Groundwater recharge assessment of Takelsa multilayer aquifer (Northeastern Tunisia)

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Plan

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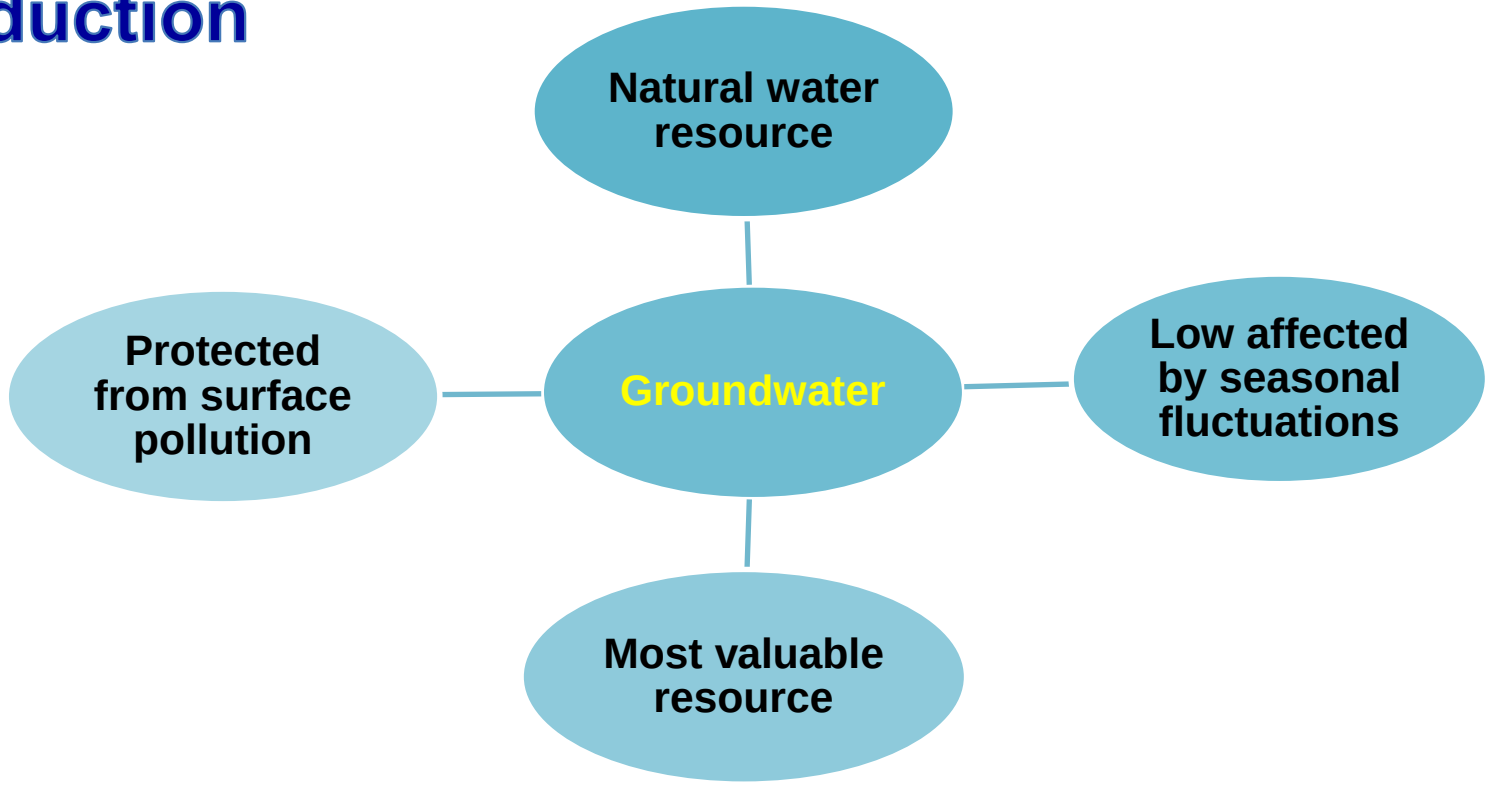
Introduction



