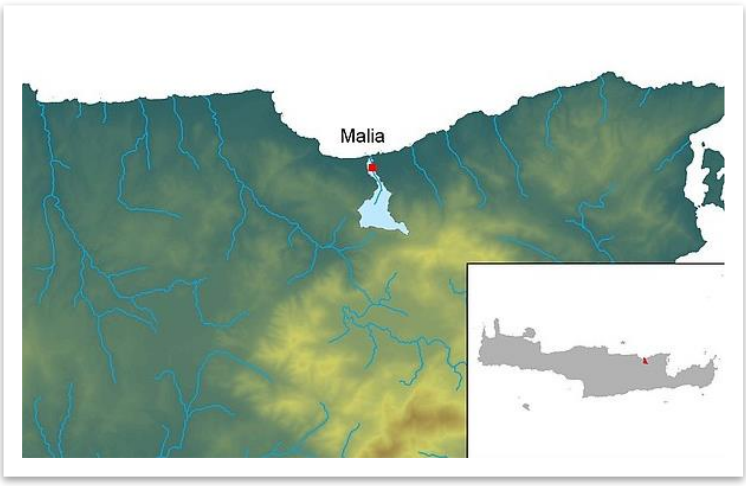
Sustainable coastal groundwater management and pollution reduction through innovative governance in a changing climate

www.sustain-coast.tuc.gr

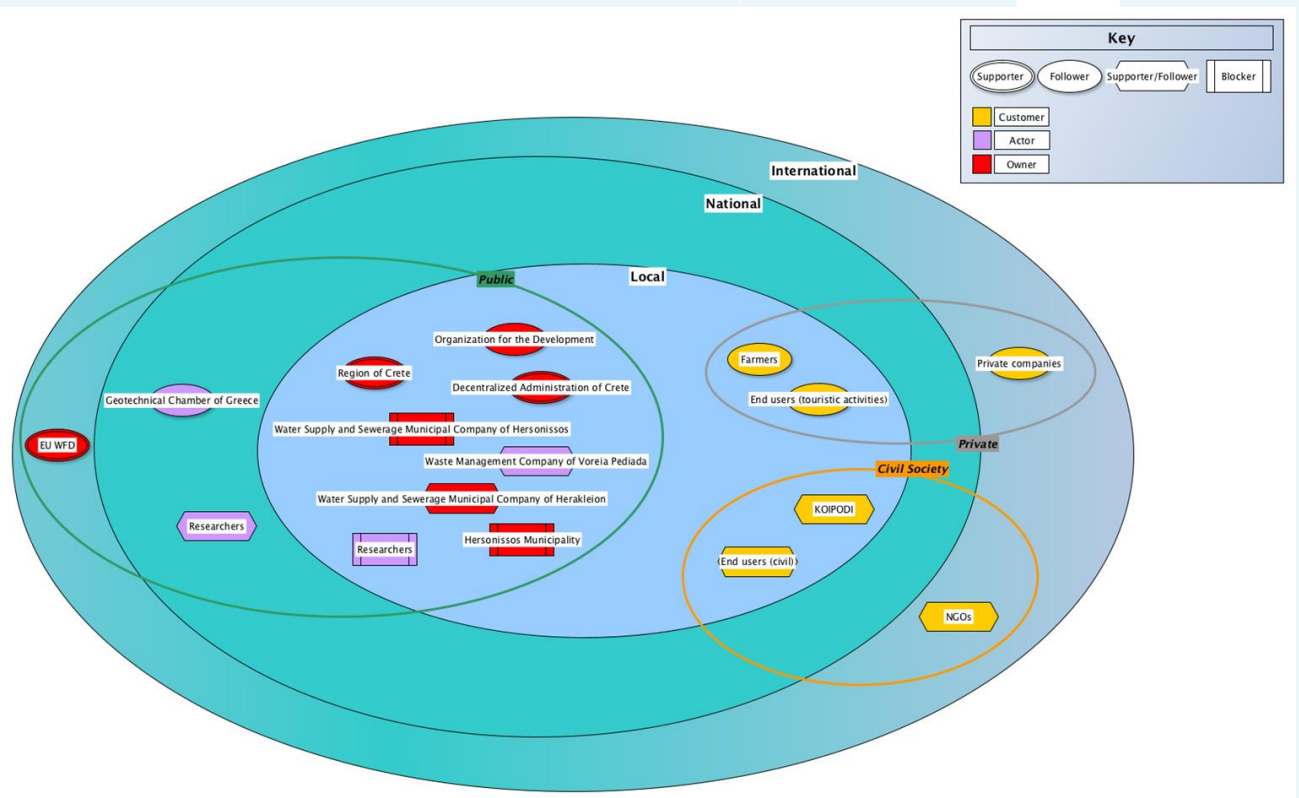
Demonstration site factsheet
Malia, Greece



