

**SALINPROVE: Mitigating groundwater SALINity impacts  
for imPROVEd water security in coastal areas  
under socio-economic and climate change**

**Project mission report Mozambique**

7-11 November, 2016, Maputo, Mozambique

## 1. Introduction

Following the awarding of the DUPC2 Research for Development project SALINPROVE, a first mission to Mozambique was planned from 7 - 11 November 2016, for meetings with Universidade Eduardo Mondlane (UEM), the research and contractual partner in the project, as well as with a large number of stakeholders, some of which are associated partners in SALINPROVE. The aim of these meetings was to discuss the overall outcomes of the project, the activities and work plan for 2016/2017, the involvement of the stakeholders, and the data requirements and acquisition strategy.

From UNESCO-IHE the following staff and project members participated: Tibor Stigter (for coordination and groundwater hydrological study), Yangxiao Zhou (for groundwater hydrological study, including modelling, with previous working experience in Maputo) and Yong Jiang (for socio-economic study).

## 2. Time Schedule, Activities and Main results

The time schedule and activities are summarized in Table 2.1. Each of the activities and main results will be briefly described in the following sections.

Table 2.1 Time schedule and activities

Date	Time	Place	Activity	Participants
07 Nov	08:00	Maputo City	Arrival	Stigter, Zhou, Jiang
	11:00	Maputo City	Meeting at UEM Faculty of Engineering	Juízo, Mussá, Stigter, Zhou, Jiang
08 Nov	10:00	Maputo City	Meeting with Laboratório Nacional de Higiene de Águas e Alimentos	Benjamin, Mussá, Stigter, Zhou, Jiang
	12:00	Matola City	Meeting with Water and Sanitation Department of Matola Municipality	Carapeto, Uane, Mussá, Stigter, Zhou, Jiang
	14:30	ARA-Sul	Meeting with ARA-Sul (Regional Water Authority)	Banze, Dias, Luís, Canda, Juízo, Mussá, Stigter, Zhou, Jiang
09 Nov	09:00	Maputo City	Meeting with Water and Sanitation Department of Maputo Municipality	Ferro, Tembe, Mussá, Stigter, Zhou, Jiang
	12:00	Maputo City	Meeting with UEM-CAP (Policy Analysis Centre)	Ramos, Raimundo, Bazagari, Jorge, Juízo, Mussá, Stigter, Jiang
	14:30	Peri-urban Maputo	Field visit to monitoring wells of ARA-Sul	Dias, Luís, Juízo, Mussá, Stigter, Zhou, Jiang
10 Nov	08:30	Matola	Meeting with AFORAMO (Association of Private Water Providers)	Chirute, Mussá, Stigter, Zhou, Jiang
11 Nov	09:00	Maputo City	Meeting with AdeM (Water Utility)	Cossa, Tivune, Goncalves, Armindo, Juízo, Mussá, Stigter, Zhou, Jiang
	11:00	Maputo City	Meeting with FIPAG (Water Supply Investment and Assets Fund)	Pacule, Juízo, Mussá, Stigter, Zhou, Jiang
	12:30	Maputo City	Final lunch meeting with UEM	Juízo, Mussá, Stigter, Zhou, Jiang

## **Day 1, 07 Nov – Project meeting with UEM**

Meeting in the morning and afternoon with Full Partner UEM (Dinis Juízo and Fátima Mussa), to discuss the agenda of the week, associated partners and other stakeholders to visit, situation of contract, budget and activities for 2017, including the training workshops to be held at IHE (how to organize and who to invite). It was also mentioned that a UEM lab staff member will be working on the project.

All the meetings of the following days were jointly attended by the UEM and IHE staff.



Photo 1 UEM Engineering Faculty

## **Day 2, 08 Nov – Meeting with Laboratório Nacional de Higiene de Águas e Alimentos**

First meeting of day 2 with Laboratório Nacional de Higiene de Águas e Alimentos (LNHAA) of the Ministry of Health. This laboratory has a large number of water quality analyses from groundwater and surface water, including the data from the official monitoring networks from ARA-Sul. The database is incomplete and, with exception of the ARA-Sul data, mostly on paper.