Groundwater —— **Depends** —— **Recharge**

To protect and evaluate the renewable groundwater resources

↓ ↑

Evaluate the groundwater recharge

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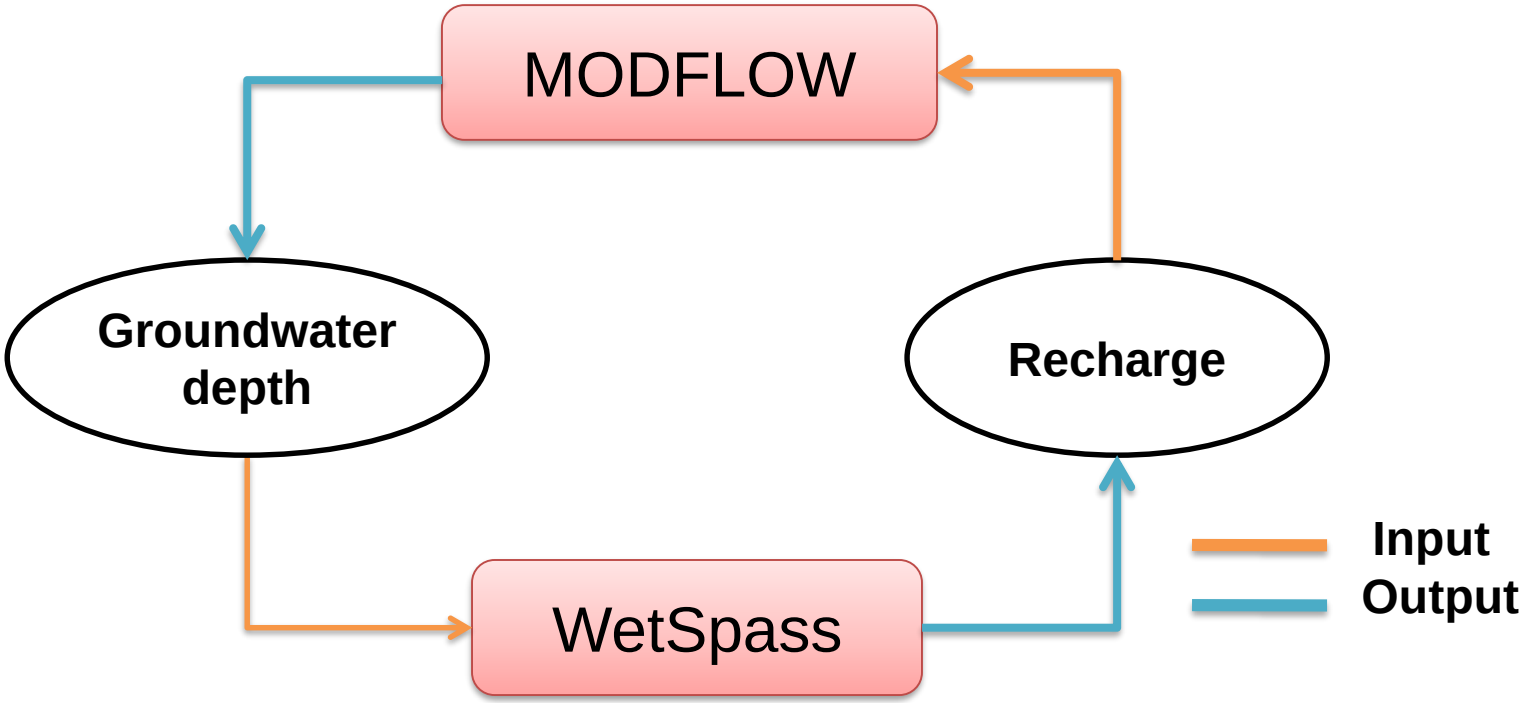
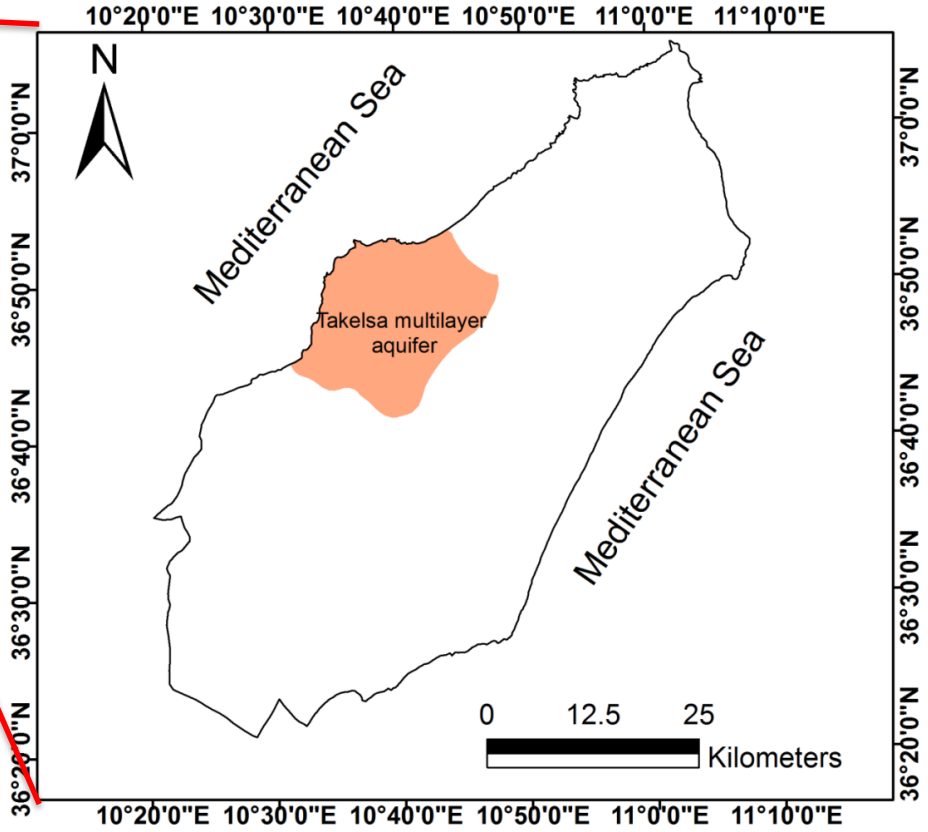


MODFLOW was used for the groundwater flow modeling. It resolves the flow equation by using the finite difference method in the steady and the transient states for multilayer aquifers.

WetSpass: It's an hydrological model that allows to the user the calculation of surface runoff, evapotranspiration and groundwater recharge. It's an acronym to :**W**ater and **E**nergy **T**ransfer between **S**oil, **P**lants and **A**tmosphere under quasi-**S**teady **S**tate.

The study area

The Northeast part of Tunisia (Cap Bon) is one of the regions that contain important aquifers with groundwater resources used mainly for agricultural needs. With the increase in water demand caused by the economic development of the region it becomes necessary to protect and evaluate the evaluable resources.



