An integrated approach for Limpopo Park groundwater characterization for biodiversity safety

Maurizio Barbieri
Sapienza University of Rome

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An integrated approach for Limpopo Park groundwater characterization for biodiversity safety

Stefania Vitale[1], Roberto Valenti[2], Maurizio Barbieri[1], Giuseppe Sappa[3]

[1]Department of Earth Sciences, Sapienza University of Rome, Italy
[2]Department of Environmental Biology University of Rome, Italy
[3]DICEA, Department of Civil and Environmental Engineering, Sapienza University of Rome, Italy

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Abstract

This paper presents a multistep study held in the context of the SECOSUD Phase II project, called "Conservation and equitable use of biological diversity in the SADC region (Southern African Development Community) [1].
The present study is developed in the activity research of the SECOSUD Phase II project funded by the Italian Ministry of Foreign Affairs in the SADC. One of this project's objectives is to strengthen the capacities of the SADC region scientific network, in the aim to consolidate and to harmonize the management of natural resources [1].
The overall objective of this study is to design an integrated approach for Limpopo Park groundwater characterization and management, based on dealing with the full water cycle by a tiered and complex program, which will follow several steps: a preliminary field study, data existing collection, the selection of sites meteorological stations, the location of monitoring surface water and groundwater points, which includes fields measurements and sampling, chemical and isotopic analysis, collection of hydrological data to design hydrological conceptual model in the area under study in order to quantify the water balance and to provide recommendations on where to focus future research. The monitoring systems should be supported by processing procedures, step by step, implementing a GIS database.

Keywords: *protected area, biodiversity, groundwater characterization, monitoring stations, geodatabase*

Introduction

Biodiversity is formally defined by the Convention on Biological Diversity (CBD) as: "the variability among living organisms from all sources including, among others, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (UN 1992 Article 2) [2]. Biodiversity is affected by multiple drivers and pressures, which are increasing more and more: habitat loss, degradation from agriculture, overexploitation, pollution and invasive alien, climate change. One response to the loss and degradation of biodiversity, is safeguarding ecosystems in protected areas, such as Limpopo National Park, in the Limpopo Basin in the Southern African Region, which is an area rich in term of biological diversity and ecological complexity.

An opportunity to develop a concerted global approach to save biodiversity is to provide a successful groundwater protection. Conservation of biodiversity depends on groundwater needs strategies that allows for the use of groundwater in a way that is compatible with the persistence of ecosystems in natural protected area.

Groundwater is the most important source of water for people living in the SADC region [3], because it is used extensively throughout the southern African region, including the Limpopo River basin, supplying a large percentage of water for irrigation, rural water supply schemes and mining. About 75 per cent of the Mozambican population relies on groundwater resources [4]. Increasing water demand, population growth and climate change are more and more putting pressure on groundwater resources in SADC Region. Lack of management has already led to contamination and overexploitation of aquifers in some areas and could result in additional water supply problems, land subsidence and deterioration of groundwater dependent ecosystems.

Background and current state

Most rural communities in SADC are served from groundwater resources. Access to these resources is one and important critical factors. The lack of management of groundwater resources is also evident in community water supplies, where in some cases groundwater resources are developed in not sustainable way. This fact leads to resource decrease and puts communities' boreholes at risk: as a matter of fact boreholes don't have operation and maintenance, many people have access to only one borehole, and pumps misuse.

Regarding the evaluation of the current state of water resources, it is important the knowledge of their legal regime.

Before 1975, year of independence, water was regulated under the Portuguese Law system. During the Portuguese colonial period (1505-1975) water could either be private or belong to the state. This changed after independence when water became state property owned and regulated by the state [5].

The first national Water Law, which replaced the Portuguese Water Law, was approved in 1991 (Law no. 25/91).

The 1991 Water Law was a key legal instrument towards decentralisation of water management in Mozambique, based on a river basin approach to water management. It created five Regional Water Administration agencies (ARAs) through the Act no. 26/91.

As a consequence of it the country has been divided into the following regions:

- ARA Sul, that covers the south border of the country to the Save river basin;
- ARA Centro, that covers Save river basin to the basin of the Zambezi River;
- ARA Zambezi that covers the basin of the Zambezi River basin;
- ARA Centro Norte - that covers the region from the Zambezi river basin to Lurio river;
- ARA Norte - that covers the Lurio river basin to the northern border.

In accordance with this law water management Limpopo basin falls under auspices of ARA Sul.

