

Technical Workshop on Monitoring Seawater Intrusion in Coastal Groundwater



Centro Interuniversitario di Ricerca Per lo Sviluppo sostenibile - CIRPS







ACCDAR PROJECT WP 2 ACTIVITY 2.2 PRESENTATION

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PLAN OF ACTIVITY – Topic: Seawater intrusion in coastal aquifer

Plan of Activity										
Sub-Activities	Sub-Activities break down	Sub-Activity Description	Sub-activity output	Instruments	Month(s)					
1. Historical data collection		Historical data collected (documents and reports provided by public authorities, academic researchers and international cooperation agencies): Precipitation and Temperature; Tidal excursion; Hydrogeological characteristics; Groundwater physical and chemical characteristics	Set of historical data		AUG 2011 - SEP 2011					
2. Hydrogeological survey campaign	a. Definition of a methodology for conducting groundwater monitoring campaigns in Dar es Salaam coastal aquifer	Methodology consists in different survey activities, that differ in temporal scales (long term, monthly and short term) and type of data to be collected (in situ and laboratory measure)	Methodology to analyze groundwater physical and chemical characteristics		OCT 2011					
	b. Design a borehole monitoring network	Monitoring network selected following these steps: study area boundary definition; georeferencing boreholes; select the boreholes to be included in the network (selection criteria: depth, location, accessibility, spatial distribution)	Borehole monitoring network	GPS Q-GIS	NOV 2011 - DEC 2011					
	c. Perform field measurements	Parameters to be monitorated: SWL, Physical parameters (T, EC, pH), Chemical parameters, Isotopic parameters	Set of current data	GPS 3 Contact Meters 3 Multiparametric Probes ARU Laboratory	JAN/FEB 2012 - OCT 2012					
3. Organizing a digital geodatabase	a. Database architecture definition and database creation	Since during seawater intrusion phenomenon analysis thousands of data will be managed (coming from the monitoring campaign), a specific relational database for the ACC-Dar boreholes network storage were built on MS Access environment	Relational database	MS Access	NOV 2011					
	b. Database population	Database population with historical and current groundwater data	Data Storage in the Database		DEC 2011 - OCT 2012					



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PLAN OF ACTIVITY – Topic: Seawater intrusion in coastal aquifer

4. Studying seawater intrusion evolution in Dar es Salaam coastal aquifer	a. Definition of a methodology for the analysis of seawater intrusion phenomenon	Decide the methodology, in relation with the available groundwater data	Working Paper about methodology		FEB 2012 - MAY 2012
	b. Seawater intrusion mapping	As for studying the seawater intrusion in coastal aquifer evolution 3 date will be considered: 1997, 2002, 2012	Seawater intrusion maps	Q-GIS	MAY 2012 - NOV 2012
5. Review and choose methodology for exploring vulnerability scenarios under CC		Methodology will consider both the physical and socio-economic factors that combine to determine community vulnerability to CC	Working Paper about methodology		APR 2012 - JUL 2012
6. Collaboration between CIRPS and ARU 7. CC vulnerability scenarios as regards seawater intrusion phenomenon	a. Collaboration in Dar es Salaam for hydrogeological survey campaign and organizing a digital geodatabase	Training activities in Dar, on climate change and groundwater, seawater intrusion theory and modelling, GIS theory and practise, data management and basic of MS Access, groundwater measures instruments theory and practise		Q-GIS	NOV 2011 - DEC 2011
	b. Collaboration in Rome for sharing methodologies	An ARU junior researcher (Lukuba Ngalya) will come in Rome for 2 months, in order to work in developing methodologies		Q-GIS	MAY 2012 - JUN 2012
	a. Assessing seawater intrusion phenomenon correlation with environmental characteristics under CC effects	Hydrogeological balance will be executed and tidal effect will be studied in order to understand possible CC effects on seawater intrusion phenomenon.	Maps or indices showing correlation	Q-GIS	JUL 2012 - OCT 2012
	b. Assessing seawater intrusion phenomenon correlation with socio- economic characteristics of the settled population	Evaluation of the socio-economic characteristics and community dependence on groundwater.	Maps or indices showing correlation	Q-GIS	JUL 2012 - OCT 2012
	c. Develop vulnerability scenarios	Vulnerability scenarios will develop under different adaptation options	CC vulnerability scenarios	Q-GIS	NOV 2012 - DEC 2012
8. Dissemination activities		Dissemination of papers, seminars			





Sub-activity 1: Historical data collection

A series of documents and reports provided by public authorities, academic researchers and international cooperation agencies were collected.

