Towards strategies for the subsiding Mekong Delta in Vietnam

The challenges: urbanization, land-use change and subsidence

The Mekong Delta in Vietnam is rapidly changing due to urbanization, land-use transformation, and intensification of economic activities. The associated increase in freshwater demand has led to:

1. Large-scale extraction of fresh groundwater with rates seriously depleting the existing fresh groundwater reserves;
2. Salinization of groundwater and surface water resources;
3. Land subsidence, with current rates up to several centimeters per year, due to groundwater extraction, loading by buildings and infrastructure, and intensive drainage of the shallow subsurface;
4. Increased flood risk and flood water depth, resulting in land loss as well as damage to buildings and infrastructure.
Results from Rise & Fall research: Decreasing fresh groundwater reserves

Fresh water in the Mekong Delta is extracted from groundwater reserves by pumping and used for domestic, industrial as well as agriculural purposes. In recent times the amount of fresh groundwater extraction has seriously increased. Our research indicates that nowadays extraction rates exceed the amount of natural infiltration due to rainfall or surface water. This results in a structural depletion of the groundwater reserves.

We expect that the fresh groundwater volumes will further reduce as an effect of past and current rising mean sea level as well as present day groundwater extractions. The exact amount and process rates are currently being assessed using advanced numerical 3D models.

Results from Rise & Fall research: Subsidence

Relative sea-level rise is the amount of sea-level rise relative to the land surface. It is determined by absolute global sea-level rise plus subsidence of the land surface in the Mekong Delta. Locally determined rates of absolute global sea-level rise in SE-Asia induced by climate change range from ~3 to 5 mm/yr (Takagi et al., 2016; Lovelock et al., 2015). However, our 3D numerical model shows that large areas experience subsidence rates of ~10-20 mm/yr in rural parts and ~25 mm/yr in cities and industrial areas due to serious groundwater extractions (Minderhoud et al., subm.). These subsidence rates substantially outpace absolute sea-level rise. Consequently, the threat posed by subsidence currently exceeds the threat of climate change induced sea-level rise.

Subsidence rates have steadily increased since the beginning of large scale groundwater exploitation in the 1990’s (Minderhoud et al., subm.). The main drivers of subsidence seem to be the drop of pressures in groundwater reservoirs due to groundwater extraction and loading of the subsurface by buildings and infrastructure.

Towards strategies

As groundwater extraction will continue to rise in the foreseeable future, subsidence and salinization of the fresh groundwater volumes will continue as well. In this process the low-lying Mekong Delta will become even more vulnerable to natural disasters, seriously limiting future economic developments.

The first results from our Rise & Fall research program indicate that there is an urgent need to develop evidence based adaptation strategies that will counteract over-exploitation of groundwater and the associated salinization and subsidence.

Developing adaptation strategies that lead to sustainable solutions require a joint effort of many stakeholders: local, regional and national governments, industries and non-governmental organizations as well as research institutes.

Actions for governments and other stakeholders

Governments, together with the other stakeholders, have an important responsibility to:

- Put the issues of fresh groundwater availability, salinization and subsidence on the political agenda;
- Facilitate research institutes in developing modelling tools and encourage data collection with the ultimate aim to develop evidence based strategies;
- Effectuate well-tuned governance strategies as well as a legislative framework.

Actions for research institutes

To support and encourage a well-informed decision-making process, research institutes should help develop monitoring strategies, generate data and develop databases and numerical models.

More specifically they should:

- Increase monitoring of ground and surface water quality, extraction and subsidence rates. This will enable the development of improved predictive models and water management strategies;
- Develop a centralized and open source database that stores monitoring data, including data on the subsurface architecture and geotechnical properties. These data should be used to monitor the impacts of groundwater management strategies and will aid predictive modelling;
- Develop 3D geological, hydro/geo/technical and geotechnical models. These models will enable the selection of the most effective and sustainable management strategies by determining the trade-offs of different policies.