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Climate change and water supply in the Mekong Delta and Ho Chi Minh City

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SUSTAINABLE WATER AND SANITATION SERVICES
FOR ALL IN A FAST CHANGING WORLD

Climate change and water supply in the Mekong Delta and Ho Chi Minh City

H. A. L. Dierx, M. E. Elzerman & H. A. M. Ketelaars, The Netherlands

BRIEFING PAPER 2030

The combination of natural and induced land subsidence, sea level rise and other effects of climate change, such as extended periods of drought, greatly affects agriculture and water supply. It aggravates and accelerates sea water intrusion further inland and reduces the availability of fresh water as a source for public water supply. The salinity of the groundwater that is used for public water supply in the city of Soc Trang in the Mekong Delta is locally very high. A surface water treatment plant will be constructed to dilute or substitute the groundwater with a chloride content exceeding the Vietnamese standard of 250 mg/l for clean water. Ho Chi Minh City relies largely on rivers for its public water supply. Raw water is taken from the Dong Nai and Sai Gon rivers. The salinity of the water of these rivers varies substantially with the tides and with the season. During the dry season with limited natural discharge salinity can exceed the Vietnamese standard for chloride. Construction of impounding reservoirs would allow selective intake of river water when salinity is relatively low.

Introduction

The 'Climate Change and Water Supply in the Mekong Delta' project is executed by a partnership of water supply companies, provincial governments, and academic institutions of Vietnam and The Netherlands (Photograph 1). Vitens Evides International (VEI), a joint venture of the two largest water companies of The Netherlands, is the lead partner. Saigon Water Corporation (SAWACO), responsible for public water supply in Ho Chi Minh City, and the water company of the Mekong Delta province of Soc Trang are two of the other partners. The project is co-funded by the Sustainable Water Fund (SWF) of The Netherlands. The project formally started in April 2013 and has a duration of four years. The inception phase was completed in 2013.



Photograph 1. Partnership



Photograph 2. Land subsidence

Background

Studies show that climate change causes a widespread and gradual increase of the salinity of groundwater in the Mekong Delta, while abstracting groundwater for domestic, industrial and agricultural consumption acerbates this process and causes land subsidence. Both these events put major stress on fresh water resources, and lead to insecure and unsustainable water supply for people living in the Mekong Delta region.

Also Ho Chi Minh City is increasingly and seriously affected by the rise of the sea-level, land subsidence related to excessive groundwater extraction by private wells, and the salinity and pollution of its raw water for public supply, which is currently taken from the Dong Nai and Sai Gon rivers.

Water companies are scrambling to meet the continuously increasing demand for water. At the same time they have to deal with a deterioration of the quality of their raw water, in particular the increasing salinity of rivers and groundwater.

River deltas are susceptible to land subsidence, and so is the Mekong Delta. Groundwater extraction and the related lowering of the groundwater level reinforces this natural process (Photograph 2). The impact on the level of salinity of groundwater may even be larger than that of the sea level rise. Excessive depletion of aquifers by water companies, but also by many private wells extracting groundwater will cause permanent land subsidence, and at a relatively rapid rate.

Project objectives

The main objectives of the 'Climate Change and Water Supply in the Mekong Delta' project are:

- Achieving climate change preparedness for public water utilities;
- Achieving water supply financial sustainability through improving operational efficiency (i.e. non-revenue water and energy consumption reduction);
- Moving away from groundwater use towards surface water;
- Providing access to water for low-income households and minorities; and
- Reduction of water consumption of industries.