We explained the objectives of the project and the potential mutual benefits of LNHAA being involved. One possible way of collaborating is to have UEM or IHE students collaborate with LNHAA to digitalize and improve the database. It was agreed that UEM will write a letter to the director to request their participation.

## **Day 2, 08 Nov – Meeting with Water and Sanitation Department of Matola Municipality**

Second meeting of day 2 with the Water and Sanitation Department (WSD) of Matola Municipality, who are responsible for water and sanitation within Matola, the second main city of Great Maputo, bordering the city of Maputo to the west. The Matola municipality has 42 “bairros” (districts), of which 70-80% is supplied by groundwater. The main groundwater providers are private operators, some systems are controlled by FIPAG. The WSD of Matola Municipality was only established

recently (about one year ago). They are trying to stimulate registration and licencing of existing wells, and have been on the ground trying to identify existing wells (currently estimated at 200-300 wells) and starting to build a database in Google Earth. Unfortunately the car of the WSD broke down in September, and since then they have been unable to continue the process. In terms of well drilling reports, they indicate many do not exist or are falsified. There is also the issue of illegal wells, which is a big challenge. Groundwater salinity is an important issue in several areas of the municipality, particularly near the Matola river. Private providers are requested to do regular (4x/yr) analysis of their well water quality, but in reality this does not happen. For this reason very little or no data exist on water quality or water level. New wells are often just drilled without adequate knowledge of the groundwater system.

We explained the objectives of the project and the potential mutual benefits of the Matola Municipality WSD being involved. One possible way of collaborating is to have UEM or IHE students go into the field to identify wells, measure water salinity and try to obtain as much information of each well as possible. This would be done in collaboration with AFORAMO, the main Association of Private Water Providers (PWP), with whom the relationship is currently also being built. We mentioned the possibility of PWM engaging in participatory monitoring, to which the WSD responded it could be framed within a mandatory monitoring/inspection campaign. It was agreed that UEM will write a letter to the Mayor of Matola city to request the participation of the WSD.



Photo 2 Meeting Water and Sanitation Department of Matola Municipality

### **Day 2, 08 Nov – Meeting with ARA-Sul (Regional Water Authority)**

Third meeting of the second day with ARA-Sul, the Water Authority of the South of Mozambique. As the responsible institution for water resources monitoring and management in the area, ARA-Sul is a key partner for the project. That was also the reason why the coordinator of the monitoring division of ARA-Sul (Lizete Dias) attended the DUPC2 impact workshop held in September in the Netherlands. Regarding groundwater monitoring, ARA-Sul operates a network of monitoring wells, including 25 double-piezometers built recently (2008) with support from the French Development Agency. A lack of resources and capacity has not allowed a proper and continuous maintenance of the monitoring network.

We were received by the General Director of ARA-Sul and the director of the head of Technical Department, as well as the coordinator of the monitoring division of ARA-Sul. We introduced ourselves and explained the objectives of the project. We also mentioned the other DUPC2 projects active in the region. The director mentioned the interest of ARA-Sul for the projects and how they hope to build on the project outputs, as well as upscale and replicate some of these outputs. ARA-Sul sees the Great Maputo Aquifer as a strategic reserve that needs to be protected and adequately monitored, which is where the project will provide significant contributions. We discussed the possibility of recruiting a young and motivated groundwater hydrologist to work at ARA-Sul, in close collaboration with UEM, in order to optimise the involvement of ARA-Sul in the project and maximize the likelihood of implementation of the project outcomes where ARA-Sul plays a key role (improved monitoring and management of groundwater resources). This might be a process that takes some time, and meanwhile we will be collaborating with the staff members of ARA-Sul already involved. One of the staff members will attend the training workshop on groundwater monitoring to be held at IHE in March/April 2017. Furthermore, Ermelinda Canda, also a employee of ARA-Sul, will be doing her MSc research at UEM, and it was jointly decided that this could be done within the scope of the project. Therefore, the latter part of the meeting was dedicated to defining and outlining the topic of research.



