University of Bologna

Integrated Geoscience Research Group

Current and future water budget of a Mediterranean coastal watershed: Quinto Basin, Ravenna, Italy.

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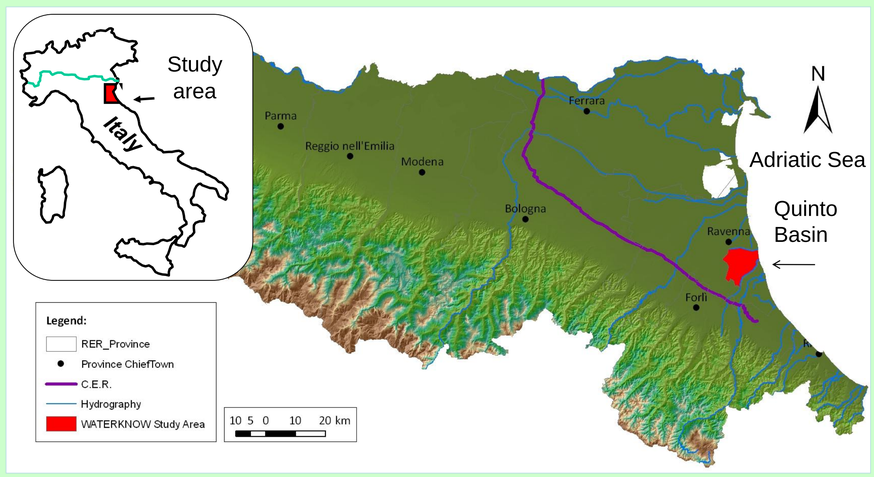
The contribution of (natural) vegetation to the hydrologic budget of Mediterranean watersheds is important, because of high evapotranspiration rates, especially in summer. The seasonal water budget of the *Quinto* Basin, a coastal watershed along the Adriatic sea in Italy, is calculated based on land use under current and future climate conditions. Estimates of the future hydrologic surplus or deficit helps to understand whether salt-water intrusion will be even a larger problem in the future than it is today, threatening both agriculture and natural ecosystems. The evaporation of open water and the evapotranspiration of wetlands, pine forests, bare soil, and irrigated agriculture are calculated with the Penman-Monteith equation (Cropwat, FAO). The current hydrologic deficit or surplus is based on average climate data from 1989 to 2008, drainage and irrigation data. Predictions for future evapotranspiration, net irrigation and hydrologic deficit are calculated with climate data from IPCC (2007), scenarios A1b and A2. From the study results that soil type may determine whether or not a crop will need more or less irrigation in the future. Water budget analysis under scenarios A1b and A2 both show an increase of water deficits in summer and an increase of water surplus in winter. This is explained by the fact that a larger percentage of the annual precipitation will fall in winter. The open water evaporation will decrease under future climate scenarios as a result of increased relative humidity in winter and decreased wind velocity. This may have a positive effect on the water cycle. The current irrigation is abundant but has beneficial effects in contrasting soil salinization and salt-water intrusion in the coastal aquifer as confirmed by groundwater monitoring and chemical data analysis. It is difficult to quantify the water use of natural areas. As an alternative to using the Penman Monteith equation for calculating the water use of the coastal pine forests, we used published sap flow measurements to get an estimate of pine tree water use. A pine tree takes up between 27 l/day and 47 l/day if water is readily available and between 10 l/day and 30 l/day if there is a limited water supply or the groundwater has a high salinity. Especially in summer, these values may exceed average daily rainfall in the area. Therefore pine tree transpiration contributes to the hydrologic deficit and salinization of the coastal aquifer.

STUDY AREA



The Quinto basin is a small coastal watershed characterized by low topography and ongoing subsidence which requires continuous mechanical drainage. The groundwater, except for some small lenses, is generally very saline. The land is used mostly for agriculture. There are two pine forests and many quarry lakes.

Abandoned and active quary lakes.

Drainage.

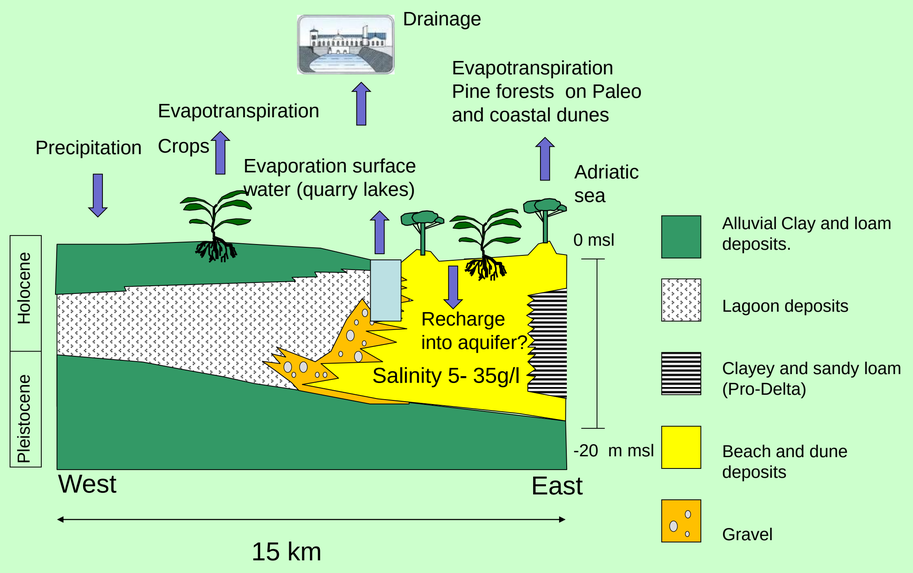
(Irrigated) agriculture.

