

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

Project mission report Vietnam

28 November – 2 December, 2016

1. Introduction

Following the awarding of the DUPC2 Research for Development project SALINPROVE, a mission to Vietnam was planned from 28 November to 2 December 2016, for meetings with the Division for Water Resources Planning and Investigation for the South of Vietnam (DWRPIS), the contractual and research partner in Vietnam for the project, with Ho Chi Minh City University of Technology (HCMUT), the other research partner in Vietnam for the project, as well as with a 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 (coordination, groundwater hydrology, including hydrochemistry) and Yangxiao Zhou (groundwater hydrological study, including modelling, with previous working experience in Vietnam).

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
28 Nov	13:00	Ho Chi Minh City	Arrival	Stigter, Zhou
	14:30	Ho Chi Minh City	Project meeting at DWPRIS	Bui, Ky, Hai, Tuc, Stigter, Zhou
29 Nov	9:00	Ho Chi Minh City	Project meeting and lecture at HCMUT	Bui, Ky, Hai, Thanh, Thong, Stigter, Zhou
	13:00	Ho Chi Minh City	Meeting with Sub-National Institute for Agricultural Planning and Projection (Sub-NIAPP)	Le Canh Dinh, Nguyen Ngoc Bich, Bui, Ky, Hai, Stigter, Zhou
	14:30	Ho Chi Minh City	Meeting with Southern Institute of Water Resources Research (SIWRR)	To Quang Toan, Trần Minh Tuấn, Dương Xuân Minh, Lê Văn Kiệt, Nguyễn Minh Trung, Đoàn Thị Kiều Anh, Phạm Khắc Thuần, two Dutch students, Bui, Ky, Hai, Stigter, Zhou
30 Nov	08:00	Ho Chi Minh City	Departure for Tra Vinh	Bui, Ky, Hai, Stigter, Zhou
	12:00	Tra Vinh Province	Field visit	Bui, Ky, Hai, Hiep, Stigter, Zhou
	16:30	Village in Tra Vinh Province	Attendance inauguration of new community home	Bui, Ky, Hai, Hiep, Stigter, Zhou
01 Dec	09:00	Tra Vinh City	Meeting with Tra Vinh Department of Natural Resources and Environment (DONRE)	Dien, Phong, Diem, Linh, Ky, Hai, Hiep, Stigter, Zhou
	11:00	Tra Vinh City	Visit Chùa Hang temple	Ngoc Men, Bui, Ky, Hai, Hiep, Stigter, Zhou
	14:00	Tra Vinh City	Meeting with Tra Vinh Department of Agriculture and Rural Development (DARD)	Truong, Tai, Chuong, Huong, Linh, Giang, Bui, Ky, Hai, Hiep, Stigter, Zhou
	15:30	Tra Vinh City	Project team meeting at Tra Vinh City hotel	Bui, Ky, Hai, Hiep, Stigter, Zhou
02 Dec	08:00	Tra Vinh City	Return Ho Chi Minh City	Bui, Ky, Hai, Stigter, Zhou
	12:30	Ho Chi Minh City	Final project team meeting at HCMUT	Bui, Ky, Hai, Thanh, Thong, Stigter, Zhou

Day 1, 28 Nov – Project meeting at the Division for Water Resources Planning and Investigation for the South of Vietnam (DWRPIS)

Following arrival at Ho Chi Minh City, we had the first meeting in the afternoon with DWRPIS (Dr. Bui Tran Vuong, Mr. Dang Van Tuc) and Ho Chi Minh City University of Technology (HCMUT, Dr. Nguyen Viet Ky, Mr. Dao Hong Hai), to discuss the agenda of the week and the purpose of the visits taking place during the week. The refined outcomes of the project were presented, the situation of the contract was discussed, and the budget and activities for 2017 were briefly addressed. We decided it would be a good idea to discuss the activities for 2017 in more detail at the end of the week. Dr. Bui then briefly presented the current status of the data collection activity 1.1.1. A large amount of baseline data has been collected already, including meteorology, groundwater level and salinity, well information, including approximate location, estimated groundwater abstraction rates, hydrogeological maps and river cross-sections.