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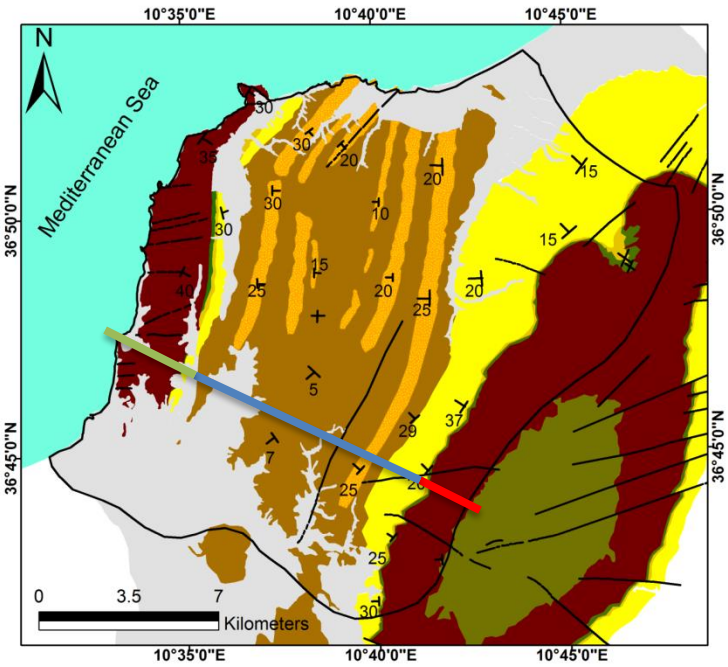
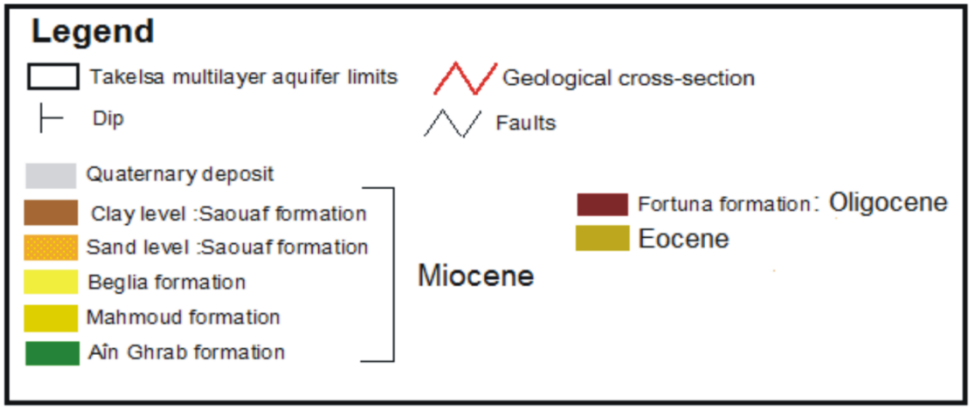
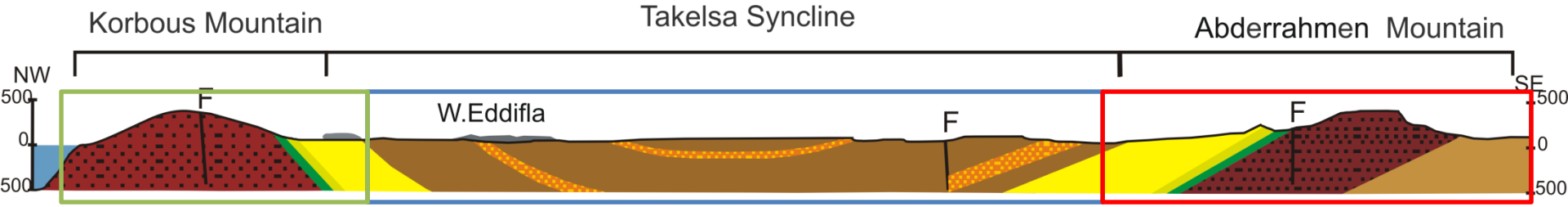




Geological cross-sections through the Takelsa multilayer aquifer



The Takelsa multilayer aquifer is mainly constituted by sandstone and clay series, dated from Oligocene to Quaternary ages. And the sandstone levels are exploited as aquifers. This aquifer is recharged by precipitation through the infiltration process in the permeable outcrops of sandstone.