Description

The catchment of Malia is located in northern Crete, Greece, 40 km east of the city of Heraklion. The study area is characterized by a gentle slope to the north of the town of Malia and by mountains to the south. The elevation varies from 0 to 200 m above mean sea level (amsl) over the coastal lowland and from 200 to 550 m amsl over the area south of the city of Malia and towards the south. The cultivated area of the municipality of Malia is 1.75 km^2. Sclerophyllous vegetation and complex cultivation patterns cover most of the study area. Other land uses include olive groves, natural grassland, non-irrigated arable land and a small area of discontinued urban fabric around the town of Malia.

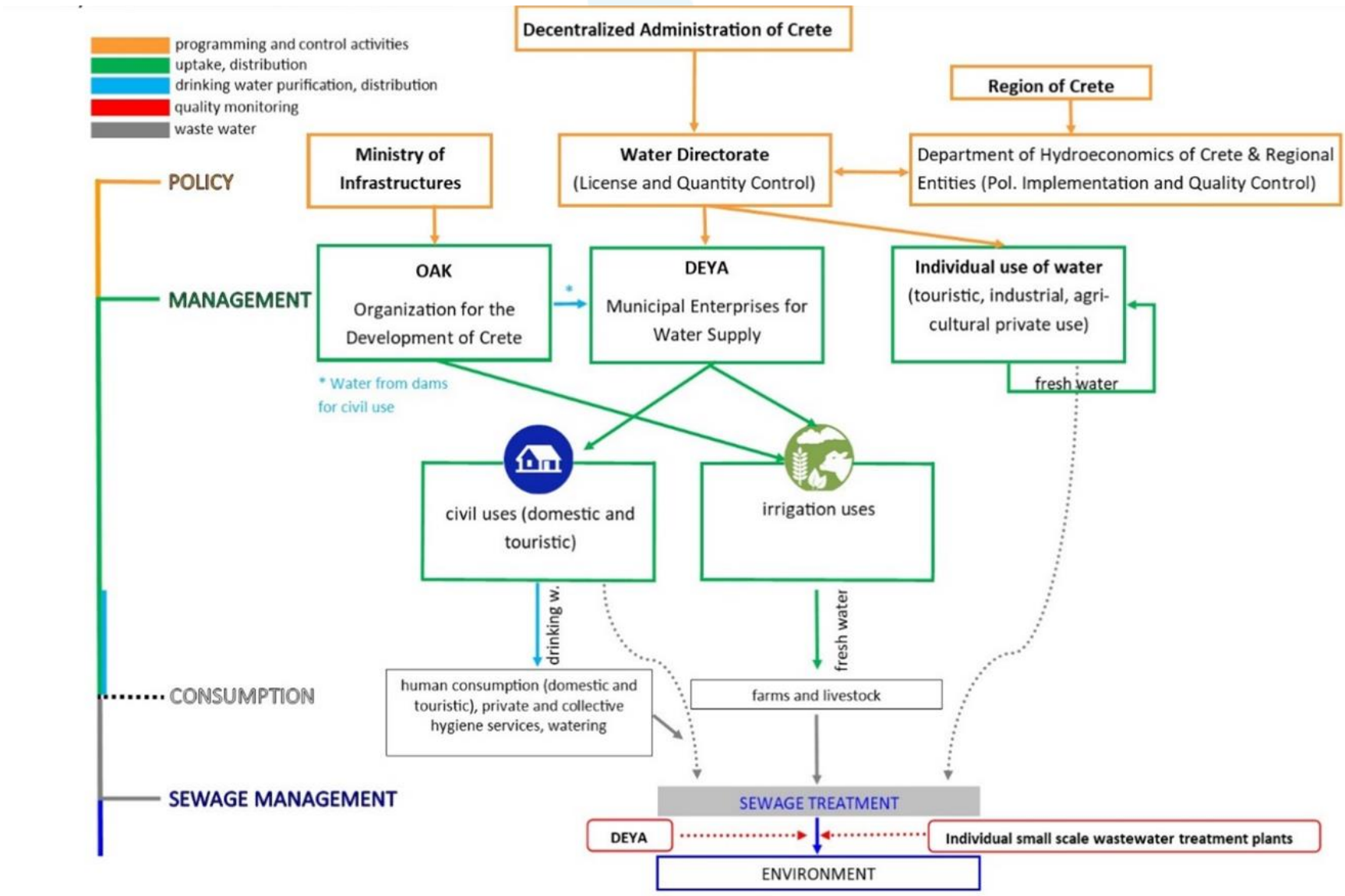
Stakeholder mapping



Sepecific problems

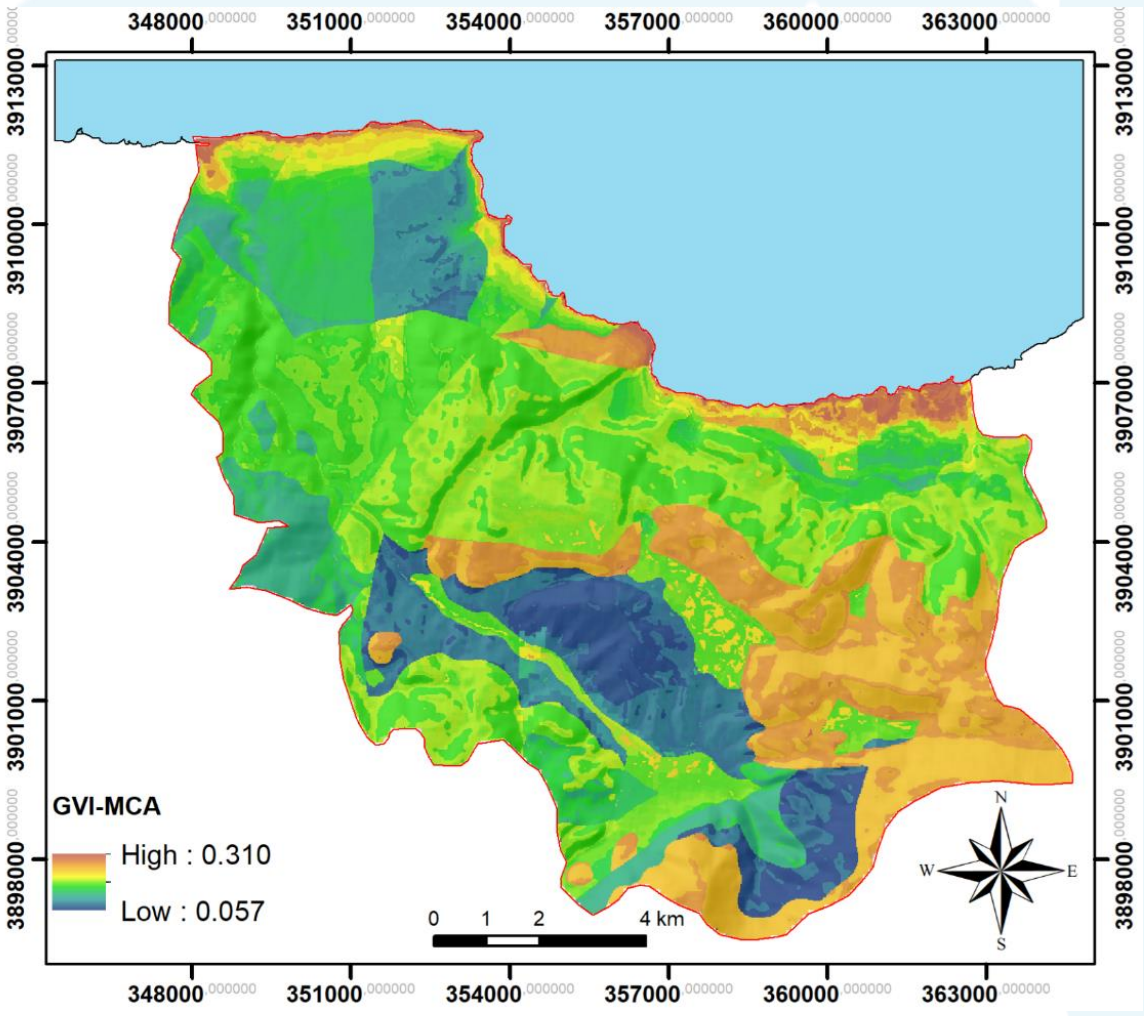
- Surface water and groundwater are used to support the extensive agricultural activity in the area, while the last 20 years the increased touristic development has raised significant water consumption demands. The water resources in the area are very important for its residents as they cover their drinking water needs as well as their welfare depends on the agricultural and touristic activities that consume large amounts of water. **Thus, groundwater level been significantly depleted the last 30 years, resulting in extensive groundwater saltwater intrusion**.
- The groundwater quality in the area has been significantly degradated due to extensive saltwater intrusion. Therefore, high Cl^- concentrations are found in groundwater which in conjunction with over-pumping result to low aquifer levels and groundwater degradation. In addition, increased nitrates concentrations are also found in groundwater due to the extensive use of fertilizert in agricultural.