Historical data collected, useful for analyze seawater intrusion phenomenon and CC effects on seawater intrusion evolution, were:

Precipitation and Temperature

Precipitation and Temperature monthly data have been collected from Dar es Salaam meteorological stations for three gages with reference to last 50 years

Tidal excursion

Tidal excursion data (annual, monthly and daily) have been collected from Tanzania Ports Authority (<u>http://www.tanzaniaports.com</u>) and from the Sea Level Center of Hawaii University (<u>http://uhslc.soest.hawaii.edu/</u>) with reference to last 10 years.

Hydrogeological characteristics

Hydrogeological data (geological stratigraphies, SWL) were obtained from academic studies, JICA (Japanese International Cooperation Agency) Reports, and DDCA (Drilling and Dam Construction Agency) Borehole Reports (geological characteristics, SWL).

Groundwater physical and chemical characteristics

Groundwater Phys-Chem data were obtained from DDCA Borehole Reports (EC, TDS and mayor ions).





Actual georeferenced boreholes dataset





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Part of the actual georeferenced boreholes dataset

ID	BH/No	District	Area/Village	Owner	Year of construction	LAT	LONG	GL (masl)	Borehole Depth (mbgl)	SWL	DWL	Q [1/s]	DDCA REPORT in PDF
1	373/2000	Kinondoni	Muogozo	M/s Mutalemwa	2000	-6,58603333	39,073	70	30				
2	175/2001	Kinondoni	Mpiji-Mbweni	M/s Municipal	2001	-6,59175	39,11371667	50	27				
3	390/2000	Kinondoni	Tete-Mpigi	M/s Mahatene	2000	-6,59265	39,1232	40	30				
4	feb-00	Kinondoni	Teta - Mpigi	M/s Muwandu	2000	-6,59861667	39,11561667	55	21	12.58			
5	156/2001	Kinondoni	Mbuju B	M/s Shuma	2001	-6,60791667	39,09206667	30	56				
6	27/2001	Kinondoni	Bunju B	M/s Mtenga	2001	-6,60831667	39,0934	70	38	29.66			
7	feb-03	Kinondoni	Bunju	M/s Lugemalila	2003	-6,61101667	39,1198	100	6	47.60			Y
8	174/2001	Kinondoni	Bunju A	M/s Municipal	2001	-6,61688333	39,11071667	90	63	43.46			Y
9	gen-01	Kinondoni	Boko	M/s Roze Ruta	2001	-6,61873333	39,13388333	80	48	38.18			
10	325/2002	Kinondoni	Boko	M/s Uronu	2002	-6,62775	39,13015	50	60	17.30			Y
11	344/2003	Kinondoni	Boko	M/s Mheto	2003	-6,6318	39,15251667	45	50	11.18			Y
12	100/2003	Kinondoni	Boko	M/s D. Nchome	2003	-6,65035	39,13863333	58	28				
13	579/99	Kinondoni	Mabwepande	M/s Jairo	1999	-6,65758333	39,1011	100	48	36.95			
14	554/99	Kinondoni	Bunju - Kinondo	M/s P.M.O	1999	-6,65858333	39,10736667	90	100	42.94			
15	197/2000	Kinondoni	Bunju	M/s Mhe. Sumaye	2000	-6,65886667	39,11256667	80	119	32.02			Y
16	41/2005	Kinondoni	Kunduchi	M/s K. Akaro	2005	-6,65898333	39,2051	18	10	8.33			Y
17	382/2000	Kinondoni	Teta- Mpiji	M/s Katakweba	2000	-6,66266667	39,07051667	95	69	26.32			
18	582/2004	Kinondoni	Kunduchi	M/s TAFIRI	2004	-6,66521667	39,2126	6	13	3.05			Y
19	380/2000	Kinondoni	Wazo Hill	M/s Chimbyangu	2000	-6,66926667	39,17568333	55	60	30.25			
20	39/2003	Kinondoni	Wazo Hill	M/s Hon. Makamba	2003	-6,67543333	39,17425	70	54	18.20			Y
21	350/2000	Kinondoni	Tegeta Kilimahewa	M/s Ngamilo	2000	-6,67596667	39,17633333	70	60	16.50			
22	446/2008	Kinondoni	Kunduchi Mtongani	DAWASA	2008	-6,6784	39,20453333	31	19	14.77			Y
23	16/99	Kinondoni	Kinduchi Mtongani	M/s Machuve	1999	-6,68591667	39,20506667	33	33	20.70			Y
24	900/2005	Kinondoni	Mbezi Beach	M/s Machuve	2005	-6,68591667	39,20506667	33	50	6.67			Y
25	519/2005	Kinondoni	Kunduchi	M/s Ge. Gimange	2005	-6,68915	39,2111	11	16	2.46			Y
26	558/2007	Kinondoni	Kunduchi	M/s Ge. Gimange	2007	-6,68915	39,2111	11	36	3.60			Y
27	316/2001	Kinondoni	Madale	M/s DAWASA	2001	-6,69218333	39,13291667	115	102				
28	663/2003	Kinondoni	Mbezi Beach II	M/s Belinda Resort	2003	-6,6946	39,22503333	5	16	4.67			Y
29	378/2003	Kinondoni	Kawe Garden	M/s Municipal	2003	-6,69928333	39,21193333	17	22	10.96			Y
30	gen-09	Kinondoni	Sala Sala	M/s Mwasonya	2009	-6,70221667	39,19606667	56	80	32.16			Y
31	48/2003	Kinondoni	Mbezi	M/s D. Magwiza	2003	-6,70883333	39,09895	128	60				