Although the technical aims and the recommendations of the Limpopo Watercourse Commission (LIMCOM) established in 2003 on the use of the Limpopo River basin and its water resources [6], the background to water resources shows a low understanding of the meaning of groundwater resources protection, an undervaluing of the groundwater potential.

Groundwater database management in Mozambique is poorly developed [7]. The monitoring data has prolonged gaps [5].

The main target of this study is to provide not only an appropriate water and management techniques, but also to develop a better understanding of system aquifer in order to protect it and the ecosystems depending on groundwater quality and quantity.

The study area

The Limpopo National Park, in the Limpopo Basin, is the study focus area.

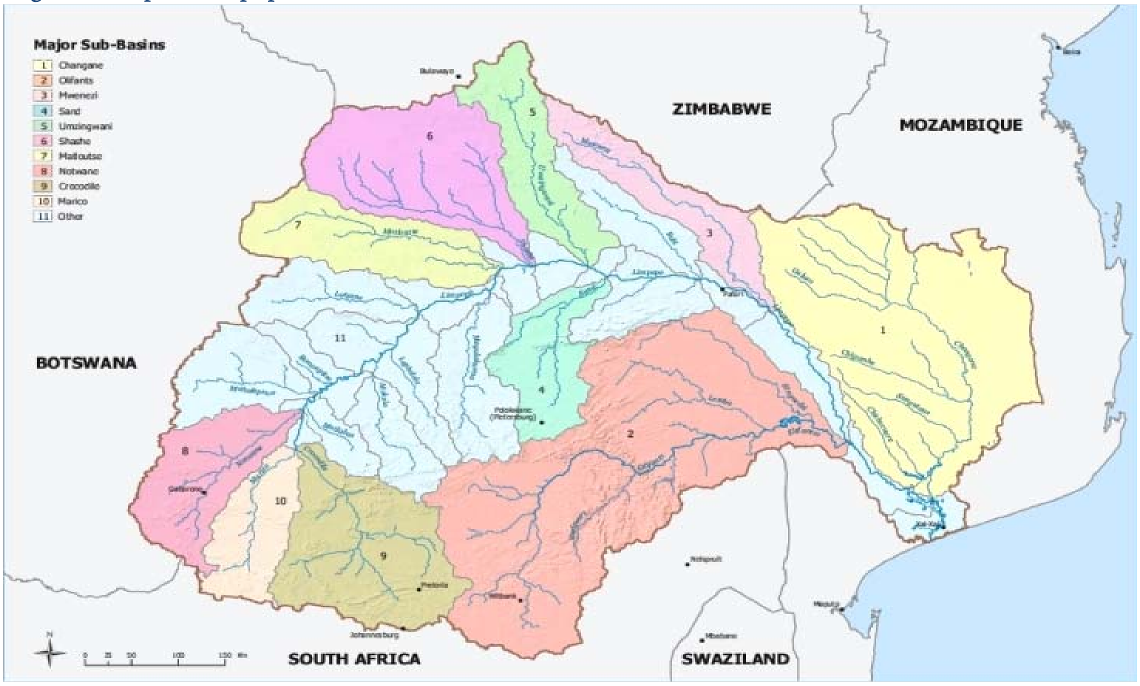
Limpopo River Basin (**Fig.1**) is situated in the East of Southern Africa, between about 20 and 26 °S and 25 and 35 °E. Its catchment area covers about 416,296 km^2, and it is shared by Botswana, Mozambique, South Africa and Zimbabwe. It is almost circular in shape with a mean altitude of 840 m above sea level. Its topography spreads above 2,000 m a.s.l. in the mountain regions of South Africa to the vast flood plains in the Mozambican part of the catchments.

The Limpopo river flows for a distance of 1,750 km from its headwaters near the border between South Africa and Botswana, and Zimbabwe. Then it flows through Mozambique before discharging into the Indian Ocean. Its catchment area lays down among South Africa, Botswana, Zimbabwe and Mozambique is 45%, 20%, 15% and 20%, respectively [8]. The Mozambique portion of the Limpopo basin consists of gently undulating terrain with numerous small tributary streams and pools.

The Limpopo River can be divided into three major reaches: the upper Limpopo, down to the Shashe confluence at the South Africa-Botswana-Zimbabwe border, forms the border between Botswana and South Africa, runoff from South Africa and Botswana; the middle Limpopo, which forms the border between South Africa and Zimbabwe between the Shashe confluence and the Luvuvhu confluence at the South Africa-Zimbabwe-Mozambique border (at Pafuri), runoff from Botswana (Shashe), Zimbabwe and South Africa; the lower

Limpopo, which flows entirely in Mozambique, downstream of Pafuri to the rivermouth in the Indian Ocean; runoff from Zimbabwe (Mwenezi), South Africa and Mozambique [8].