Water gouvernance system in Malia



SUSTAIN-COAST results

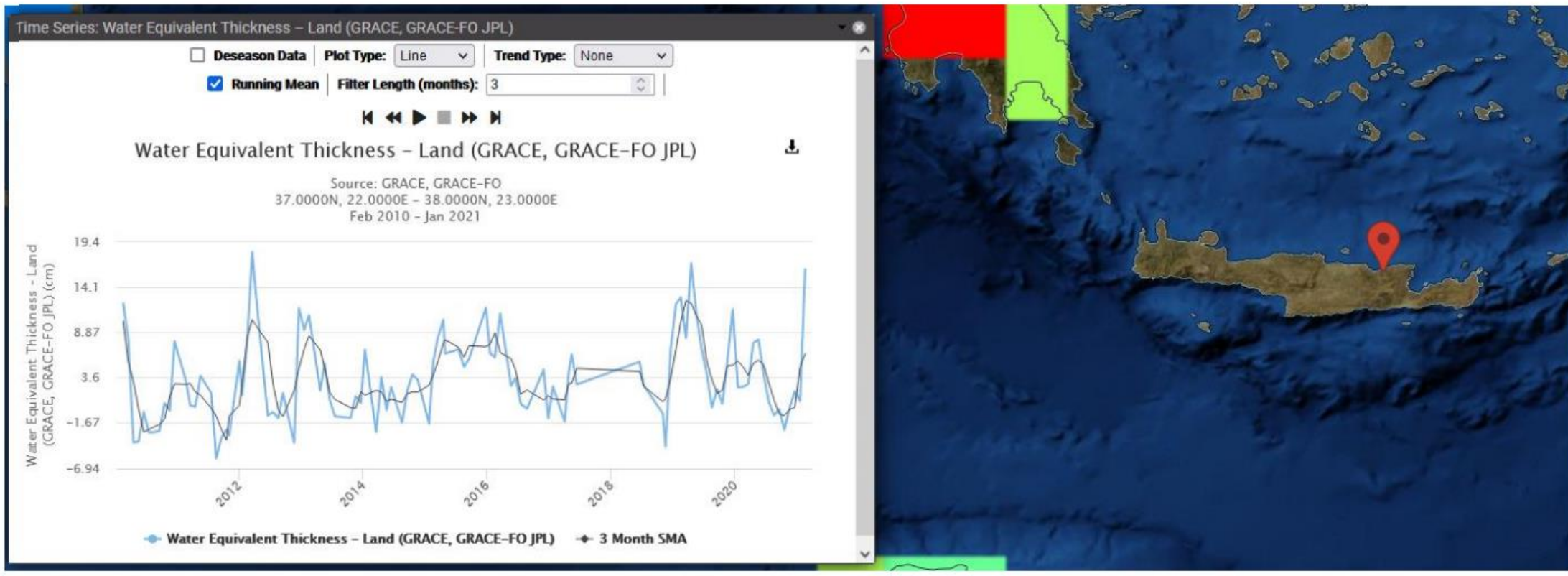
Groundwater Vulnerability Index values*



The Groundwater Vulnerability Index values of the Malia Coastal Aquifer range from 0.057 to 0.310. While a big part of the aquifer has a low GVI value, the coastal part values are pretty high. 23% of the study area has a high vulnerable potential to contamination, and approximately 2% has a very high potential vulnerability. These very high potential vulnerable areas are areas of high concentration of tourist activity and residential houses.

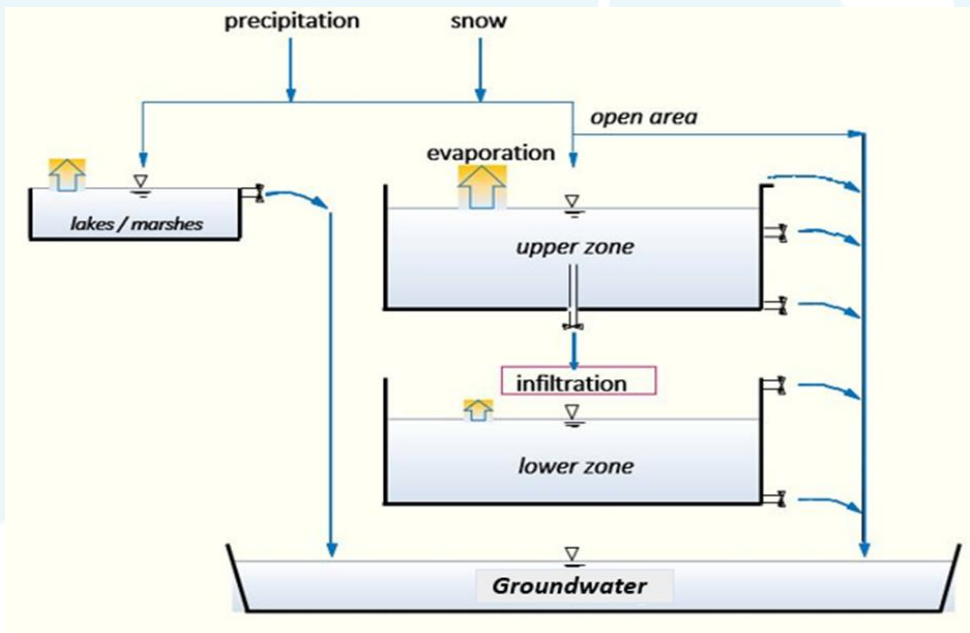
*The groundwater vulnerability index is a method of assessing the vulnerability of aquifers to surface contaminants

Variability of groundwater in terms of water equivalent thickness



The global database from the Gravity Recovery and Climate Experiment (GRACE) mission was used to assess the groundwater level change and implement the cost benefit analysis.

Cost- benefit analysis



Malia - Greece	2021	2031	2041
Groundwater use	30%±3	36%±6	25%±3
Surface water use (reservoir)	55%±3	51%±5	62%±3
Other sources e.g., treated wastewater	15%	13%±9	13%7
Aquifer recharge/% of groundwater use	80% ± 5	77% ±8	76%±11
Financial benefit compared to groundwater use only	28%	24%	33%

Considering the available information and applying the proposed cost-benefit analysis methodology it is obtained that for Malia case study, up to 18 overpumping violations are allowed when groundwater is only used. However, mitigation measures (groundwater and surface water used together) are more affordable compared to intensive groundwater use only. The proposed mitigation measures consist of the balanced use of available water resources (groundwater, reservoir water and treated wastewater) according to the calculated values presented in the table. In addition, the projected water use balance for the next decades is presented.