All the meetings of the following days were jointly attended by DWRPIS, HCMUT and IHE staff.

Day 2, 29 Nov – Project meeting and lecture at HCMUT

The first meeting of day 2 was held at HCMUT, where more of the staff members involved in the project attended the meeting. We briefly presented the project objectives and refined outcomes, as well as several of the necessary outputs. Dr. Bui then asked the staff members to briefly mention other data that they were able to collect. This included a report on groundwater use, daily meteorological data for 2007-2015, and river cross sections showing the depth of the rivers and the shape of the river beds. Prof. Ky mentioned the existence of a report on a project he had been collaborating in, on the feasibility of the use of rainwater harvesting for managed aquifer recharge in the Tra Vinh province.

Following the meeting Dr. Zhou gave a lecture on saline groundwater occurrence and flow and analytical solutions for flow in coastal aquifers, as well as numerical modelling, vulnerability assessment and monitoring of saltwater intrusion. This was followed by a discussion on the most suitable vulnerability index for seawater and saltwater intrusion assessment.



Photo 1. Lecture on saltwater intrusion at HCMUT



Photo 2. Group picture at HCMUT

Day 2, 29 Nov – Meeting with Sub-National Institute for Agricultural Planning and Projection (Sub-NIAPP)

For the second meeting of the day, with Sub-NIAPP, the Sub-National Institute for Agricultural Planning and Projection, we were received by the Vice Director, Dr. Le Canh Dinh. We presented the objectives of the project and explained the kind of collaboration we were seeking with Sub-NIAPP. We were given an explanation of agricultural and irrigation practices, as well as challenges and threats due to climate variability, such as those linked to surface water salinity issues (as river water is the dominant source for irrigation). For ongoing research in salt-tolerant cropping Sub-NIAPP mentioned the Agricultural Sciences Institute. For more information on aquaculture (related to the many shrimp ponds found in the Tra Vinh region) we were referred to another institute. Finally, Sub-NIAPP mentioned that a Climate Change Projection and Adaptation Plan would be made in 2017. We were also informed that more detailed data on land use and agricultural economics would be available in 2017.

Day 2, 29 Nov – Meeting with Southern Institute of Water Resources Research (SIWRR)

The third meeting of the second day was with SIWRR, the Southern Institute of Water Resources Research, where we were received by Dr. To Quang Toan, deputy in charge of Department for Training & International Cooperation. Other colleagues of SIWRR were also present. We presented the objectives of the project and explained the kind of information we were looking for and collaboration we were seeking with SIWRR. Dr. Toan mentioned that SIWRR had a wide-ranging knowledge on surface water flows and seawater intrusion in the Mekong Delta. The salinity intrusion programme of the Mekong River started in 2002. Recently a number of stations were installed in several of the distributaries of the Mekong in the delta area, with real-time monitoring of stage and salinity. In a presentation on the Mekong river, it was shown that the building of many hydropower dams has largely decreased discharge in the wet season and somewhat increased the flow in the dry season. More importantly, the minimum-flow months have shifted to December-January, where it used to be April-May. The problem is that there is no forecasting or early warning system for farmers, which may cause them to use brackish water for rice crop irrigation, thereby lowering their yield or damaging their crops. In the severe drought of 2016, saltwater intrusion

through the river occurred up to 50 km inland, up to July. There are available data on the resulting damage to the crops and shrimp farms (as the local shrimp species require brackish water and cannot tolerate more saline conditions). Among the proposed mitigation solutions the main one related to the building and improvement of infrastructure. The location of sluice gates could be problematic due to sea-level rise.

Dr. Toan mentioned that a hydrodynamic model for the river has been built and can be used by the project team. This is interesting, as the river can be influent in some reaches, losing water to the aquifer. It is therefore important to carefully study the possible groundwater-surface water interactions. In terms of climate scenarios it is also possible to collaborate with SIWRR, as the institute is linked to ongoing projects with Vietnam's Institute of Meteorology, Hydrology and Environment (IMHEN).