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<u>Sub-activity 2.a.: Hydrogeological survey campaign - Definition of a methodology for conducting</u> <u>groundwater monitoring campaigns in Dar Salaam coastal aquifer</u>

A methodology to analyze groundwater physical and chemical characteristics were defined in order to have a set of current data, that will be useful for evaluating the evolution of the seawater intrusion phenomenon.

Different types of monitoring campaigns \rightarrow necessity to establish the boundary conditions

After designing the monitoring boreholes network \rightarrow the future monitoring campaigns will be performed following this scheme (type of data to be collected different temporal scales for survey activity):

- A long term monitoring activity involving the whole boreholes network to be executed 2 times in about 9 months: at the beginning (when ARDHI will have the instruments) and at the end.

Data to be collected: SWL measure, Phys-Chem parameters in situ measure, water samples collection for the laboratory analysis.

- A monthly monitoring activity, involving only a sub-group of boreholes (exact number to be decided). Data to be collected: SWL measure, Phys-Chem parameters in situ measure.

- A short term monitoring activity (2 times per day during an entire week, but not necessary in a specific month) just for few boreholes (exact number to be decided) located strictly near the coastline. This campaign has to be performed in order to study the tidal effect on groundwater salinity.

Data to be collected: SWL measure, Phys-Chem parameters in situ measure.





Sub-activity 2.b.: Hydrogeological survey campaign - Design a borehole monitoring network

Study Area Boundary Geology Alluvial and river terraces Raised coral reef limestones White-buff sands Clay-bound sands and gravels Pugu-kaolinitic sandstones Indian Ocean 12 Kilometers INDIAN OCEAN

1. STUDY AREA BOUNDARY DEFINITION

Dar es Salaam Coastal Aquifer (Quaternary sandy Plain)



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CRITERIA:

-Dar es Salaam morphological and geological characteristics

- Data availability for boreholes



SUB-ACTIVITIES TO BE PERFORMED DURING NOVEMBER-DECEMBER 2011 MISSION

Sub-activity 2.b.: Hydrogeological survey campaign - Design a borehole monitoring network

1. GEOREFERENCING BOREHOLES

Since the analysis of seawater intrusion phenomenon will be conducted in a GIS environment, a number of boreholes has to be localized on field and georeferenced by GPS coordinates

2. SELECT THE BOREHOLES TO BE INCLUDED IN THE MONITORING NETWORK FOLLOWING THESE CRITERIA:

- Availability of the DDCA Report (availability of groundwater historical data in the same water point)
- Uniform spatial distribution of the monitoring boreholes inside the study area → based on a georeferenced grid of almost 2 km X 2 km
- Borehole depth: the monitoring borehole has to tapped from the study coastal aquifer
- Boreholes accessibility: owners availability to use their boreholes for the monitoring campaign, and borehole characteristics (borehole diameter, presence of pump, etc.), in order to perform easily the in situ measures

Sub-activity 3.a.: Organizing a digital geo-database - Database architecture definition and database creation

Since during seawater intrusion phenomenon analysis thousands of data will be managed (coming from the monitoring campaign), a specific relational database for the ACC-Dar boreholes network storage has to be built





SUB-ACTIVITIES TO BE PERFORMED DURING NOVEMBER-DECEMBER 2011 MISSION

Georeferenced grid used to verify the spatial distribution uniformity





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ABOUT THE FUTURE HYDROGEOLOGICAL SURVEY CAMPAIGN

HUMAN RESOURCES for the hydrogeological survey:

- 3 or 4 technical teams to perform field measurements: we suggest 2 people per team;
- Local supervisor.

INSTRUMENTS NEEDED:

- 3 Contact Meters for SWL;
- 3 Multiparametric Probes;
- ARDHI Laboratory for hydrogeochemical and isotopical analysis;
- Transport for the different teams.





Work in progress ...



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Page 12