Dry summers, salt water intrusion, soil salinization

Pine tree forest

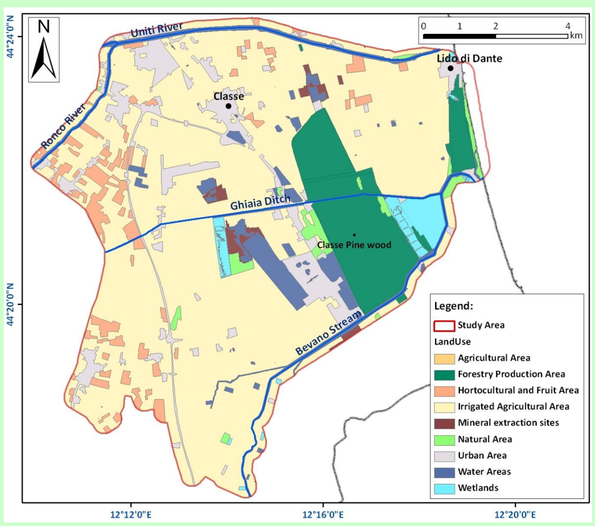
Bevano river and Adriatic sea

Research Question: Wat is fresh water budget now and in future? Is there any surplus fresh water that can infiltrate into the unconfined aquifer to counteract salt water intrusion?

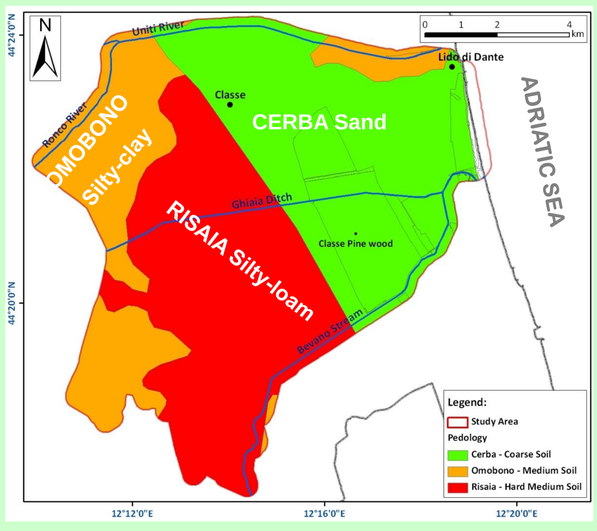


METHOD: WATERBUDGET CALCULATIONS WITH CROPWAT (FAO) AND PENMAN MONTEITH

Land use



Soil

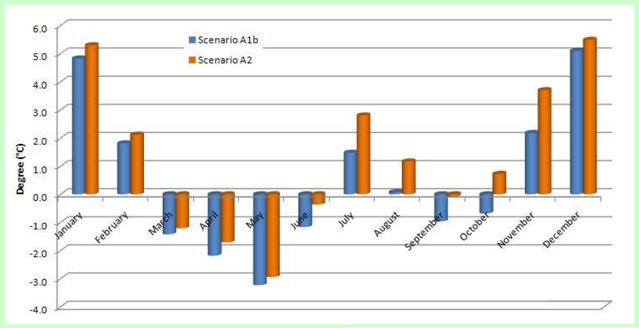


PRESENT CLIMATE: Average of monthly data from 1987 to 2008

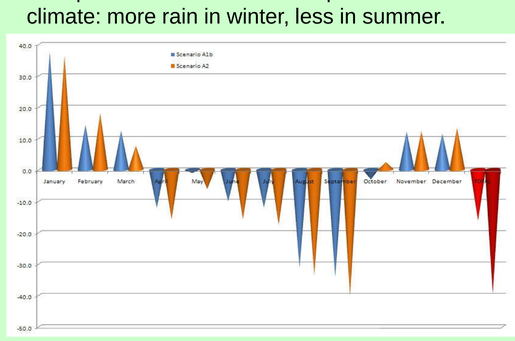
FUTURE SCENARIOS: IPCC (2007) A1b & A2

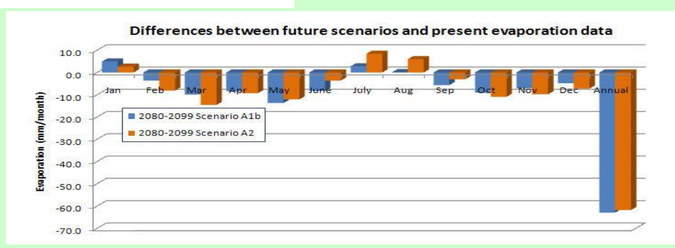
The climate data in vector format have been extracted from NetCDF files for the selected grid point for the period 2080-2099.