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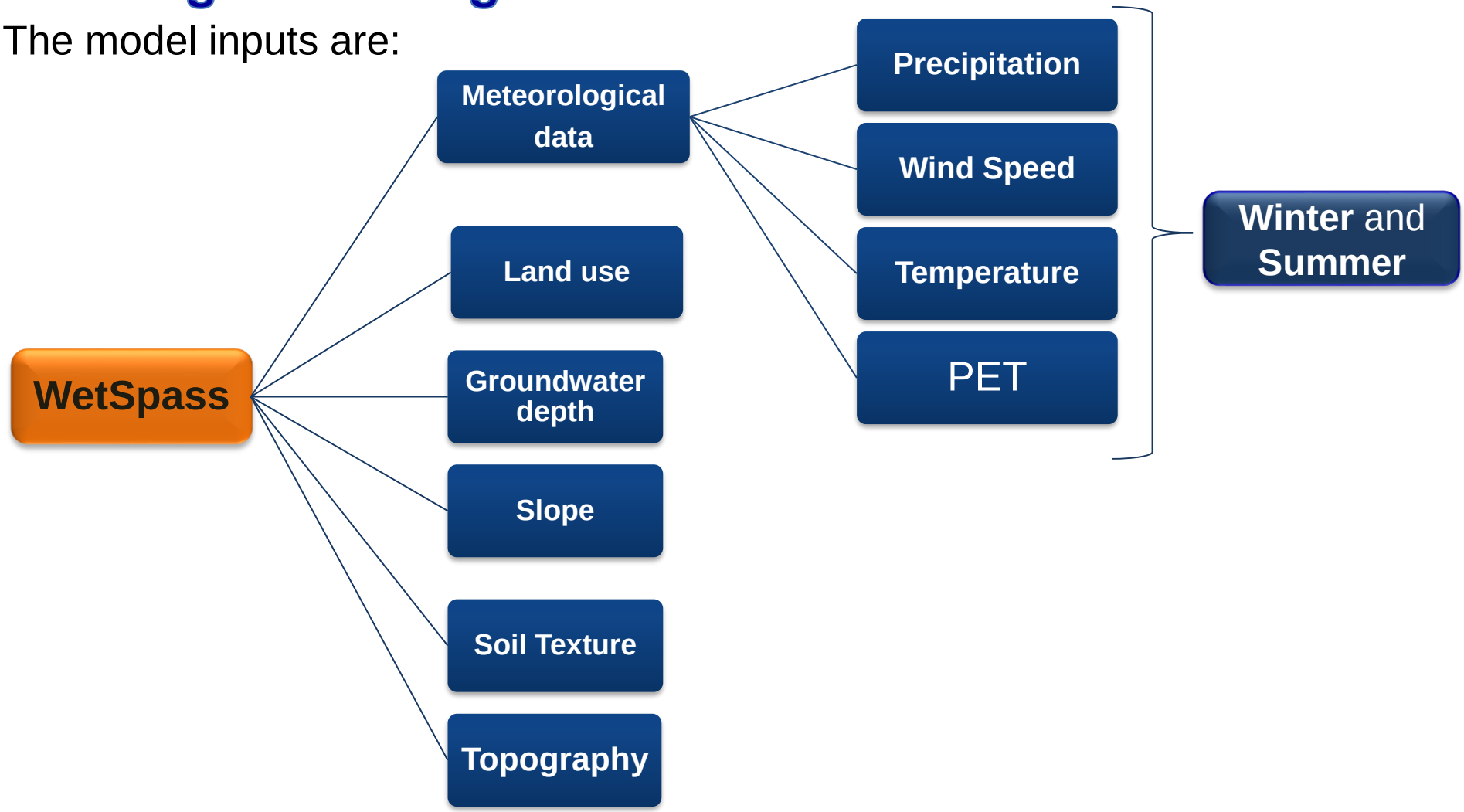
Recharge modeling

The model inputs are:



The groundwater recharge is calculated by considering the results of the water balance:

$$R\ (mm) = P - S - ET - I$$

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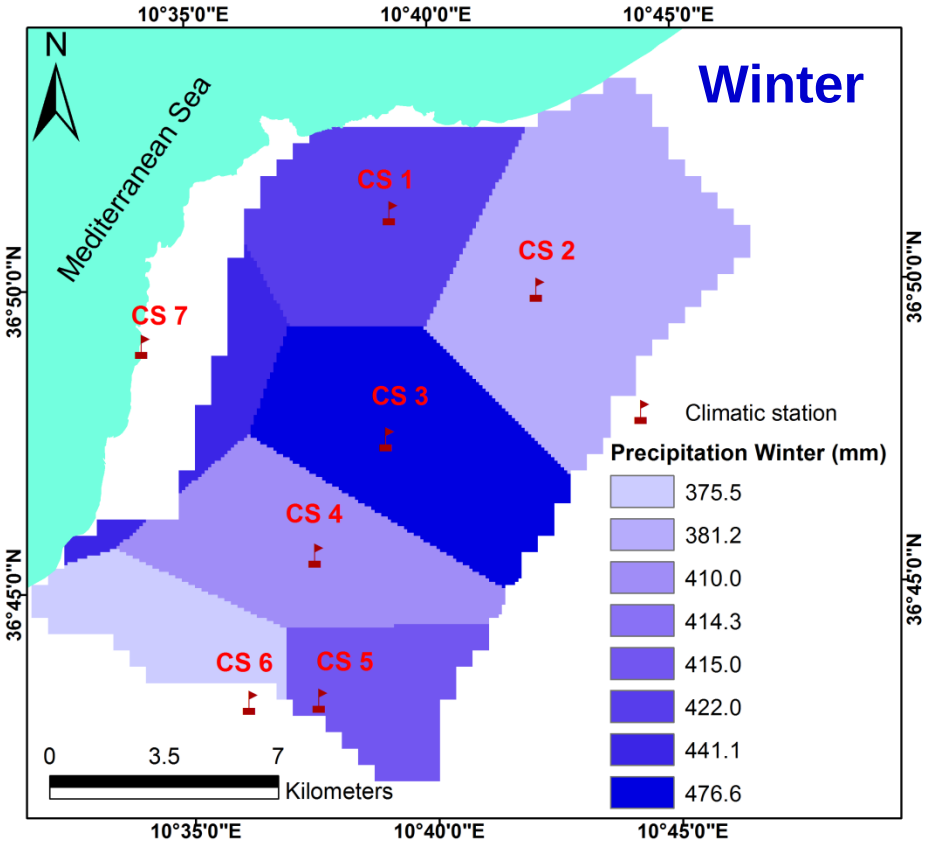
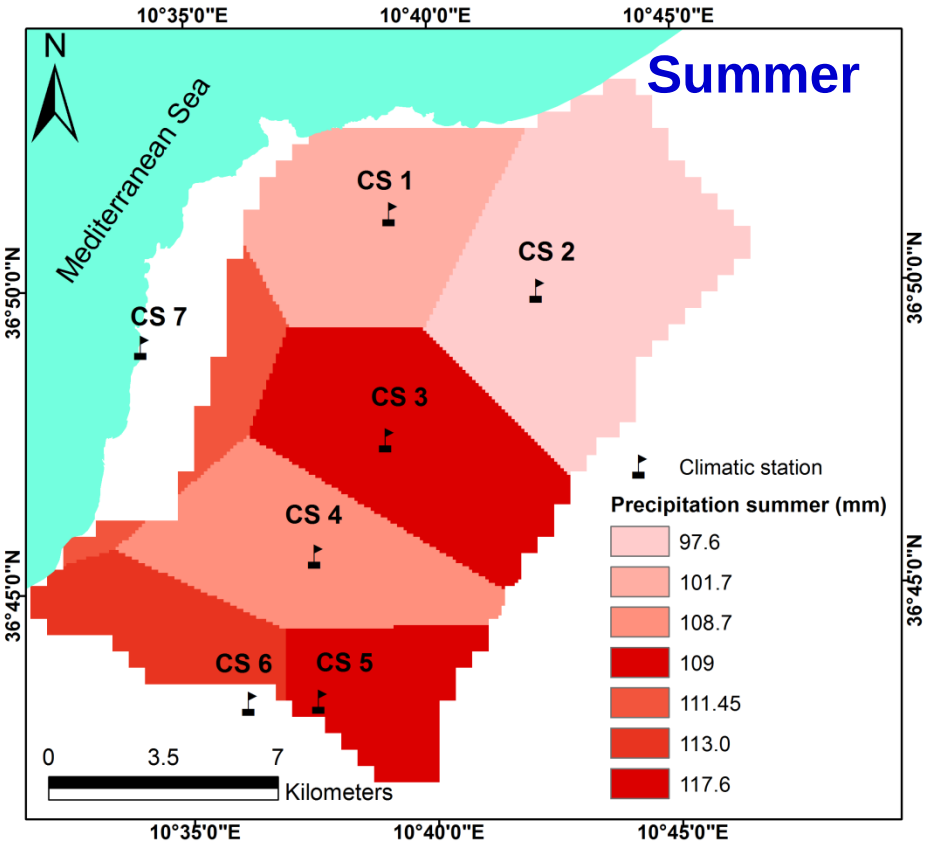
Precipitation