Photo 3. Meeting at Southern Institute of Water Resources Research

Day 3, 30 Nov – Field visit to Tra Vinh Province

In the morning we went from Ho Chi Minh City to the Tra Vinh province, for a field visit. Mr. Hiep from Tra Vinh University joined us for the visit and the meetings on day 3 and 4. Mr. Hiep is doing his PhD on groundwater salinization in Tra Vinh, so that collaboration within the project is useful. We visited four of the 14 observation wells (at six locations) from DWRPIS. At one location four monitoring wells are installed. The shallowest well is 5 m deep, installed in the Holocene aquifer. Three other observation wells at the same location have depths of 160 m (in aquifer of geological layer qp₂₋₃), 250 m (layer n₂²) and 352 m (layer n₂¹). During manual water measurements the deepest well had the highest hydraulic head (water level 7 m below top of well), 65 cm higher than the well of 160 m depth. The shallow well showed a water level near the surface.

During the field visit we also visited the area nearest to the coast, which despite higher salinities, showed intense agricultural activities, including shrimp farms and vegetable fields (e.g. onion), locally irrigated with groundwater from small private wells. For domestic use the houses received groundwater from a nearby power plant that pumps up water from 100-150 m depth. The power plant uses rice husk and coal as fuel.



Photos 4a and 4b. Groundwater level monitoring wells of DWRPIS and monitoring device



Photo 5a (top). Onion field near the coast irrigated with groundwater
Photo 5b (bottom). Satellite image of onion fields and shrimp farms near the coast

Day 3, 30 Nov – Attendance inauguration of new community home

In the afternoon, following the field visit, we attended the inauguration of a new community home. This is part of a charity project coordinated by the HCMUT University, where every year students are sent to the Tra Vinh province to help build new homes for the poor. The inauguration was attended by Huyen Hoi commune Cang Long district head, People's Council, Women's Union and others. The ceremony of the transfer of the new home to the family ended with a meal to which the project team was invited.



Photos 6a-d. Ceremony inauguration of new community home

Day 4, 1 Dec – Meeting with Tra Vinh Department of Natural Resources and Environment (DONRE)

The first meeting of day 4 was held at DONRE, the Tra Vinh Department of Natural Resources and Environment. As it was our second visit to DONRE, they already knew the project. We mostly discussed possible ways of collaboration and existing data that could be used by the project. Some of these data, such as soil maps and meteorological data, as well as detailed irrigation canal network design, might be available, but need to be requested through an official request by DWRPIS. DONRE showed us a list of planned projects, including the building of a database, the delimitation of wellhead protection zones, and the implementation of 75 more monitoring wells. The latter request was made to the Ministry, and constitutes a long-term plan. Based on a survey coordinated by DWRPIS in 2006, around 84000 boreholes exist in the Tra Vinh province, but there is very little information on groundwater levels or salinities, limited to the 14 wells of the official

monitoring network. It is known that salinity in fact increases inland, towards Tra Vinh city, rather than increasing towards the coast. DONRE has a monitoring unit, which we will aim to involve in the project. DONRE staff was also invited to the outreach workshops where project results are presented and discussed.



Photo 7. Meeting at Tra Vinh Department of Natural Resources and Environment

Day 4, 1 Dec – Visit Chùa Hang temple and Vinh Long Television interview

In the late morning we visited the Chùa Hang temple. A crew from Vinh Long Television was present to make a documentary about local Wood Carving Art and the making of sculptures by the people living in the temple. They asked to interview us, and following the interview we came to know that they also report on environmental issues, and that we could contact them if we wanted to disseminate the results of our project.