Photo 3 Meeting at ARA-Sul

### **Day 3, 09 Nov – Meeting with Water and Sanitation Department of Maputo Municipality**

First meeting of day 3 with the Water and Sanitation Department (WSD) of Maputo Municipality, who are responsible for water and sanitation within Maputo, the main city of Great Maputo. 65-70% of water supply to the city is by surface water provided through the water supply network operated by the Water Utility AdeM. The remaining part is supplied by private operators, and some systems are controlled by FIPAG. The WSD is trying to stimulate registration and licencing of existing wells. In one district (Cambuguena) digital registration has been performed. The licencing of private operators has to go through the Maputo Municipality as well as the Water Authority, ARA-Sul, who

gives the authorization for groundwater exploration. The regulating entity is CRA. A new regulation was created recently by DNAAS that recognizes the existence of PWP and considers their activity as legal, as long as they correctly register and licence their wells. Implementation and operationalization of the regulation through the municipalities, ARA-Sul and CRA has proven to be very difficult, due to limited resources and capacity. Moreover, FIPAG and AdeM, who jointly manage and operate the public water supply infrastructure, intend to expand the coverage of their network in the Greater Maputo Area. Because of these plans, in some areas the PWP providing groundwater are put under pressure to end their activities. The local population claims that where the network already exists, the public supply is very unreliable, with many disruptions or in some case complete lack of access because of insufficient pressure.

In terms of well drilling reports, the WSD indicates that many do not exist or are falsified. There is also the issue of illegal wells, which is a big challenge. New wells are often just drilled without adequate knowledge of the groundwater system. Some data on groundwater use, well location and water quality exist in four districts mostly supplied by groundwater. The municipality also drilled a number of wells for the population in places without access to freshwater. There are some statistical data available on domestic water use, from the National Institute of Statistics. Price of water us gone up, from 25 to 40 MZN per m<sup>3</sup>. In terms of agriculture, by far the largest part (95%) of vegetables is imported from South Africa.

We explained the objectives of the project and the potential mutual benefits of the Maputo Municipality WSD being involved. One possible way of collaborating is to have UEM or IHE students go into the field to identify wells, measure water salinity and try to obtain as much information of each well as possible. This would be done in collaboration with AFORAMO, the main Association of PWP. We mentioned the possibility of PWM engaging in participatory monitoring of groundwater salinity. The next step if for UEM will write a letter to the Mayor of Maputo city to inform about the project and request the participation of the WSD of Maputo.