Figure 1 Map of Limpopo River Basin



The Limpopo river has a relatively dense network of more than 20 tributary streams and Rivers, divided on the left bank and on the right bank, though most of these tributaries have either seasonal or episodic flows. In historical times, the Limpopo river was a strong-flowing perennial river but is now regarded as a weak perennial river where flows frequently cease.

The bed of the Limpopo River is dry for most of the year. The climate in the Limpopo River Basin ranges from tropical rainy along the coastal plain of Mozambique to tropical dry, savannah and tropical dry desert further inland, south of Zimbabwe. The basin's climate varies spatially because it lies at the transition of major climate zones. Three wind systems have a strong influence on the basin's climate. These are the tropical cyclones from the Indian Ocean, the south-easterly wind systems the Inter-Tropical Convergence Zone (ITCZ) [7]. Rainfall is highly variable. The rainy season is predominantly from November to March when about 83% of the total annual rainfall occurs. The basin consists largely of undulating terrain between ranges of hills and mountains. The Mozambique portion of the Limpopo basin consists of gently undulating terrain with numerous small tributary streams.

Mozambique has one major dam, Massingir Dam on the Olifants River, with a storage capacity of 2840 x 106 m^3, which is mainly for irrigation. The Chokwe irrigation scheme (29 000 ha) along the banks of the Limpopo River is supposedly its largest consumptive water user (an estimated 517 x 106 m3 year"1) in Mozambique [8].

The rich biodiversity of Limpopo can be attributed to its biogeographical location and to diverse topography. Limpopo National Park, one of the jewels in the crown of Mozambique's protected areas, came into existence in November 2001, when the area encompassing a former hunting reserve, was reclassified as a national park. It covers an area of about 11.433,156 km^2 (**Fig.2**).

The Limpopo National Park (LNP) is placed at west of Gaza Province, near the South Africa border and south of Zimbabwe border. The mighty Shingwedzi River flows through the heart of Limpopo National Park, ensuring that it is populated with a wide range of wildlife and breathtaking scenery. The park takes up the river catchment and borders both the Limpopo and Olifants rivers for long stretches. It includes part of Shinwingezi, Oliphant lower and Lower Middle Limpopo Sub-basins (**Fig.3**).

Figure 2. The focus area Limpopo National Park

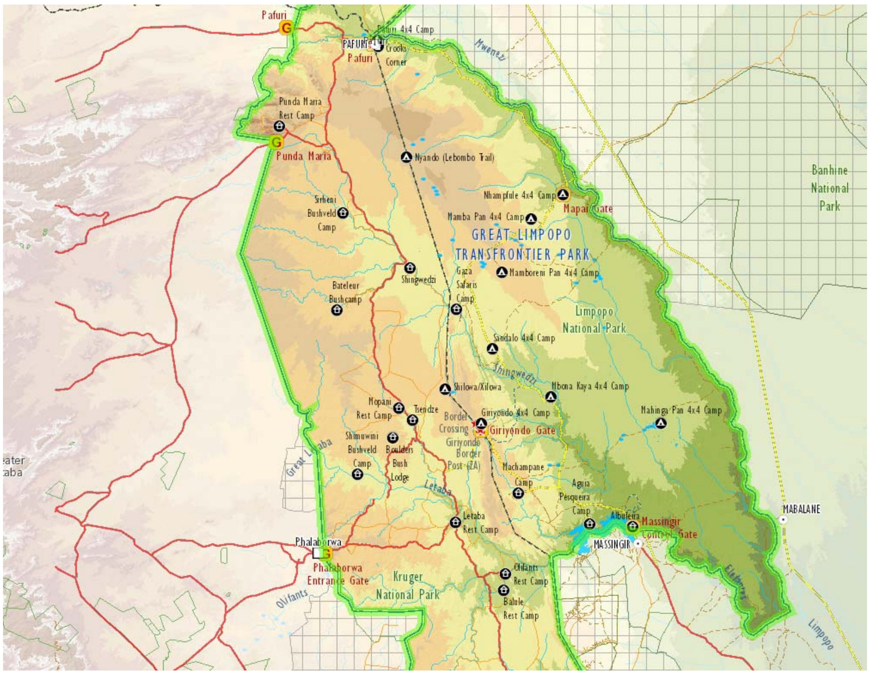


Figure 3. Subbasins of Limpopo River in the focus area

The Park can be accessed through 4 Entrance gates as follows:

- Giriyondo Border Gate: This is a formal border gate situated between PNL and KNP (northeast of Letaba)
- Pafuri Border Gate: This is a formal border gate situated in the north of PNL and KNP.
- Massingir Park Entrance Gate: Massingir gate is located within Mozambique in the south of the Park.
- Mapai Park Entrance Gate: Mapai gate is located within Mozambique in the east of the Park.