The project aims to have the following impacts:

- Water companies adapted to climate change effects – including climate change awareness and more sustainable development of drinking water supply;
- Improved financial sustainability of water companies – lower levels of non-revenue water (NRW) – optimized operations and improved maintenance of existing infrastructure, allowing sufficient income to be generated for reinvestment in new infrastructure to respond to population growth: 22,000 m^3/day can be gained through NRW reduction, enough to provide safe access to an additional 178,000 people;
- Reduced reliance on groundwater – and related positive impacts on the environment – providing a concrete example of a compact but efficient surface water treatment plant based on Dutch technology (Perfector-R of PWN Technologies), which will be constructed in Soc Trang;
- Increased access to safe water resulting in improved health (less waterborne diseases) and more time for economic activities – 130,000 people in three peri-urban communities are to benefit from access to safe water;
- Sustainable industrial activity in the Mekong Delta – industries will improve their profitability through groundwater saving measures and environmental impact will be reduced simultaneously;
- Positive environmental impacts, including less extraction of groundwater and overall reduction in NRW and consumption of chemicals and energy; and
- A higher level of trained professionals in the water sector and new jobs to support operation and maintenance activities.

Salinity of groundwater of wells in Soc Trang

In order to assess the impact of climate change on the quality of groundwater extracted by wells currently used as sources of water for public supply in the city of Soc Trang, past analyses of the water samples have been graphed and studied. Special attention was given to salinity of the groundwater. Figures 1 and 2 show the past trends of the concentration of chloride (Cl^-) in the clean water produced and distributed by two of the six production sites operated by Soc Trang water supply company.

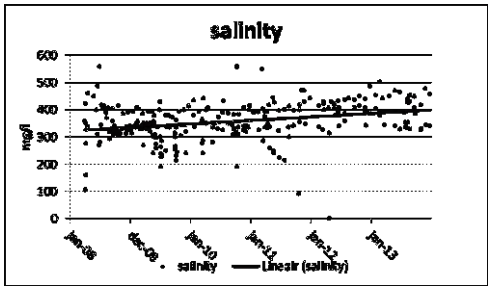


Figure 1. Salinity water WTP 2 (Phu Loi)

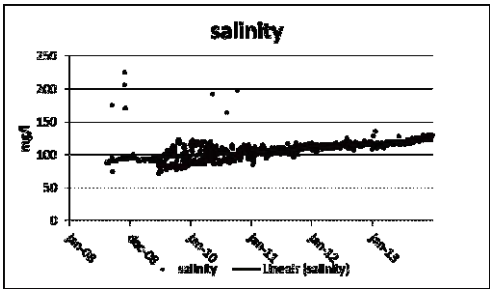


Figure 2. Salinity water Khu Cong Nghiep

An overview of all water production facilities serving the public water supply of Soc Trang city is provided in Table 1. Water is extracted from an aquifer at around 100 m and another one at around 400 m of depth. Generally, the iron (Fe^{2+}), manganese (Mn^{2+}) and ammonium (NH_4^+) concentrations of the raw water are elevated. The raw water does contain sulphate (SO_4^{2-}), but no nitrate (NO_3^-). Removal of iron, manganese and ammonia can be done by a conventional water treatment of aeration and sand filtration.

Table 1. Current (2013) and predicted (2018) salinity of groundwater at Soc Trang city

Water treatment plant (WTP)		Average current salinity 2013 (mg/l Cl^-)		Predicted average salinity 2018 (mg/l Cl^-)	
Name	**Design capacity (million m^3 / year)**	**100 m deep wells**	**400 m deep wells**	**100 m deep wells**	**400 m deep wells**
WTP 1 (Nha May 1)	5.11	467	135	560	135
WTP 2 (Phu Loi)	2.92	432	424	706	424
Khu Cong Nghiep	2.92	127		157	
Sung Dinh	1.08		222		222
Ward 7 (P7)	0.73		196		250
Ward 8 (P8)	1.46		134		200

Many of the 100 m deep wells show a significant increase in salinity over time; some of the 400 m deep wells also, although the salinity in others seems stable (Table 1). The water produced at WTP 2 at Phu Loi does not meet the Vietnamese standard for clean water of 250 mg/l with respect to chloride (Cl^-), nor the 300 mg/l as per special dispensation. The water company of Soc Trang province intends to use the water that will be produced by the Perfector-R surface water treatment plant to dilute the water produced at Phu Loi. Eventually water production at this well field may have to be stopped altogether.