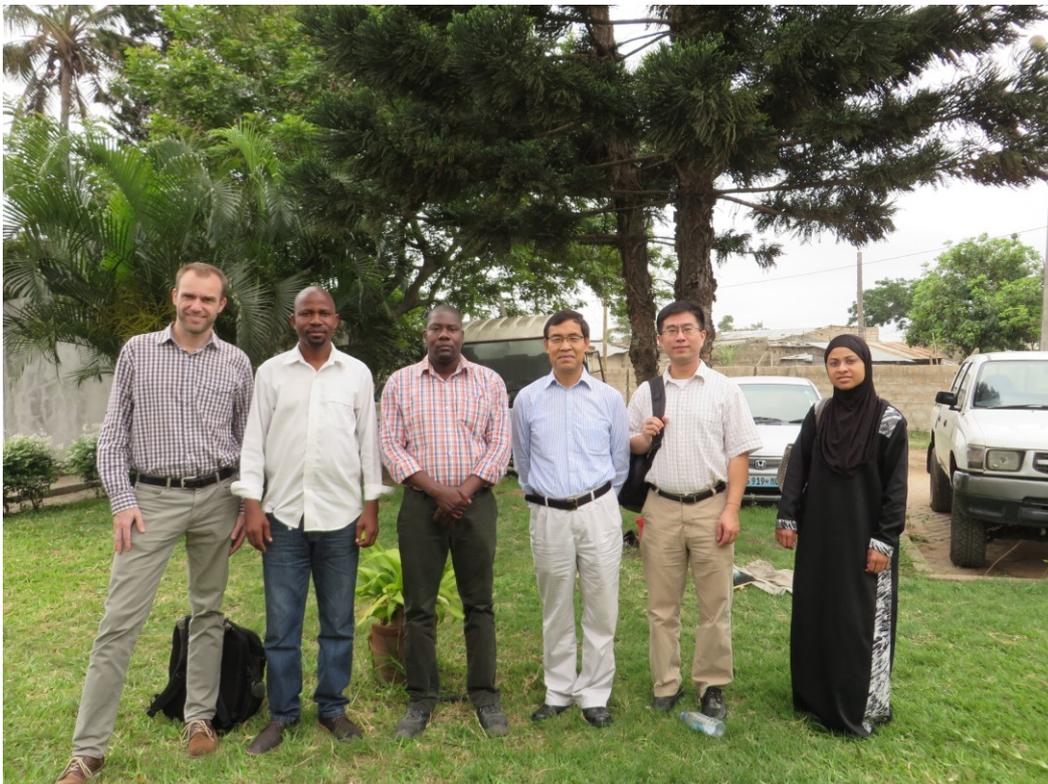


Photo 4 Meeting Water and Sanitation Department of Maputo Municipality

### **Day 3, 09 Nov – Meeting with UEM-CAP, the Policy Analysis Centre**

Second meeting of the third day with colleagues of UEM-CAP, the Policy Analysis Centre of the university. This was the first formal contact between colleagues from the UEM Engineering Faculty and UEM CAP, facilitated by the project. We explained the objectives of the project and the importance of combined natural and socioeconomic research in the project. Both research groups of UEM agreed and mentioned the need for more collaboration in general. Prof. Raimundo of UEM-CAP mentioned she is involved in another DUPC2 project (the project of small cities, coordinated by Giuliana Ferrero), and thought that because of that she could not be involved in SALINPROVE. We explained that we were well aware of the other project and that we were aiming at finding synergies and maximizing communication and collaboration. From UEM-CAP Prof Ramos will be the official coordinator for our project, and the work will mostly be performed by two researchers (Jorge and Adelaide), in collaboration with MSc students. We explained the type of socio-economic data we were interested in with regard to the dependence on groundwater and impact of salinity. We agreed that the next step will be a more in-depth discussion on the socio-economic study to be developed, a meeting for which will be organized by Yong Jiang and Mireia Tutusaus from IHE.



Photo 5 Test student lunch at UEM-CAP

### **Day 3, 09 Nov – Field visit to monitoring wells of ARA-Sul**

In the afternoon two monitoring wells (double piezometers) were visited, together with colleagues from ARA-Sul (besides UEM and IHE). A number of continuous level recording devices (pressure sensor with data logger) (five) were installed by ARA-Sul, but only one has been working properly. When visiting the first well (PZ4), near the Incomati River, we were able to verify that the pressure sensor had been installed below its maximum range (10 m of water column pressure), which likely explains why no correct data could be retrieved. At the time of the visit it was not possible to read out the recording device, perhaps due to battery problems. Colleagues from ARA-Sul mentioned that the company who sold the equipment would visit the wells next week and look into the problem of the sensor. Manual measurements indicated that both the unconfined and semi-

confined aquifer contained freshwater, and that the latter had a slightly higher hydraulic head. The second monitoring well (PZ1) contained a working pressure sensor in the deep well. No shallow piezometer exists at this location, as a shallow (larger diameter) well exists nearby. That well was dry, which made it impossible to record the hydraulic head. In the other well, EC, level and T were measured, and the level was compared to the one recorded by the (air-compensated) pressure sensor. The cause of the discrepancies between the values and the way to correct it in the reading software were explained to the technician from ARA-Sul (who had received previous training from the company selling the equipment).



Photo 6 Check problem at observation well PZ4



Photo 7 Check data at observation well PZ1

#### Day 4, 10 Nov – Meeting with AFORAMO (Association of Private Water Providers)

First and only meeting of day 4 with AFORAMO, the Association of Private Water Providers (PWPs). AFORAMO is the main association of PWPs, with over 470 members (88% of all memberships, followed by AMATI, with 61 members, 11% of all memberships; 278 PWPs are not affiliated (source: SUWASA Project). All PWPs use groundwater as their only source.