Geological, hydrogeological and hydrogeochemical setting

The African continent comprises a mosaic of old, stable, mostly crystalline, crustal blocks (called cratons) surrounded, and welded together, by an interconnected network of younger orogenic belts comprising deformed metamorphic rocks and granites, called mobile belts. One of these the Limpopo Belt has been interpreted as an Archean collisional orogeny and comprises the North Marginal Zone, Central Zone and South marginal Zone [4]. The geographic position of Mozambique in the framework of Gondwana, makes the country a geologically important terrain particularly because it contains boundaries between cratonic and mobile belt terrains.

The crystalline basement of Mozambique belongs to three major 'building blocks' or terranes, East, West and South Gondwana, that collided and amalgamated during the Pan-African orogeny to form the Gondwana Supercontinent. The main geological features of the Limpopo River Basin are the Limpopo Mobile Belt (where considerable mineralization has taken place), the Kalahari Craton, the Archaean Craton, the Karoo system and the Bushveld Igneous Complex (**Fig. 4**).

The Limpopo Belt of Southern Africa is a high-grade metamorphic province which includes Archean and Palaeoproterozoic lithologic components, and is bounded by the Zimbabwe and Kaapvaal Craton. The geological features of this area consist mostly of basic mafic and ultramafic intrusive rocks, accompanied by extensive areas of acidic and intermediate intrusive rocks. At the southern and eastern periphery of this area, large dolomite and limestone formations occur, accompanied by extensive mineralization along their contact zones [9].

The lower Limpopo Basin is characterized by extensive erosion plains, gently dipping coastward. The coastal belt is characterized by a dune area with an average width of 30 km, but extending to 100 km in some places. The lower Limpopo Basin consists largely of unconsolidated and consolidated sedimentary rocks with granitic intrusions exposed as erosion remnants in the landscape.

The hydrogeology of the basin is dominated by the Limpopo Mobile Belt, a metamorphic zone of high grade, that lies in the collision zone between the KaapVaal craton and the Zimbabwe craton, two Archean continental shield areas.. Due to the metamorphism, these rocks have very limited primary porosity or permeability and the groundwater occurrence is largely restricted to secondary features such as fault zones, joints, lithological contact zones [9].

The Karoo Volcanics of the Limpopo Basin in Mozambique are hydrogeologically quite similar to the crystalline rocks everywhere else in the Limpopo basin, where primary and secondary fractures are the most important water bearing features [10]. The water-bearing formations of the Basement complex are low productive and discontinuous. The groundwater occurrence are associated with geologically weak zones.

The aquifers are divided into separate lenticular units and are found in the deep alteration zone of the rocky substratum; contact zones between rocks of different types; faulted, fractured or crushed zones. The aquifers in the formations of the crystalline complex are of only local size [11]. They furnish low unit yields, rarely in excess of 2 l/s . Dug wells generally take advantage of a suspended aquifer on the top of a lateritic layer [12].