Day 4, 1 Dec – Meeting with Tra Vinh Department of Agriculture and Rural Development (DARD)

The second meeting of day 4 was with DARD, the Tra Vinh Department of Agriculture and Rural Development. As it was our second visit to DONRE, they already knew the project. We mostly discussed possible ways of collaboration and existing data that could be used by the project. The main partner of interest to the project is a Centre within DARD, namely the Centre for Clean Water and Sanitation, who unfortunately could not be present at the meeting. Some additional information was given on groundwater use in the area. Tra Vinh City is supplied by groundwater from wells around the city, and information on those wells and total pumping rates can be supplied upon request. There are plans to (partly) supply the city with water from the river in the future. There are about 120 wells supplying water to the communities of Tra Vinh. Some of these wells could be monitored for salinity within the scope of the project. The colleagues from DARD mentioned that they were very open to collaborate with us and share data and information. If we clearly indicate the type of data needed, then there would be no problem in providing the data. DARD staff was also invited to the outreach workshops where project results are presented and discussed.



Photo 8. Meeting at Tra Vinh Department of Agriculture and Rural Development

Day 4, 1 Dec – Project team meeting at Tra Vinh City hotel

At the end of the day we held a project team meeting to discuss a number of aspects. Prof. Ky explained the possible causes of increasing salinities inland, relating it to paleoclimate and paleohydrogeology. There is an ongoing PhD study by Mr. Hung Van Pham at Utrecht University on this topic. We have been in contact with Mr. Pham and will plan a meeting with him and his supervisor, Gualbert Oude Essink, to discuss synergies between the projects.

Another aspect we discussed was how to proceed with data acquisition on groundwater salinity. The option proposed by Mr. Hai was believed to be most reliable, namely to involve the 9 districts within Tra Vinh province in groundwater salinity measurements. Dr. Bui also showed the results of a large number of VES surveys conducted in the area, which already allowed the mapping of the spatial distribution of groundwater salinity in the different geological layers that constitute the seven different aquifers.



Photo 9. Project team meeting in the hotel of Tra Vinh

Day 5, 2 Dec – Final project team meeting at HCMUT

On day 5 we returned back to Ho Chi Minh City, where we had a final project team meeting, where we discussed the project activities for 2016, in particular the activities and outputs required until the workshop on monitoring to be held in Delft in March 2017. To make this clearer and to feed the discussion, these outputs were written on the chalkboard. They basically consist of:

1. Salinity maps per aquifer and cross-sections (parallel and perpendicular to the coast). This is not only based on direct salinity measurements, but also on geophysical surveys. In the case of Tra Vinh province, in fact the geophysical surveys are the main data used.
2. Maps with the (approximate) location of all the boreholes/wells per aquifer (can be combined with the salinity maps), according to well type:
 - a. production wells:
 - i. private supply
 - ii. community supply
 - iii. agricultural supply
 - iv. industrial supply
 - b. observation/monitoring wells
3. Detailed EC measurements in field measuring campaigns:
 - a. In saline areas
 - b. In the (120) community supply wells
 - c. In the DWRPIS observation wells
4. Time series of groundwater levels and salinities where available (as far back as possible)
5. Time series of rainfall, evapotranspiration and temperature (as far back as possible)
6. Vulnerability assessment of saltwater intrusion:
 - a. Seawater intrusion:
 - i. VFA
 - ii. SWI Index
 - b. Salt groundwater intrusion vulnerability assessment, based on:
 - i. Freshwater body salinization
 - from top
 - from bottom
 - lateral
 - ii. Semi-confining layers
 - ii. Hydraulic head differences

We further agreed that a detailed table of contents would be made for the first report by the project coordinator in January 2017. A questionnaire would be built for the surveys to be held in areas where wells are difficult to find (asking about groundwater use, salinity, well characteristics, etc.). Finally, information on the type of EC meters, CTDs and GPS or mobile phones (for GPS and EC measurements) would be shared between the partners, so as to find out if there are local distributors of the equipment needed.

