ACC DAR Adapting to Climate Change in Coastal Dar es Salaam

Second International Workshop on
TOWARDS SCENARIOS FOR URBAN ADAPTATION PLANNING

The ACC DAR Project

MONITORING SEAWATER INTRUSION IN THE COASTAL AQUIFER OF DAR ES SALAAM

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Outline of Presentation

- Background and Aim
- Borehole monitoring methods
- Reconnaissance survey of Monitoring boreholes
- Long-term monitoring campaign
- Short-term monitoring campaign
- Data Compilation, Communication and Analysis
- Benefits of groundwater monitoring
- Conclusion and Recommendations

Background and Aim

Work packages (WP 2): Adapting to Climate Change in Coastal Dar es Salaam is Development of methodologies for exploring Climate Change vulnerability scenarios

- The aim is to identify and fill the gaps in existing methodologies to improve scientific knowledge on peri-urban dynamics
- This is crucial to explore future impacts of CC on the livelihoods of those living there, and to formulate effective strategies to enhance their capacity to adapt
- The outcomes of this activities has fed into the training programme undertaken under WP3

Activity 2.2: Develop methodologies for exploring CC vulnerability scenarios: Saltwater Intrusion

Sub-activities under Activity 2.2 of WP 2:

- (1) Definition of boundaries of study area;
- (2) collection of historical Data (documents and reports provided by public authorities e.g. DDCA);
- (3) hydrogeological survey (Design a borehole monitoring network and georeferencing the boreholes and field measurements); and,
- (4) Organizing a digital geodatabase (Database architecture definition and database creation).

Borehole monitoring methods

- Monitoring borehole reconnaissance survey (Oct to Nov 2011):
- Preliminary assessment on the suitability of the selected borehole for the monitoring campaign
- Physical identification of the location of the boreholes and taking the coordinates of the boreholes using handheld GPS equipments
- Navigation in the study area using the map to locate the boreholes that were selected from the Drilling and Dam Construction Agency (DCCA) reports and mapped within grids of sizes of 2x2 km^2

Borehole monitoring methods

- Monitoring borehole reconnaissance survey (Oct to Nov 2011):
- Visiting the borehole owners to request for the permission to use their boreholes for the monitoring campaign
- The objectives, expected outcomes and benefits of the project had to be well articulated for convincing the borehole owners to grant the permission
- Promised to avail the results of our measurements to the owners should they be interested in them
- Assured them that the measurements results and information they will avail to us will strictly be used for achieving the objectives of our research project and not otherwise

Reconnaissance survey of Monitoring boreholes

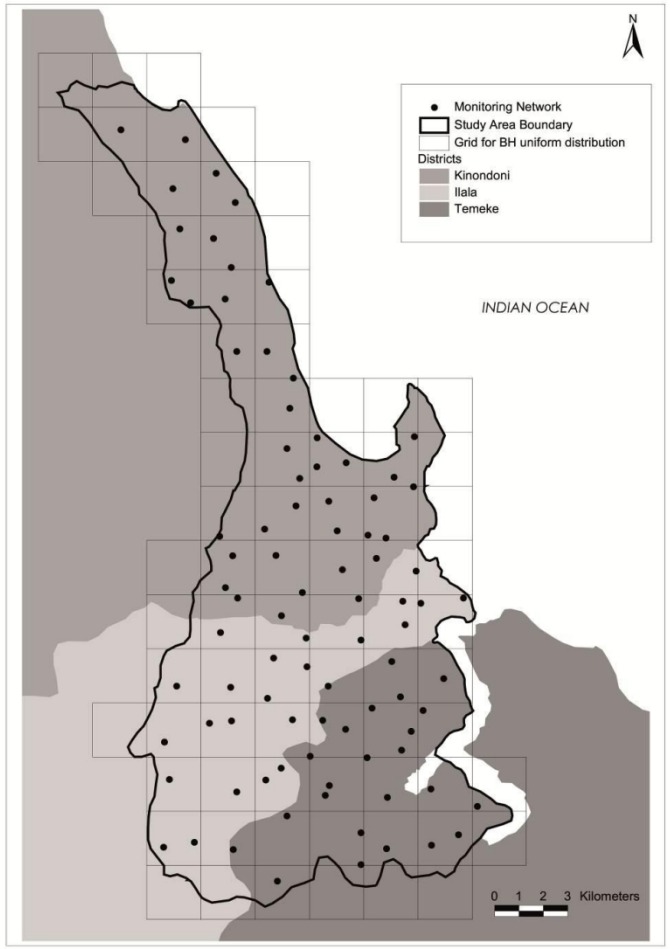
- Before starting the two weeks (long-term) monitoring campaign in Feb 2012 the reconnaissance exercise conducted again
- There were possibilities that the situation at the selected monitoring boreholes may have changed due to a 4 month delay in starting the monitoring campaign
- Indeed some boreholes were observed to have encountered some operational and technical problems during the four month delay
- Contact persons of some boreholes were also found to have changed thus necessitating renegotiation on the permission to use the BH for the monitoring campaigns.