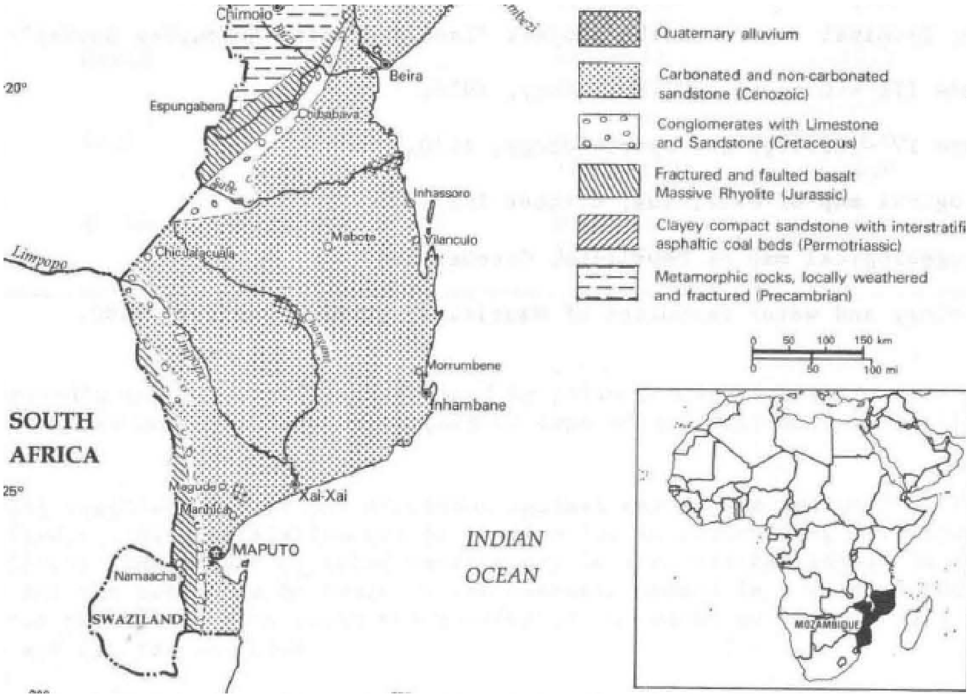


Figure 4. Main Geological and Lithological Units- Mozambique (Naturale resources. Water Series No. 19, 1989)

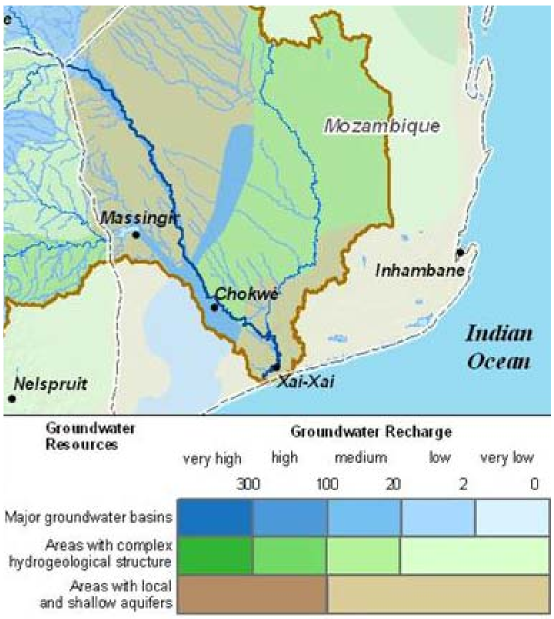


Figure 5. Groundwater resources in the area of concern (After, *WHY Map 2009)*

The aquifers in the lower parts of the Limpopo Basin in Mozambique are of poor water quality due to the salinity emanating from the high mineralisation [13]. Old alluvial plains (bordering the dune area) and erosion plains and erosion valleys (shallow eluvial cover of sandy clays over the entire inland area) have highly mineralised groundwater [14]. However some of the alluvial aquifers do have good water quality such as recent coastal dunes, alluvial deposits along the Limpopo River and erosional plains along rivulets, all of which are regularly recharged [14].

Many reports conclude that large-scale groundwater abstractions in the Limpopo River Basin are very limited as a consequence of low productivity and poor water quality [14]. There exists a deep aquifer between 250–350 m below ground level, which may be continuing to the south, but exploitation of this source is not economically feasible. Water quality becomes progressively worse downstream of Chokwé irrigation scheme and the confluence with the Changane River, aggravated by inadequate management of the irrigation and drainage systems [13].

Only the dune unit can be used for small and medium-scale abstractions without restrictions posed by water quality. For irrigation purposes, safe groundwater yields are too small and groundwater has negligible impact as an irrigation resource. Serious salinity and sodicity problems exist in the majority of the alluvial soils, especially in the lower Limpopo River areas [13]. This is caused by the presence of saline and sodic lacustrian and estuarine deposits under the alluvium. As indicated, inadequate management of the irrigation and drainage systems, especially at Chokwé Irrigation Scheme, aggravates this water quality problem downstream [14].

Water chemistry studies carried out by Chilundo out as part of the CGIAR Challenge Program on Water and Food Project 17, pointed to elevated cadmium levels in surface water and groundwater in several locations within the Limpopo Basin in Mozambique [15].

Materials, method and first hydrogeochemical results

The first phase of the study seeks to gain the knowledge of the water resource nowadays status.

In October 2016, there was a preliminary field survey. The pieces of information gathered from it backed with literature data, conduct to have a comprehensive picture of the local water profile.

The first step for a sound water resources planning is the knowledge of the hydrological conceptual model to assess the water balance in the area under study. The basic components of the hydrological cycle should be measured or estimated, such as precipitation, temperature, evaporation and evapotranspiration, taking into account temporal and spatial aspects of hydrological and hydrogeological processes.