We were received by the president of AFORAMO, Adriano Chirute. We explained the objectives of the project and the potential mutual benefits of AFORAMO being involved. In some areas salinity is a major issue affecting the service provision by the PWPs, but it is not clear where, when and to which degree the problem of groundwater salinization occurs, and what the exact causes are. This are aspects the project will address. For that reason, AFORAMO has a large interest in the project and is willing to cooperate. The president of AFORAMO mentioned that they had collaborated in a number of projects in the past, but never seen any results. We mentioned that one major goal of our project was the co-construction, communication and sharing of the data among partners and water actors. This includes the organization of outreach workshops, to which we will invite AFORAMO, but also the direct collaboration in the field. It was agreed that a next meeting will be scheduled shortly (within a week), to plan a large field campaign in which UEM and AFORAMO will work together to make a detailed inventory of groundwater wells and their characteristics, in particular well depth, groundwater depth and salinity. Following this first inventory, a map can be made of groundwater salinities and further studies can be planned to increase the understanding of saline groundwater occurrence. This will include the installation of a number of salinity monitoring devices that can be used by the PWPs in a participatory monitoring campaign, for which they will be trained.



Photo 8 Meeting AFORAMO

## Day 5, 11 Nov – Meeting with AdeM (Water Utility)

First meeting of day 5 with AdeM, the Water Utility for Great Maputo. AdeM is contractual partner in another DUPC2 project, on alternative water supplies, coordinated by Janez Susnik. We were received by Carlos Cossa, Armingo, Elias Gonçalves and Arone. They mentioned that public water supply in the Great Maputo area had a coverage of around 65%. Within that area by far the dominant water source (99%) is surface water supplied by a dam in the Umbeluzi. They are further investing in future dams that according to AdeM will supply sufficient water to the city. However, this may take several years to complete. The current situation is critical, with the Umbeluzi dam at 18% of its total storage capacity. Meanwhile the rains have started, so that this may change. Currently AdeM mentions they are supplying 13-14 hours per day, around 70-90 l/day per capita. Physical losses from the system are estimated at 20%, but may be much higher. Total (unaccountable) losses are estimated at 45%. Currently groundwater is not considered for integration into the water supply system, although emergency wells were drilled during the drought situation (as requested by the ministry). The question is if groundwater should not be considered as a constant alternative source, in combination with surface water. In principle it should be, although no large concentrated well fields can be built due to the relatively moderate hydraulic conductivity of the aquifer. And the issue of salinity would need to be well controlled and monitored (fits within the objective of the project). The districts that still largely depend on groundwater, not supplied by the AdeM network, are Catembe and Matola. In Catembe the productivity of the wells is dropping, but it is not clear why (in older wells this could be due to clogging). Many attempts to drill wells for freshwater in Matola failed, due to the presence of saline water. In more peripheral districts a few wells were drilled by AdeM to allow access to freshwater. This was not done by FIPAG at the time, because FIPAG did not exist.



Photo 9 Meeting AdeM (Maputo Water Utility)

### **Day 5, 11 Nov – Meeting with FIPAG (Water Supply Investment and Assets Fund)**

Second meeting of day 5 was with FIPAG, the Water Supply Investment and Assets Fund. This meeting was scheduled at the last moment, and we were unable to speak to the correct people. We were received by Ovídia Pecule, who mentioned the existence of a master plan for future water supply. A next meeting was planned with FIPAG, so that more people could be present and more information about the role of groundwater in water supply could be shared. FIPAG and AdeM are closely related: FIPAG is in control of the water supply infrastructure, whereas AdeM operates the water supply. The separation is not always as clear, partly because AdeM already existed long before FIPAG and still carries out some of the infrastructure works, also because getting a procurement is easier.



Photo 10 FIPAG Office

### **Day 5, 11 Nov – Final lunch meeting with UEM**

The day and week was ended with a lunch meeting, where the results of the earlier meetings and a number of other project issues were discussed. Important topics included: i) the recruitment of a young groundwater staff member in ARA-Sul, together with UEM; ii) the MSc study of Ermelinda Canda; iii) the start of the fieldwork by UEM in collaboration with AFORAMO and the municipalities; iv) the training workshops to be held in the Netherlands; and v) the next visit to Mozambique.

Water quality aspects are also questioned. In many cases they prefer and therefore continue to use groundwater, but there is no regulatory framework around this use, and the spatial distribution of the water quality is poorly known or understood.



Photo 11 Final project meeting