The precipitation values range from 375.5 to 476.6 mm for the winter and from 97.6 to 117.6 mm for the summer. High values are located mainly in the central area of the Takelsa syncline.

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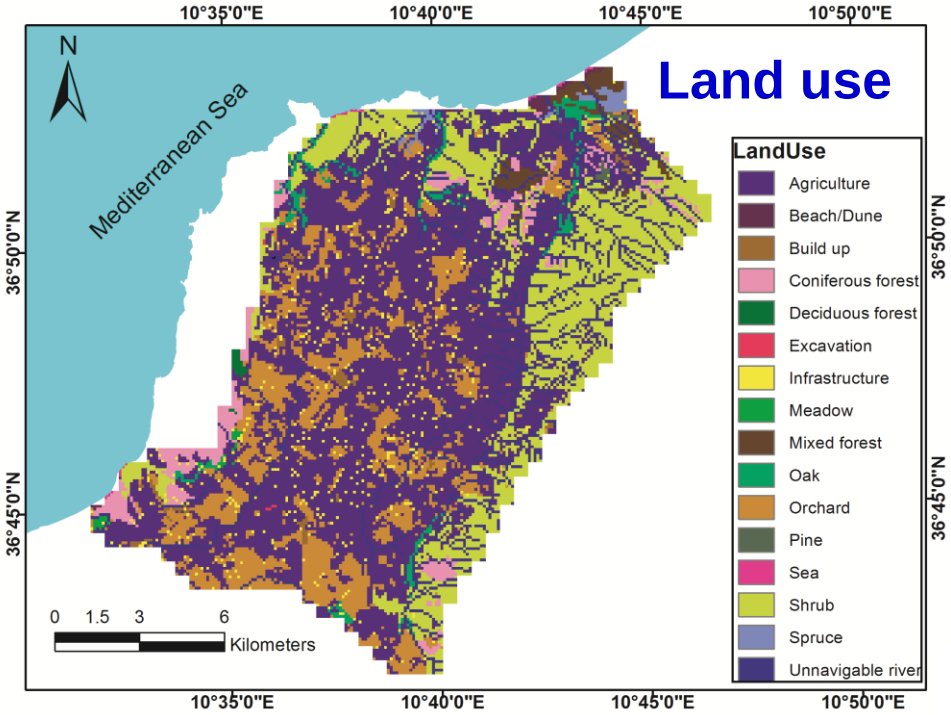
Climatic data