The Limpopo National Park hasn't a sufficient coverage of rainfall records for his scale basin wide. Operational rainfall stations are mostly located on the East Southern part of Mozambique.

This first survey was undertaken to explore the possibility and the feasibility (distance and accessibility) of setting up a monitoring stations network suitable for the local conditions around Limpopo national park area, for a better understanding of the quantitative and qualitative aspects of the water resources [16].

The selection of the stations placements took in account the safe access under all conditions, such as under wet season, too.

In this context, the choice of new key stations should as much as possible be made to consider existing stations that are still in operation.

These key stations will ensure reliable daily rainfall data.

The design of the monitoring rainfall network will consist of the following stations, including existing operative stations, listed in **Table 1**.

Each station will be equipped with The Vantage Pro2™ (6152, 6153) and Vantage Pro2™ Plus (6162, 6163) Wireless Weather Stations, which includes two components: the Integrated Sensor Suite (ISS), which houses and manages the external sensor array, and the console which provides the user interface, data display, A/D conversion in the ISS, and calculations. The ISS and Vantage Pro2 console communicate via an FCC-certified, license-free frequency hopping transmitter and receiver. User-selectable transmitter ID codes allow up to the stations to coexist in the same geographic area. They are the same installed in the National Kruger Park Meteorological Network.

The installation of the meteorological stations will be done in safe access points near schools, villages, or other public local institution. For this task, one of the target is training local technicians, in the operation and maintenance of the monitoring stations.

The most part of Mozambican people lives in rural areas and depends on agriculture, for food and employment. Rural water supply and sanitation are not sufficient.

The Preliminary survey was undertaken in the South Eastern part of Limpopo National Park buffer zone. It helped to refine the logistical aspects of monitoring, for example the access to water point and to select sites sampling water.

The traditional method of obtaining groundwater in rural areas of the developing world, and still the most common, is by means of hand-dug wells. Some communities use the skill and knowledge of local well-diggers, but often the excavation is carried out, under supervision, by the villagers themselves.

Water is abstracted by means of either a bucket and windlass above an access hole, or a handpump, depending upon the yield of water available. A hand-dug well fitted with a handpump can serve the needs of about 300 people [17]. Groundwater samples was normally taken at these existing wells or boreholes.

Based on the conditions, considering the fact that a certain site may be found impractical for a variety of reasons, (e.g. transport difficulties), the following sites listed in table 2 were selected as representative covering of area under study as well as close to the surrounding villages, main river and main tributary (Rio Elephant, River Limpopo and Shimgezi), lake, ponds or canals that discharge into the river (**Table 2**).
Each site was mapped using a portable global position system (GPS).

Since the final goal of the global research activity will be to create a geodatabase to link geospatial and temporal water data about quality parameters, each monitoring point has been labeled by a code: SW for surface monitoring site and GW for groundwater monitoring points.

For a quality characterization of water the variables to be measured as part of the sampling program should reflect a consideration of the uses to which the water is put in.
In the area under study the covered services are human health and drinking-water, agriculture.

The selected parameter that can be monitored are the following:
Basic parameters, e.g. water temperature, pH, conductivity, DO used for a general characterization of water quality;
Suspended particulate matter, e.g. suspended solids, turbidity and organic matter (total organic carbon (TOC), BOD and COD;
Indicators of pollution with oxygen-consuming substances e.g. DO, BOD, COD and ammonium
Indicators of acidification, e.g. pH, alkalinity, conductivity, sulphate, nitrate, aluminium;

Specific major ions, e.g. chloride, sulphate, sodium, potassium, calcium and magnesium: these are essential factors in determining the suitability of water for most uses, such as public water supply, livestock watering and crop irrigation;
Specific minor ions, e.g. arsenic and fluoride: Metals, e.g. cadmium, mercury, copper and zinc, iron.
The frequency of sampling will be seasonal.
During this preliminary survey (October 2016) simple field-measured variables have been collected using portable equipments: temperature: Temperature, pH, electrical conductivity (EC), dissolved oxygen (DO).

Preliminary Water chemistry studies pointed to elevated V, Cr, B, Zn and Hg levels in surface water and groundwater in several locations within the Limpopo Basin in Massingir discrict.
The monitoring frequency at monitoring stations will be seasonal, but the frequency could be higher depending on the analytical results.

After a year of monitoring and sampling if the number of data have a statistical significance to identify the origin of elements which have overpassing value standard WHO guidlines, could be useful characterize background conditions at groundwater site based on a statistical and geostatistical assessment.