Analysis shows that also the water produced at the largest treatment plant of Soc Trang water company, i.e. Nha May 1, is at risk of exceeding the national standard for chloride: the reliance on water produced by the deep wells will increase over time, and this does not seem to be sustainable. A more definite solution will need to be found to be able to guarantee the public water supply of Soc Trang in the long-term.

Salinity of the water of the Dong Nai and Sai Gon rivers

The Dong Nai and Sai Gon rivers are currently used as the main sources for public water supply in Ho Chi Minh City (HCMC). In addition, there is still some reliance on the use of groundwater produced by wells in parts of the city where the level of services would otherwise be low. The intention of Saigon Water Corporation (SAWACO), the umbrella organization in charge of management and coordination of water supply services in HCMC, is to gradually phase out the production of water by wells and rely fully on surface water for public water supply.

The quality of the water of the Dong Nai and Sai Gon rivers is very poor due to the high organic load – high chemical oxygen demand (COD), high biological oxygen demand (BOD), low dissolved oxygen (DO) – from domestic, industrial and agricultural wastes, and to high discharges in the rainy season (turbidity, colour, manganese). The counts of coliforms and *E. coli*, the level of turbidity, and the concentrations of ammonia (NH_3-N) and manganese (Mn) exceed the Vietnamese and World Health Organisation (WHO) standards for raw water to be used for public water supply.

The subsequent treatment of water applied by SAWACO is able to remove these contaminations and produce water that meets standards for clean water. However, in order to prevent sudden high surface loading of the sand filters used in the treatment plants (and subsequent breakthrough of particles and micro-organisms) at high turbidity levels storage of river water in impounding reservoirs has been recommended. Impounding reservoirs would also serve in case of (accidental) industrial or agricultural spills, as well as in case of extreme high chloride concentrations during high tides in the dry season. Moreover, impounding reservoirs would allow SAWACO to stabilize the regime of its water treatment facilities and to use the clear water reservoirs of the plants solely for purpose of coping with daily demand fluctuations (and not as a back-up of water in case the intake of raw water has to be halted temporarily).

The salinity of the water of the Dong Nai and Sai Gon rivers varies substantially with the tides and with the season. During the dry season with limited natural discharge of the river, salinity can exceed the Vietnamese standard for clean water of 250 mg/l chloride (Cl^-). This is indicated in Figures 3 and 4 which show respectively the maximum daily chloride content of the raw water taken in by SAWACO from the Dong Nai river (Figure 3), and the daily average chloride content of the clean water distributed by the 700,000 m^3/day Thu Duc water treatment plant (Figure 4). SAWACO has adopted an internal standard to stop intake of water from the Dong Nai river if the chloride content exceeds 120 mg/l.