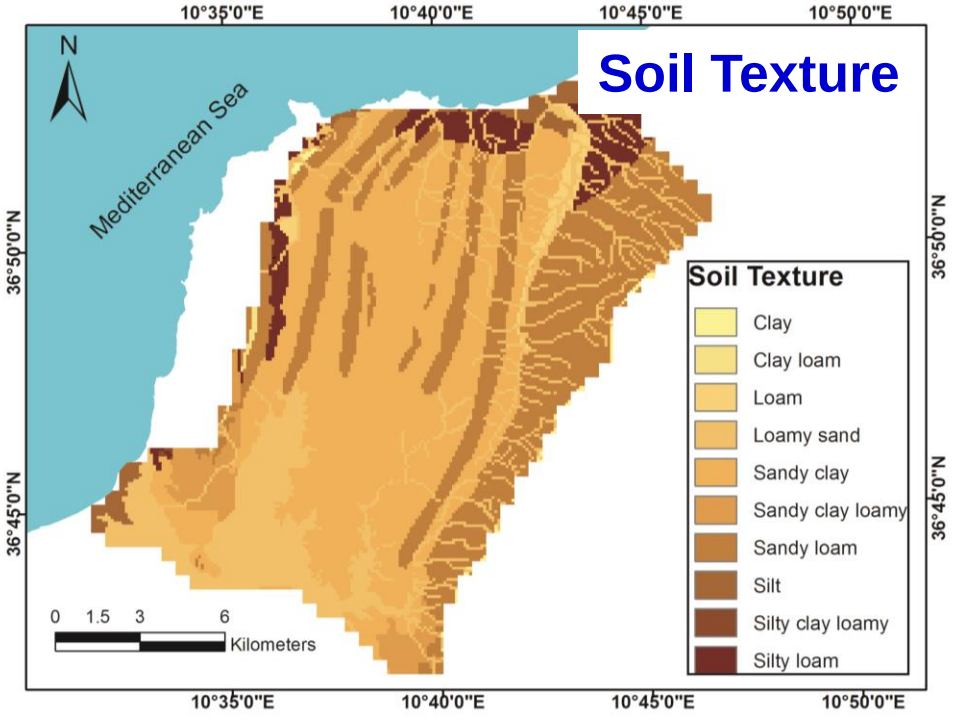
The potential evapotranspiration, the temperature and the wind speed were calculated using monthly measured values during the period 1980-1984.

	Winter	Summer
PET (mm)	315	566
Temperature (°C)	16	19.6
Wind Speed (m/s)	3.73	3.70



The land use map is dominated by agricultural land, orchards, shrub, forest and build up area. The agricultural land and the orchards, distributed through all the syncline, are the main land use of the area.

There is a gradual change in the soil texture and 10 classes are recognized with the dominance of sandy clay, sandy loam and loamy sand.



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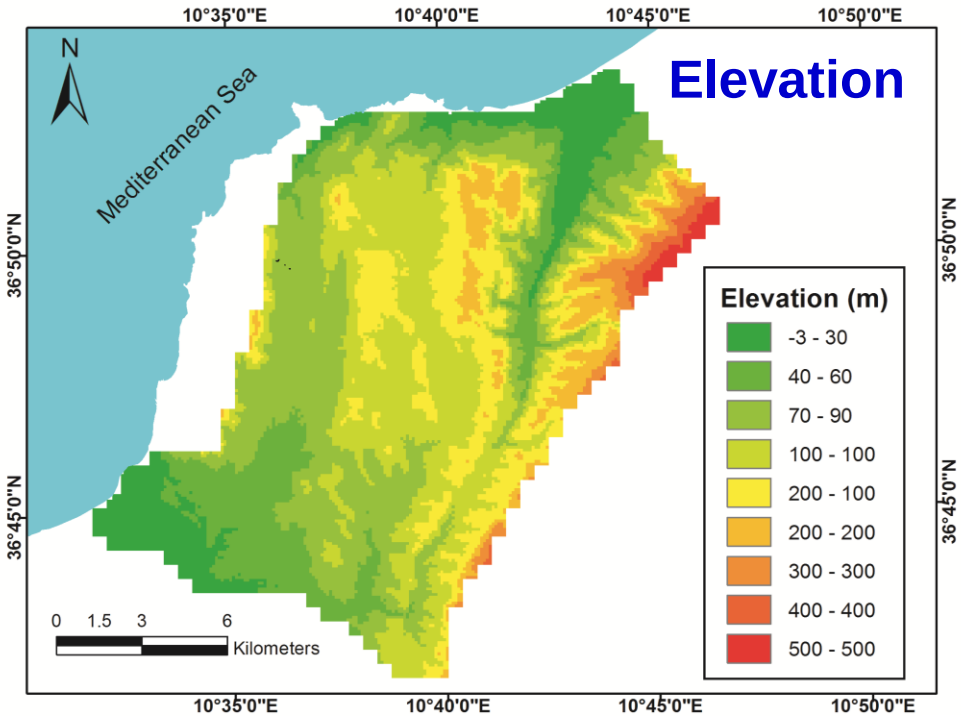
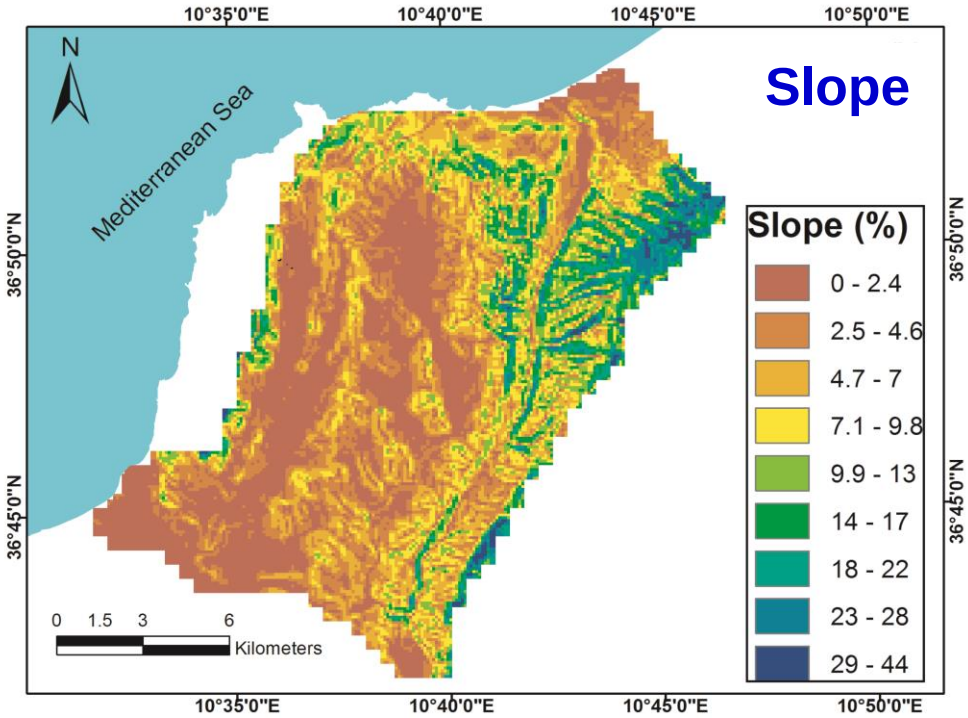