Meteorological Stations	Geographical coordinates	
Mapai	22°51'7.01"S	31°58'1.99"E
Mapulanguene	24°29'25.89"S	32° 4'55.47"E
Komatipoort	25°25'37.96"S	31°57'7.00"E
Pafuri	22°27'0.10"S	31°19'16.50"E
Letaba	23°51'22.72"S	31°34'37.63"E
Combomune	23°28'8.98"S	32°27'14.55"E
Devende	23°20'30.34"S	32°20'53.30"E
Nyando	22°47'46,28"S	31°25'33,94"E
Giriyondo	23°35'2.09"S	31°39'36.08"E
Massingir	23°55'15.68"S	32° 9'43.05"E
Phalaborwa	23°56'51.53"S	31° 8'18.11"E
Mabalane	23°25'21.05"S	32°48'30.42"E
Chicualacuala	22° 5'4.29"S	31°40'46.70"E

Figure 6 – Meteorological Stations network

Code	Description	Latitude	Longitude
SSW1	Nhianganhianga Village	23°50'34.95"S	32°32'8.78"E
SSW2	Malabane Village- Rio Limpopo	23°50'46.64"S	32°34'49.36"E
SSW3	Muvama Village – Rio Limpopo	23°53'37.27"S	32°34'1.05"E
SSW4	Mkumba village	23°55'45.28"S	32°34'0.93"E
SSW5	Munamane Village Rio do Elefantes river	24° 0'27.92"S	32°28'23.72"E
SSW6	Panzu village	23°57'35.05"S	32°21'9.06"E
SSW7	Maquashane Village Rio do Elefantes river	23°56'39.47"S	32°18'40.00"E
SSW8	Rio do Elefantes	23°52'25.94"S	32°12'58.39"E
SSW9	Chiboutane Village	23°51'27.75"S	32°13'27.10"E
SSW10	Machaule Village	23°50'16.78"S	32°12'27.80"E
SSW11	Rio Shingwezi Machaule	23°49'11.77"S	32°11'44.51"E
SSW12	Machaule water access point	23°49'19.82"S	32°11'24.57"E
SSW13	Shingwezi river bed	23°47'23.05"S	32° 8'45.02"E
SSW14	Tsendze river - Shingwezi	23.095.523"S	31.417.464"E
SSW15	Kumba -river bridge	23.818.783"S	31.628.876"E
SSW16	Letaba- oliphant road 546	23.854.673"S	31.576.367"E
SSW17	Skukuza-Tshokwane-Satara-Olifants	24.061.885"S	31.689.205" E
SSW18	Mavodze village- lago di Massingir-	23°48'39.92"S	32° 3'22.49"E
SSW19	Lake Massingir. North shore (Mavodze)	23°49'30.51"S	32° 4'28.99"E
SSW20	Lake Massingir south shorepoint access covane	23°52'56.12"S	32° 4'33.15"E
GW1	Tzinami Buffer Limpopo park	23°47'4.63"S	32°30'27.18"E
GW2	Shimangue	23°51'22.84"S	32°33'41.18"E
GW3	Muvama	23°53'37.27"S	32°34'1.05"E
GW4	Mkumba	23°55'45.28"S	32°34'0.93"E
GW5	Magueli village	23°58'39.21"S	32°33'0.47"E
GW6	Mahanuque village	24° 1'58.03"S	32°34'39.30"E
GW7	Makaringue village	24° 7'31.82"S	32°35'34.33"E
GW8	Makonguele village	24° 2'28.77"S	32°29'50.07"E
GW9	Panzu village	24° 2'28.77"S	32°29'50.07"E
GW10	Munamane	24° 0'41.76"S	32°28'45.38"E
GW11	Kuzi village	24° 0'41.76"S	32°28'45.38"E
GW12	Madingale Village	23°52'23.11"S	32°17'50.39"E
GW13	Machaule	23°49'19.82"S	32°11'24.57"E
GW14	Massingir Hospital	23°55'6.03"S	32° 9'44.82"E

Table 2. Table Surface water and groundwater monitoring network

Interlinking hydrogeochemical results with ABS outcomes

In the framework of the preliminary field survey, a sort of "ABS questionnaire" has been divulgated and left for answering to local population. This action has been facilitated by some "chefe da localidade" and teachers, that slowly are now releasing data back.
According to the activities reported by local population, the seasonal calendar for food source and income activity would follow:

- Oct-Feb for rainfalls;
- May and Oct-Dec for land preparation;
- Dec-Jan for weeding;
- Nov-Jul for maize, Nov for planting, Dec for weeding, Jan-Feb for green consumption, Mar-Jul for harvesting;
- Nov-May for cowpeas, same scheme as maize;
- Jan-May for groundnuts, same scheme;
- Nov-Apr for pumpkins and water melon, same scheme;
- Nov-Aug for sweet potato;
- Mar-Jul for beans;
- Nov-May for pigeon peas;
- May-Sep for vegetables;

The lean season last from Oct to Dec. Wild food resources are collected along all the years, with the exception of Jul and Jan. Charcoal from May to Jan. Livestock and alcohol sale during the whole years. Fishing from Nov to Jan.