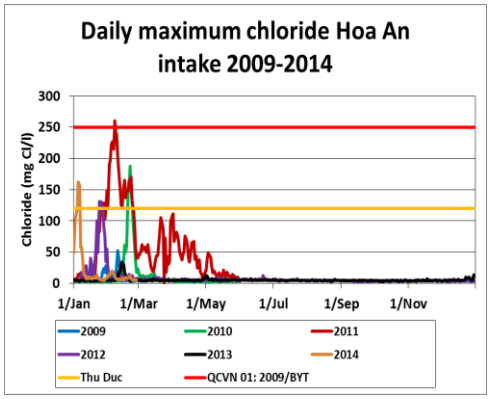


Figure 3. Maximum daily chloride of the Dong Nai river at the Thu Duc intake

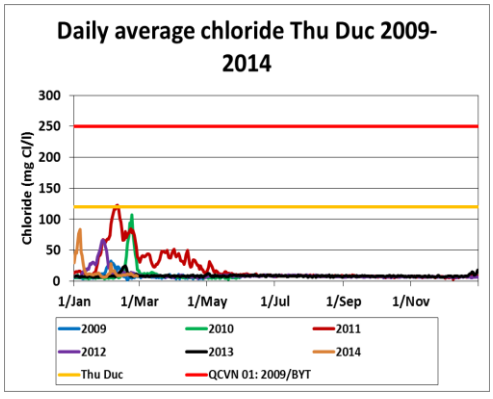


Figure 4. Daily average chloride distributed by the Thu Duc plant

The situation at the intake for the 300,000 m^3/day Tan Hiep water treatment plant in the Sai Gon river is even more critical as indicated in Figure 5 which shows the chloride content at the intake of the plant during the dry season – January through April – of (for example) 2010.

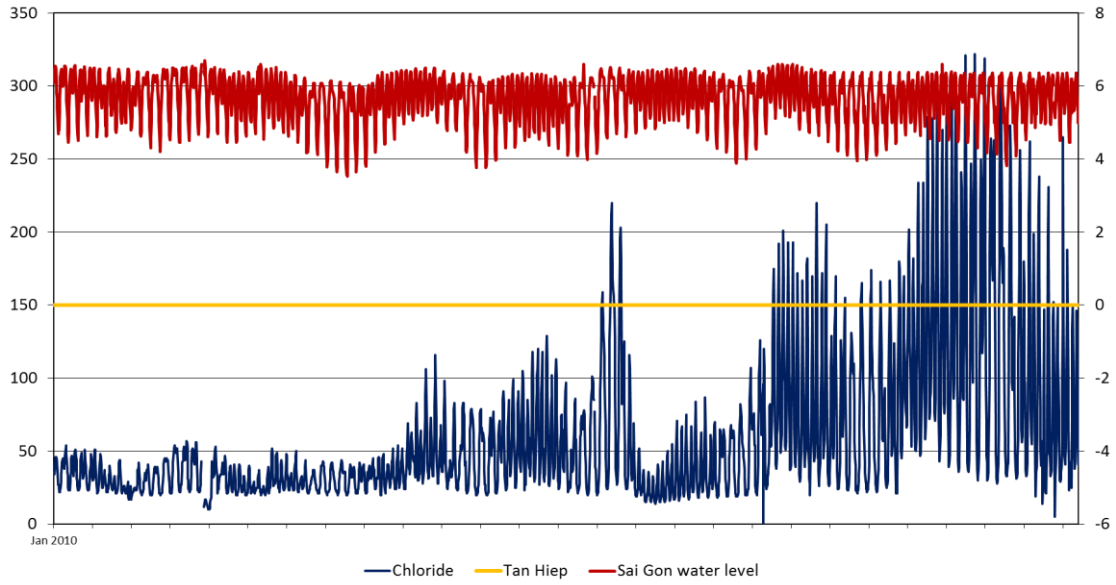


Figure 5. Salinity of the Sai Gon river at the Tan Hiep intake from January to April 2010

Figure 6 provides detailed insight in the daily fluctuations of the chloride content of the Sai Gon river at the intake for the Tan Hiep water treatment plant and how this parameter is closely related to the level of the river, which is strongly influenced by the tides. The figure shows that an impounding reservoir with a capacity of a day's production of the plant would allow to limit the intake of saline water. However, rising sea levels as a result of climate change will make the situation at the intakes in the Dong Nai and the Sai Gon river for respectively SAWACO's Thu Duc and Tan Hiep water treatment plants more precarious.