The Digital Elevation Model (DEM) was obtained from the Shuttle Radar Topography Mission (SRTM) dataset of the National Aeronautics and Space Administration (NASA).

The slope map is directly derived from the DEM using the slope calculation option in Spatial Analyst Tools in ArcGis 10. The slope ranges from 0 to 44 % with a mean value of 6 %.



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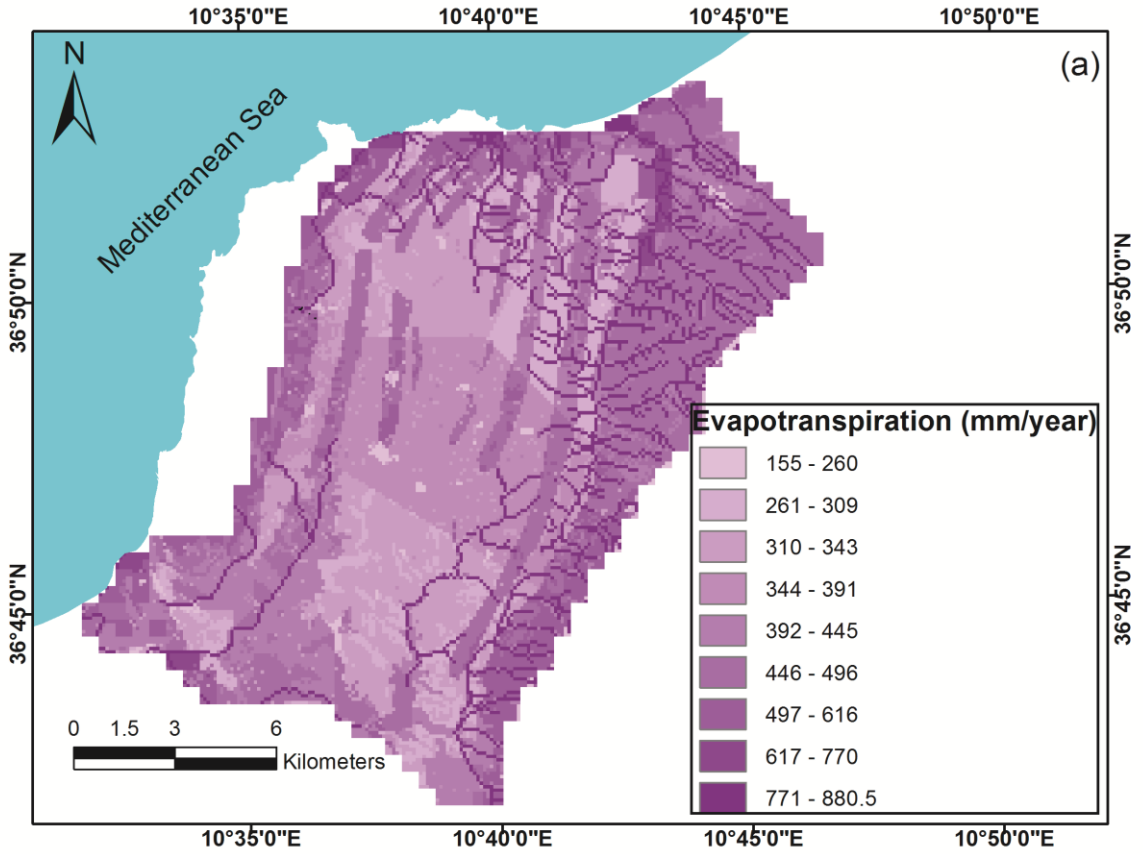
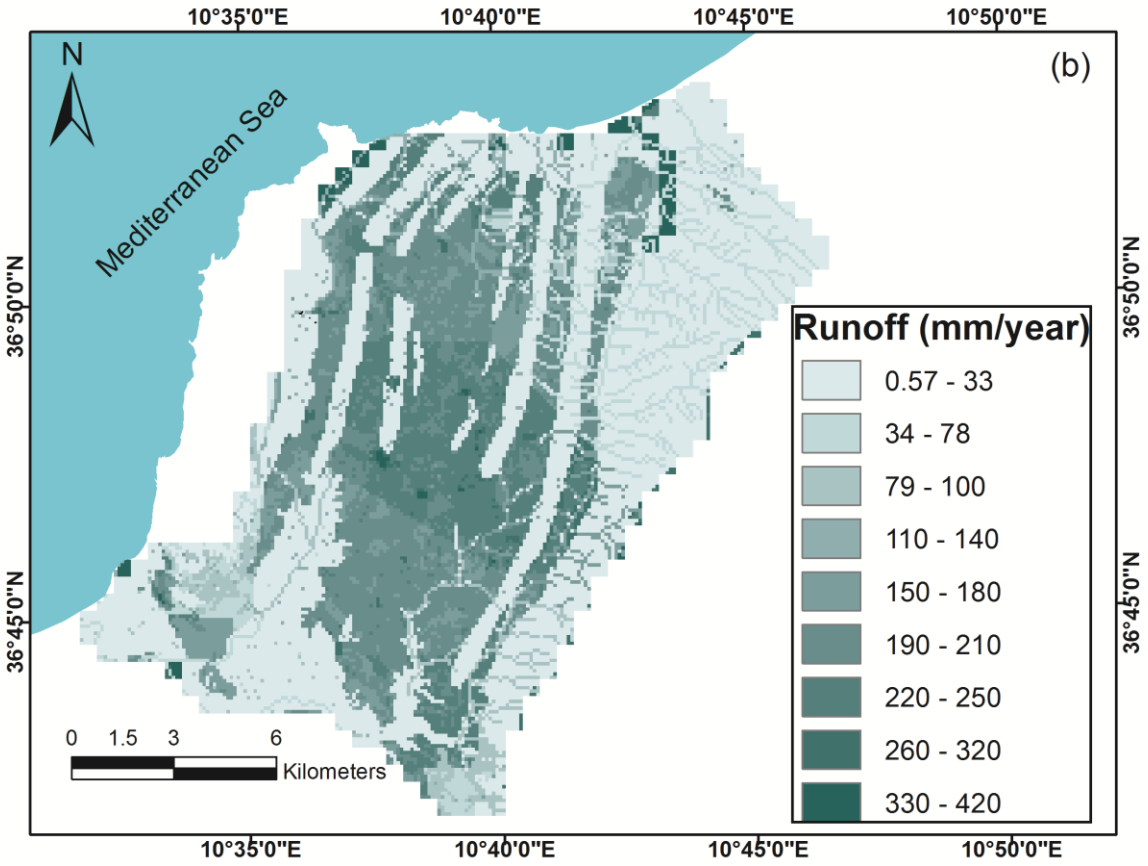
WetSpass Results