LỊCH CÔNG VIỆC			
THỨ 2	THỨ 3	THỨ 4	THỨ 5
1. Salinity maps / Cross-sections	2. Plot 84,000 Wells + 120 Wells "center"	3. EC measurements	4. Plot gw level TDS
		on salinity maps	1) Wells on saline areas: Village
			2) 120 wells
			3) DWRPIS observation wells
			graph 1922 2015
			March Eijkelkamp
			Districts
			EC maps/aquifers
			Workshop ↔
			1. Network design
			↳ DWPPIS wells
			↳ Production wells
			* New wells
			↳ CTD Divers
			↳ EC meters
			↳ Measuring tap
			↳ Probe ↔ EC
BẢNG THEO DÕI CÔNG VIỆC			
NỘI DUNG CÔNG VIỆC		THỰC HIỆN	THỜI GIAN
5. Plot Rainfall Temperature Evaporation			
6. Vulnerability assessment of saltwater intrusion		1) Seawater ← VFA swI index	
		2) Salt gw { Fresh water body Semi-confining layer head differences	Top saline bottom saline side saline
NGƯỜI THEO DÕI			
CTD DIVER			
Workshop			
DWRPIS			
DWARP			
Districts			
2: Install/implementation			

Photo 10. Outputs expected for March 2017, written on the chalkboard

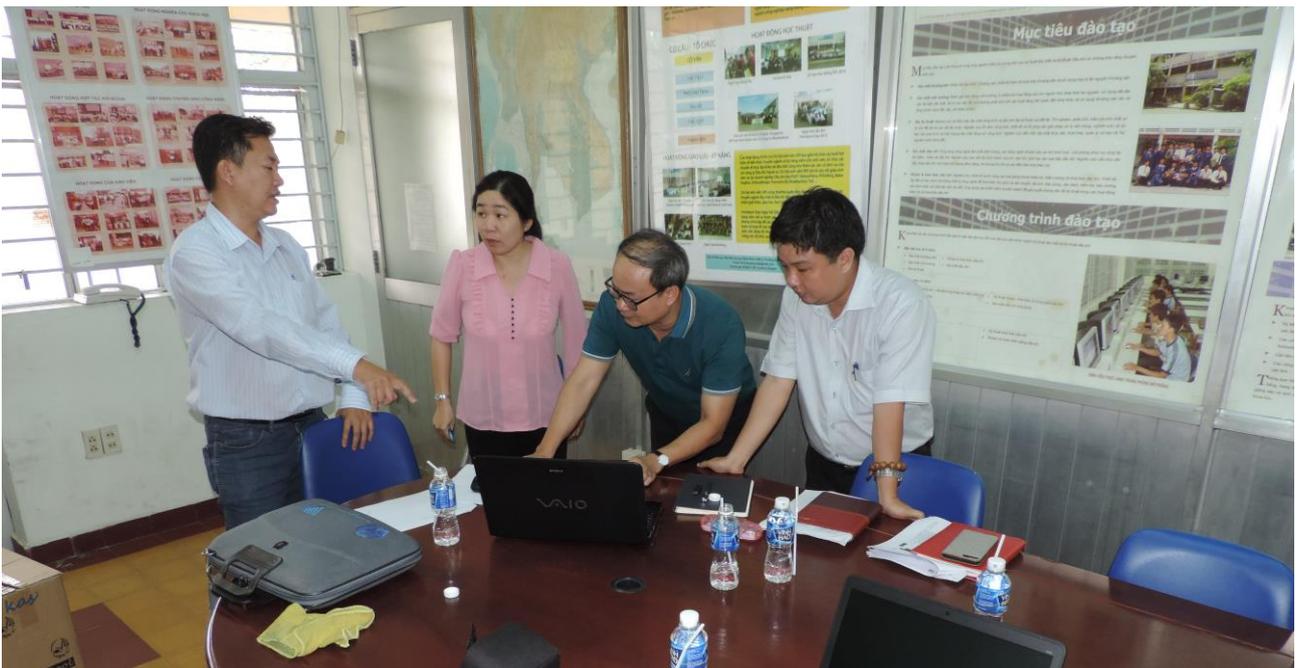


Photo 11. Discussion around the expected outputs