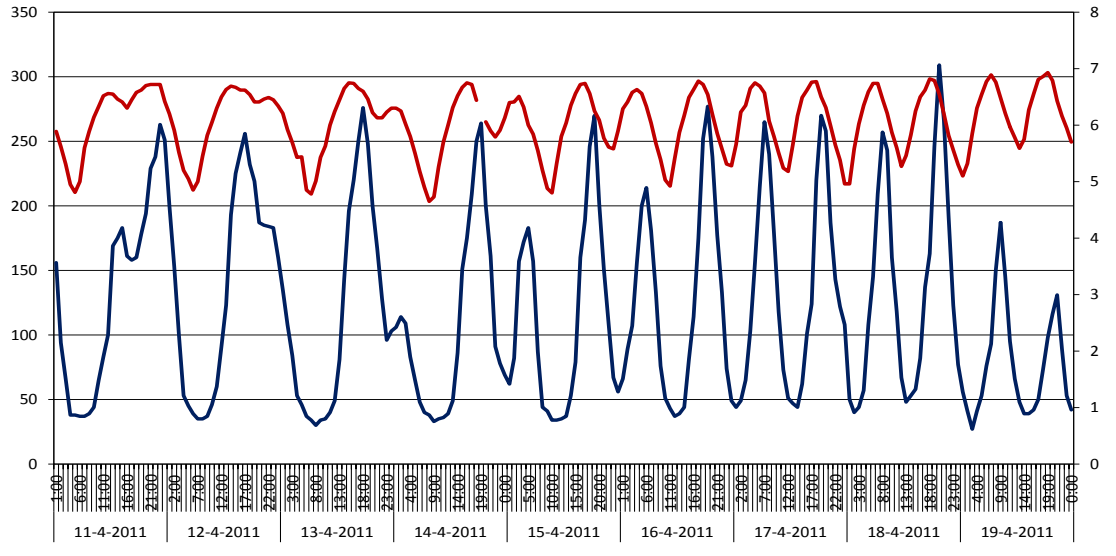


Figure 6. Salinity of the Sai Gon river at the Tan Hiep intake from 11 to 19 April 2011

Preliminary lessons learnt

Production deep wells with filters at a depth of about 100 m and used for public water supply in Soc Trang in the Mekong Delta are getting more saline relatively rapidly; those at a depth of about 400 m are generally more stable. Further research will need to be done to determine the main cause of the salinization of the

wells experienced: (a) gradual intrusion of seawater replacing less saline groundwater due to a rising sea-level, (b) up-coning of saline groundwater due to over-extraction, (c) infiltration of brackish surface water from rivers and canals during the dry season, (d) other. Over-extraction of groundwater by public water utilities, agriculture and industry appears to be a major cause of salinization. Provincial government will need to put in place and enforce effective regulations to control and minimize over-extraction of groundwater.

During the dry season when there is little runoff in rivers, the salinity of the water in the downstream parts of rivers increases. However, there can be substantial variations in salinity during the day depending on the tides. This allows a water company to selectively extract water from a river, especially in case of the availability of an impounding reservoir to store raw water. Even an impounding reservoir with a capacity equal to the production of one day could substantially enhance the reliability of water supply.



Figure 7. Location of the Mekong Delta, Soc Trang and Ho Chi Minh City

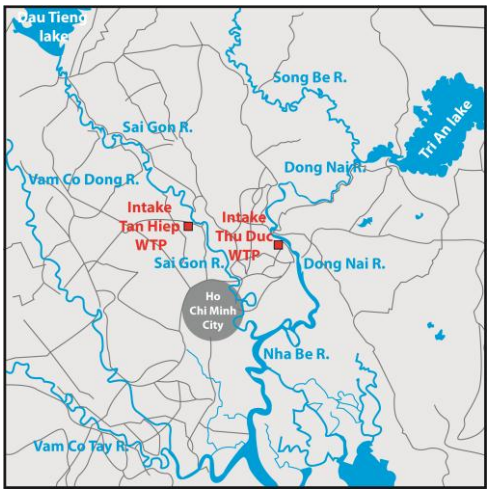


Figure 8. River water intakes serving Thu Duc and Tan Hiep water treatment plants

Contact details
H.A.L. (Rik) Dierx
SAWACO Building, Room 305
1 Cong Truong Quoc Te, D.3, Ho Chi Minh City
Tel: +84 908 576 500
Email: rik.dierx@vitens.nl
www.vitensevidesinternational.com