Reconnaissance survey of Monitoring boreholes

- Challenges encountered during the reconnaissance survey:
- (i) Some boreholes originally selected for monitoring were not working and had to be replaced by other boreholes, which are located within the same grids as close as possible to the formerly selected ones;
- (ii) some of the persons initially contacted were no longer there especially for boreholes belonging to institutions and companies
- (iii) some contact persons had forgotten about issues pertinent to the borehole monitoring campaign
- Some BH had to be replaced and new contact persons identified

Long-term monitoring campaign (June and Nov 2012

- **Criteria**: Two BHs for 2×2km^2 in urban area and 1 BH in PU areas
- 88 boreholes were involved
- 79 (89.8%) boreholes were measured out of 88 boreholes earmarked to be surveyed
- Most of the boreholes, which could not be measured it is because they were no longer working due to defective pumps and electrical connection problems among other reasons



Long-term monitoring campaign

- In situ measurement of static water levels and heights were done using water level indicators (Model BFK-100; P.A.S.I. srl - Via Galliari, 5/E - 10125 Torino - Italy)
- Physical parameters (temperature, conductivity, specific conductance, salinity, resistivity, total dissolved solids (TDS) and pH) were measured in situ using handheld multiparameter probes (YSI Professional Plus; SYSTEA S.p.A, Via Padun, France)
- Two litres of water sample was collected from each borehole and taken to the Ardhi University Environmental Engineering Laboratory for analysis

Long-term monitoring campaign

- 11 parameters including calcium, magnesium, sodium, potassium, bicarbonate, nitrate, chloride, sulphate, phosphorus, fluoride and ammonia were analysed and reported during the long-term monitoring campaign
- Analysis of seawater: Two sea water samples were taken at different times and analysed for 15 different parameters (i.e. pH, EC, TDS, Salinity, Sodium, Potassium, Magnesium, Manganese, Nitrate, Sulphate, Phosphate, Bicarbonate, Chloride, Fluoride and Iodine)

Static water level measurement

- The static water level was measured by dipping the water level indicator through any opening between the borehole casing and the borehole pipe
- An alarm sound from the water level indicator signalled that the groundwater table has been touched

Long-term monitoring campaign

- Well discharge and some other pertinent information (e.g. depth, diameter, well log, etc.) for the boreholes, which were identified for replacement of the originally selected ones were sought
- It was difficult to get the information because most of the borehole were privately owned and did not record /keep the BH data
- It was assumed that the hydrogeological characteristics of the area in which the replacement borehole is found is similar to that of a nearby borehole whose hydrogeological characteristics are known

Short-term monitoring campaign

- Monthly monitoring activities in which SWL and physical parameters were measured
- Conducted for two consecutive months of September and October 2012
- 33 boreholes out of 88 boreholes identified for the short-term monitoring campaign
- Three (3) could not be monitored due to reluctance of the owners to grant access and defective pumps

Data Compilation, Communication and Analysis

- Database was established for compiling saltwater intrusion monitoring parameter values
- Data for describing borehole characteristics including depth, location, diameter and well log were extracted from DCCA and JICA hard and soft copy files and fed into the established saltwater intrusion monitoring database
- Data on SWL and water quality were fed into the database located at Sapienza University of Roma via internet during the monitoring efforts
- Analysis of the monitoring for establishing the extent and magnitude of the saltwater intrusion phenomenon is being done at Sapienza University of Roma

Benefits of groundwater monitoring

- Awareness creation to the Government officials and private borehole owners on climate change impacts on groundwater resources
- Borehole owners will have some insight on the quality of water they consume
- Enhancement of the capacity of members of staff (especially junior researchers) of Ardhi University to conduct research and train on issues pertinent to groundwater, salt water intrusion and climate change
- Information generated may help Wami/Ruvu Basin Water Office in development of groundwater monitoring programmes

Benefits of groundwater monitoring

- If shared the results may influence policy modification and formulation in the water sector as well as inform sound professional practice in groundwater resources exploration and exploitation in coastal areas
- The study has a potential for replication in other coastal urban centres such as Tanga City and Mtwara Municipality facing similar groundwater exploitation challenges
- Results may enable the water resource management and pollution control authorities (Wami/Ruvu Basin Water Office, DDCA, Dar es Salaam Water and Sanitation Authority, National Environment Management Council) to put in place pragmatic intervention measures in a timely manner

Conclusion and Recommendations

- Since we did not install our own monitoring boreholes, the success of the monitoring exercise solely depended on willingness of the owners to allow us to use their boreholes
- The approach used that relied solely on the willingness of owners to avail their BH for monitoring may not be sustainable for long-term campaign
- Drilling of few monitoring BH at strategic areas /locations which will be able to yield results that represents to the reasonable extent the saltwater intrusion condition in the area of interest is recommended

Conclusion and Recommendations

- Feedback to owners on the quality of water of their BH will have to be given cautiously since microbiological quality (the most important parameter in determining the suitability of GW for domestic use) was not determined
- DSM City will likely continue to depend heavily on groundwater in the foreseeable future since expansion of piped water supply system is lagging behind
- Groundwater monitoring program should be established for monitoring changes in quality and quantity so as to put in place strategic intervention measures in a timely fashion for safeguarding groundwater resources against overexploitation, saltwater intrusion and pollution

THANK YOU FOR YOUR ATTENTION!