departments of Water Affairs from neighbouring members (SADC grouping).