Maximum Temperature difference with respect to current climate

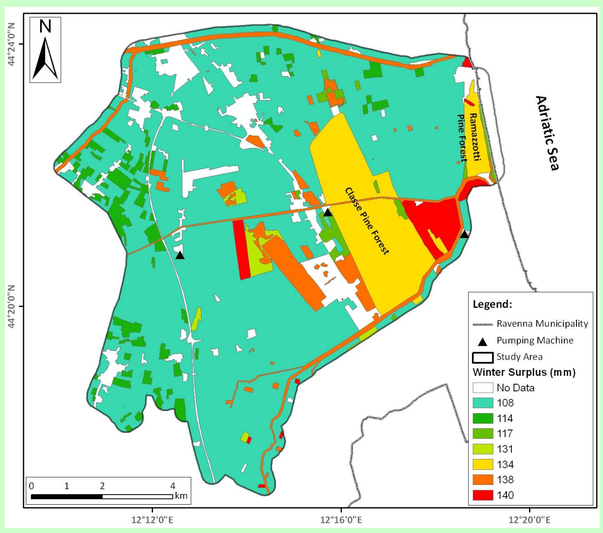


Precipitation difference with respect to current climate: more rain in winter, less in summer.

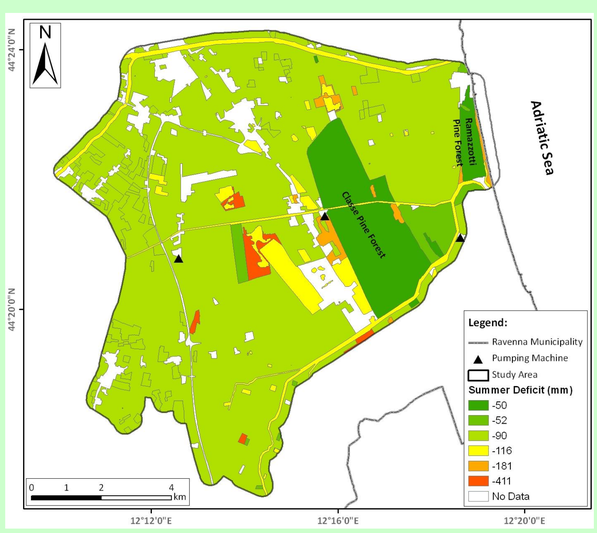




Difference in Winter Surplus between A2 scenario and Present.

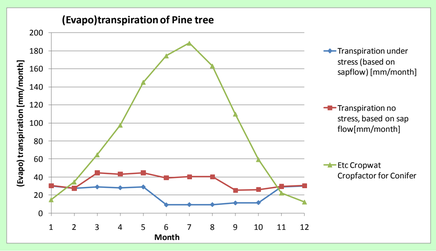


Difference in Summer Surplus between A2 scenario and Present.



The hydrologic deficit or surplus is defined as precipitation minus evapo(trans)piration. Evaporation is calculated with Penman Monteith (1948), Evapotranspiration with Cropwat (Smith, 1992) using different cropfactors for maize, wheet, reed, bare soil and Conifer (as a proxy for pine tree). Using future climate scenarios in these calculations gives an estimate of the future hydrologic deficit or surplus.

Food for thought: What is the (evapo) transpiration of natural vegetation now and in the future?



CONCLUSIONS

1 Including drainage and irrigation data in the water budget calculations show that there is currently a surplus of 455 mm in summer and of 57 mm in winter. Assuming that this is the water that ends up recharging the aquifer, the average daily recharge in summer is 2,5 mm/day and in winter 0.3 mm/day.

2. Climate data for our region extracted from GCM's indicate a strong increase in minimum temperature and a more distinct separation in a wet and dry season; a larger percentage of the rain will fall in winter.

3. Wind and air humidity have a large influence on open surface water evaporation but these parameters are hardly ever discussed

4. Soil type is a very important parameter to consider in view of climate change for agriculture, determining to a large extend how much water is needed for irrigation. It is, therefore, very important in to include considerations on which crop type can be grown on a specific soil type in regulations for water management in view of climate change.

5. Water budget analysis under future climate scenarios A1b and A2 both show an increase of water deficit in the summer and an increase of water surplus in the winter. This is explained by a relatively larger portion of winter rainfall.

6. Current excess irrigation exerts a heavy toll on the water budget but has beneficial effects in contrasting soil salinization and saltwater intrusion in the coastal phreatic aquifer. Costs and benefits of this practice need to be evaluated and maybe integrated in a more extensive practice of managed aquifer recharge (MAR) and water saving.

Acknowledgements

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