Major human diseases are registered during the wet season, animal ones during the dry one. From May to Oct conflicts with wild animals are more occurring as well as poaching and captures. Usually from Sep to Dec prices are subjected to increase cause to lack of foodstuffs. This seasonal calendar show quite well as the rainy season is the heavy work on land preparation, planting and weeding. But in other hand this is the lean season, at least up to the moment when people can cut immature 'green' maize for consumption.

They gather wild foods in this lean time to bolster their dwindling food stocks or substitute for grain purchases. The bottom of the calendar represents the months of highest prices before the new harvest relieves the market. Returning to the middle part of the year, we understand that a very important cash-earning activity, charcoal making and selling, continues through this season even though people must work on their fields, or seek extra cash working on other people's fields when labor demand is at peak.

The rising river and other water areas in the rains offer the advantage of more abundant fish to catch. On the negative side, this time of so much important economic activity is blighted for many households by the fact that key working members go down with malaria.

This is not, of course the whole story of the calendar – important things also happen in the rest of the year, beginning above all with the first maize harvest from March as well as the digging up of the sweet potato crop. Sweet potatoes are harvested in the dry season as they are grown by the river with irrigation. Livestock have their own calendar too: for cattle the peak time for births is the rainy season, whilst goats give birth especially at the end of the rainy season in February and for the first two dry season months.

Currently we already outlined, in the framework of the ABS questionnaire response, at least 24 genetic resources (plants) well known and utilized by local communities in order to provide many medical treatments for a large number of diseases.
As results of this first field survey it is possible to underline the following list of utilized species, well knowing that according to the first ABS outcomes much probably Indigenous Local Communities (ILCs) use daily a number of about 60 plants for medical treatments.

Species

Aloe marlothii	A. Berger
Aloe zebrina	Baker
Sclerocarya birrea	(A. Rich.) Hochst.
Sarcostemma viminale	(L.) R. Br.
Adansonia digitata	L.
Boscia albitrunca	(Burch.) Gilg & Gilg-Ben.
Boscia foetida	Schinz subsp. filipes (Gilg) Lötter
Maerua edulis	(Gilg & Gilg-Ben.)De Wolf
Combretum imberbe	Wawra
Terminalia sericea	Burch. ex DC.
Cucumis metuliferus	E.Mey. ex Naudin
Cucumis zeyheri	Sond.
Spirostachys africana	Sond.
Cassia abbreviata	Oliv.
Colophospermum mopane	(Benth.) Léonard
Dalbergia melanoxylon	Guill. & Perr.
Elephantorrhiza elephantina	(Burch.) Skeels
Trichilia emetica	Vahl subsp. emetica
Tinospora caffra	(Miers) Troupin
Ficus sycomorus	L.

Olax dissitiflora	Oliv.
Ximenia americana	L.
Ansellia africana	Lindl.
Gardenia volkensii	K. Schum.

Future field activities will allow SECOSUD II to provide a whole and general project for assessing rural development in the Massingir District.

ABS can easily provide, according to the incoming data, a case of study fruitful for local communities and based mainly on the improvement of life quality of the villages based on water quality and availability, as well as the strenghtnening of traditional knowledge in collecting some genetic resources, possibly generating a socialand economic chain.

Conclusion

This paper has presented the preliminary phase of a study, which is part of the SECOSUD research project, granted by the Italian Foreign Affairs Ministery, in the aim of preserve biodiversity in some areas in Limpopo National Park, which is included in Mozambique territory. The aim of this part of the project, considered preliminary for the follow up, is to assess the current state of groundwater resources in the area under study by a methodological approach to evaluate the different aspects of groundwater to protect it and biodiversity. As a matter of fact it has been planned to set up ten meteorological gauge stations in the aim of carry out the evaluation of groundwater recharge [18], [19] as one of the most important aspect for biodiversity conservation. On the other hand the choice of some sampling points is aimed to have a geochemical characterization of these groundwater, as this aspect is very fundamental in the same target. At the state of art of this project it has been considered interesting to present the design of the characterization program, which is going to be applied, in the aim of sharing any step, the research project is going to do.

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