Climate change analysis

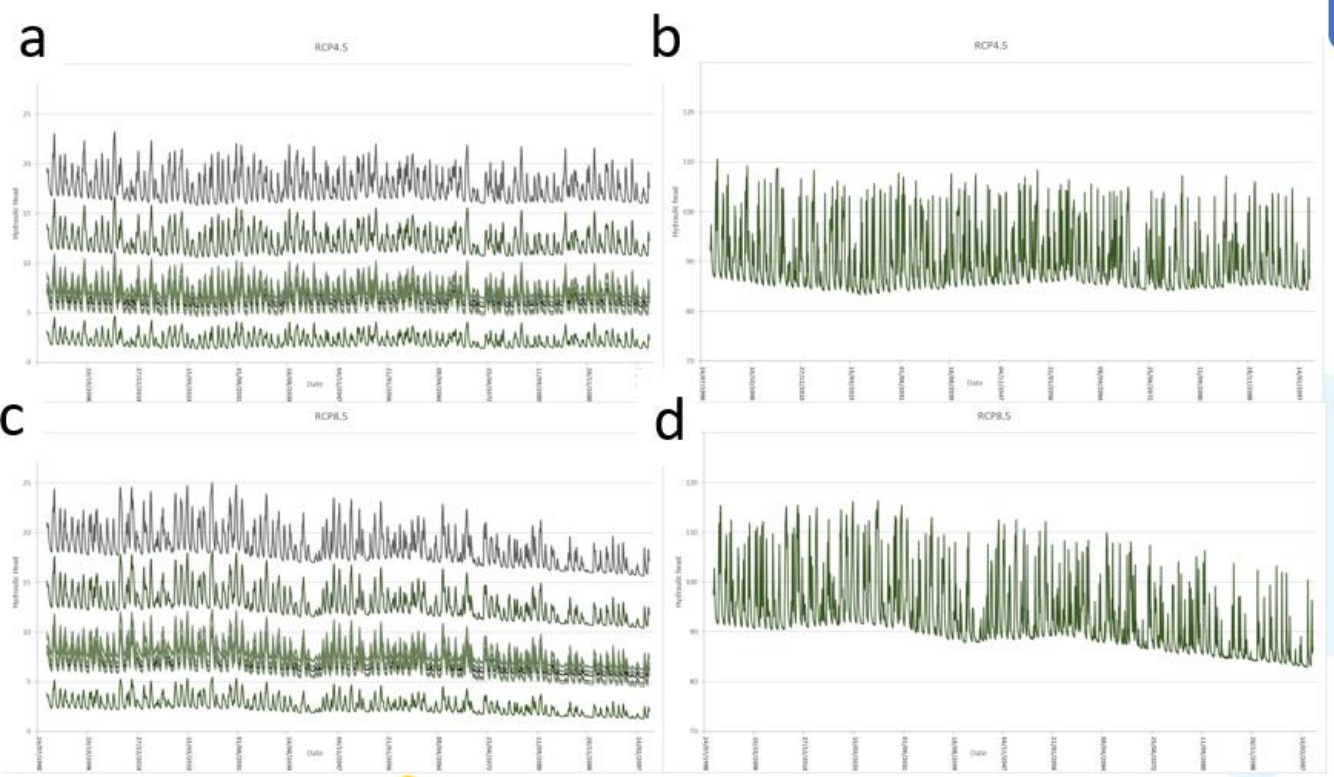
The climate scenarios are a combination of Regional Climate Models (RCMs) and General Circulation Models (GCMs) – 17 scenarios produced

They were based on the Representative Concentration Pathways (RCPs) 4.5 and 8.5

Data from 1976 – 2005 consist of historical simulation which is the control period

2006-2098 is the scenario period

Climate Scenarios Results – Hydraulic Head



RCP4.5

- Graphs a, b
- Low hydraulic head
- Small fluctuations in hydraulic head

RCP8.5

- Graphs c, d
- Hydraulic head decreases during the entire time period
- Until 2045 higher values for hydraulic head in comparison with RCP4.5

An increase of the pumping rate due to climate change would be severe for the Malia aquifer

The north-west part of the study area appears to have a greater problem of salt water intrusion

Climate scenarios results for both RCP4.5 and 8.5 show a depletion in hydraulic head in the future

RCP8.5 shows greater decrease in hydraulic head especially after the year 2050