Site Description

The Gaza Strip is a part of the Mediterranean coastal plain (31°26’N, 34°23’E) (Figure 1). Its area is about 365 km² and its length is approximately 45 km. The urban areas are very dense. An estimated 1,7 million people live in Gaza by the end of 2012, with a density of more than 4,500 people/km², making it on of the most overcrowded areas in the world. Nowadays, the need of water is not satisfied by the available resources, and this is causing a huge deficit between water demand and supply. Considering the nowadays population growth rate of about 3.5 %, by year 2035 the population will reach a total number of about 3.7 million. This rate plays a big role in the planning and management of water resources.

Partners of this Case Study

- Ludwig-Maximilians-Universität (LMU), Munich, Germany
- Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets (CEMAGREF), Montpellier, France
- Centro di Ricerca, Sviluppo e Studi Superiori, Sardegna (CRS4), Italy
- Forschungszentrum Juelich GmbH, Juelich, Germany
- Joanneum Research Forschungsgesellschaft mbH, Graz, Austria

Focus of this Case Study

Report on the site characterization was carried out with interpreting the observations and understanding processes within Gaza site, comparing observations among study site and establishing a basis for similarities and differences so that inter site comparison can be facilitated. This task carried out in collaboration with the study site responsible partners and a Microsoft Office Access Program has been developed for this task by CERTE. The data base system present 8 types of information as follows:
1. Morphology of the basin
2. Climatic data
3. Surface water
4. Groundwater
5. Soils
6. Land use land cover
7. Socio-economic
8. Anthropogenic influences

Map for LULC of 2004 and 2010 had been developed in remote sensing and GIS format

In order to assess the Gaza Strip land cover in 2004 and 2010, satellite images of the SPOT 5 sensor were used. In a first step, SPOT images were orthorectified with the help of the SRTM DEM. In order to correct local un-relevant classifications, a post-classification was carried out by visual interpretation from SPOT 5 and Google Earth images. The methodology employed is presented in Figure 3.

Coordinates of reference points were obtained from Google Earth. Nine classes and Ten classes were identified on images of 2004 and 2010, respectively. The 10 m resolution of 2004 images did not allow to isolate olive orchards. They were subject to much confusion. As a consequence, olive orchards are part of the “Mixed agriculture” class. Several Field monitoring and field validation by CLIMB team in Gaza for the remote sensing data in cooperation with CEMAGREF had been done.

Figure 2: Access data Base System

Figure 3: Methodology used for LULC 2004 on Gaza

Figure 4: Field survey for remote sensing data, validation in December 2010

Figure 5: LULC classification areas of Gaza Strip in 2004 and 2010
Detailed soil map had been developed by laboratory analysis of 200 samples

CLIMB team had developed a solid texture map which had more details compared to the previous map made in 1995. The map was developed in 2012 based on field survey and laboratory analysis for around 200 samples for top soil. Post graduate student of Environmental and Earth Science Department in IUG was involved in soil sampling and analysis. The updated map gave IUG more details on soil of the study site. Other chemical parameters for soil had been analyzed at the IUG laboratory.
Develop Hydrological models as decision support system

**WaSiM Model**

Particular attention given to the way vegetation dynamics are simulated and new approaches were implemented when deemed necessary to properly evaluate vegetation dynamics and interaction with soil moisture dynamics under changing climatic conditions. This task was done in cooperation with our partners, LMU and CRS4. First model results for one RCM, KNMI-RACMO2, driven by ECHAM5 with emission scenario A1B, show decline in actual evapotranspiration for the scenario period compared to the reference period. The model shows exemplarily the water balance, as difference of precipitation and evapotranspiration for the scenario period. Evidently the agriculturally used areas account for negative water balances, due to high evapotranspiration, caused by high irrigation.

![Figure 10: Validation and different model results of WaSiM Model](image)

**CODESA-3D**

CLIMB team (CRS4 IUG and LMU) Developed and Simulated several scenarios for groundwater for 2040. The hydrogeological model of the Gaza Strip is calibrated in steady-state conditions with 1935 water levels, considering average climate conditions and natural conditions (‘no-pumping’ scenario), by coupling simulation (CODESA-3D) and optimization (PEST) modules. The simulated fields of water tables and groundwater salt concentration in 2010 are used as basis to simulate the response of the hydrological basin to future scenarios of climate. In the study are considered a combination of 20 scenarios for each period, resulting from 4 GCM-RCM models and one more ‘artificial’ RCM (CC-0) within the same trend depicted for the historical period (1981-2010), and a combination of different pumping management and SLR setup. The analysis of outputs coming from all the simulations shows that the increasing or decreasing in water levels, and higher and lower values of groundwater heads, corresponding in general to the NetP trends however, different climate scenarios variables, in this case, lead to differences in the groundwater system that can be hardly be appreciated if compared with pumping effects.

![Figure 11: Expected sea water intrusion of different simulated scenarios for groundwater in Gaza Strip](image)
Sustainability of the project

IUG start to finance the new establishment of Geophysical Lab which will support the future sustainability of the project. Based on the Gaza existing situation we are working on:

• **Upgrading Geophysical Laboratory** by purchasing additional equipment. The new instruments that will help IUG in collecting geophysical data for research purposes. Post Graduate students from IUG started new investigation of treated wastewater recharged to the aquifer in North Gaza Strip.

• **New metrological station** was purchased in January 2013. The new station will provide updated information for future modeling research which will help the IUG staff continuing research in the field and sustain the project after 2013. In addition, the collected new metrological data will be available for other local academic and governmental institutions.

Upcoming Activities

• Finalize Climate Scenarios (2041-2070)
  - Precipitation, Evapotranspiration, Groundwater Recharge

• Analysis about Climate Change Impacts on Groundwater
  - Water Levels, Chlorides Concentrations

Contact

For detailed information about the CLIMB Case Study: Gaza Strip, please contact:

**Prof. Dr. Samir Afifi** (case study leader)
safifi@iugaza.edu.ps

For general information about the CLIMB project, please contact:

**Professor Dr. Ralf Ludwig** (project coordinator)
r.ludwig@lmu.de, +49-89-21806677

**Dr. Thomas Ammerl** (project management)
ammerl@bayfor.org, +49-89-9901888120