Simulated evapotranspiration map



The evapotranspiration values obtained ranged from 155 to 880.5 mm/year with a mean value of 461 mm/year. High values are observed especially in water courses and forests areas characterized by sandy loam and loamy sand soil.

Simulated Runoff map



The surface runoff varied between 0.6 and 418.3 mm/year with an average value of 92 mm/year. The runoff is less accentuated in the Mountain areas. It is due to the high slope values and the presence of the shrub and the orchard associated with sandy loam and loamy sand soils. The omnipresence of agricultural land in the synclinal and the sandy clay levels with low slope reproduce high surface runoff.

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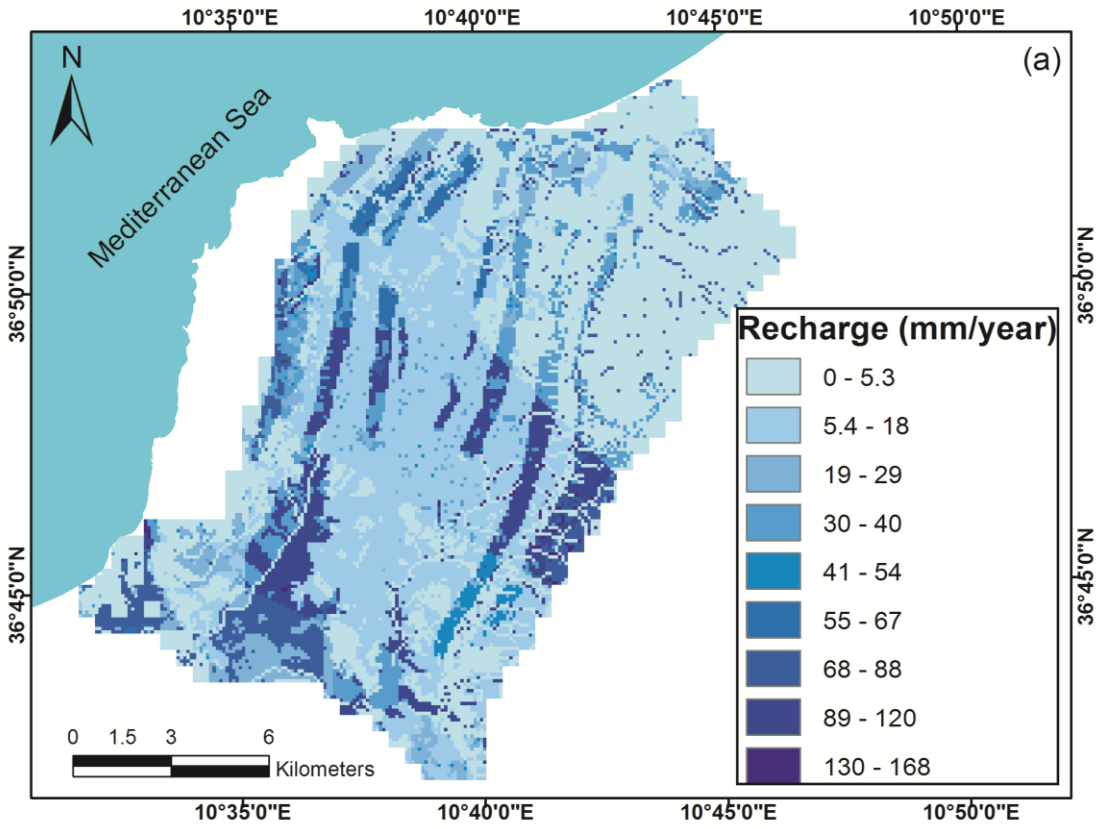
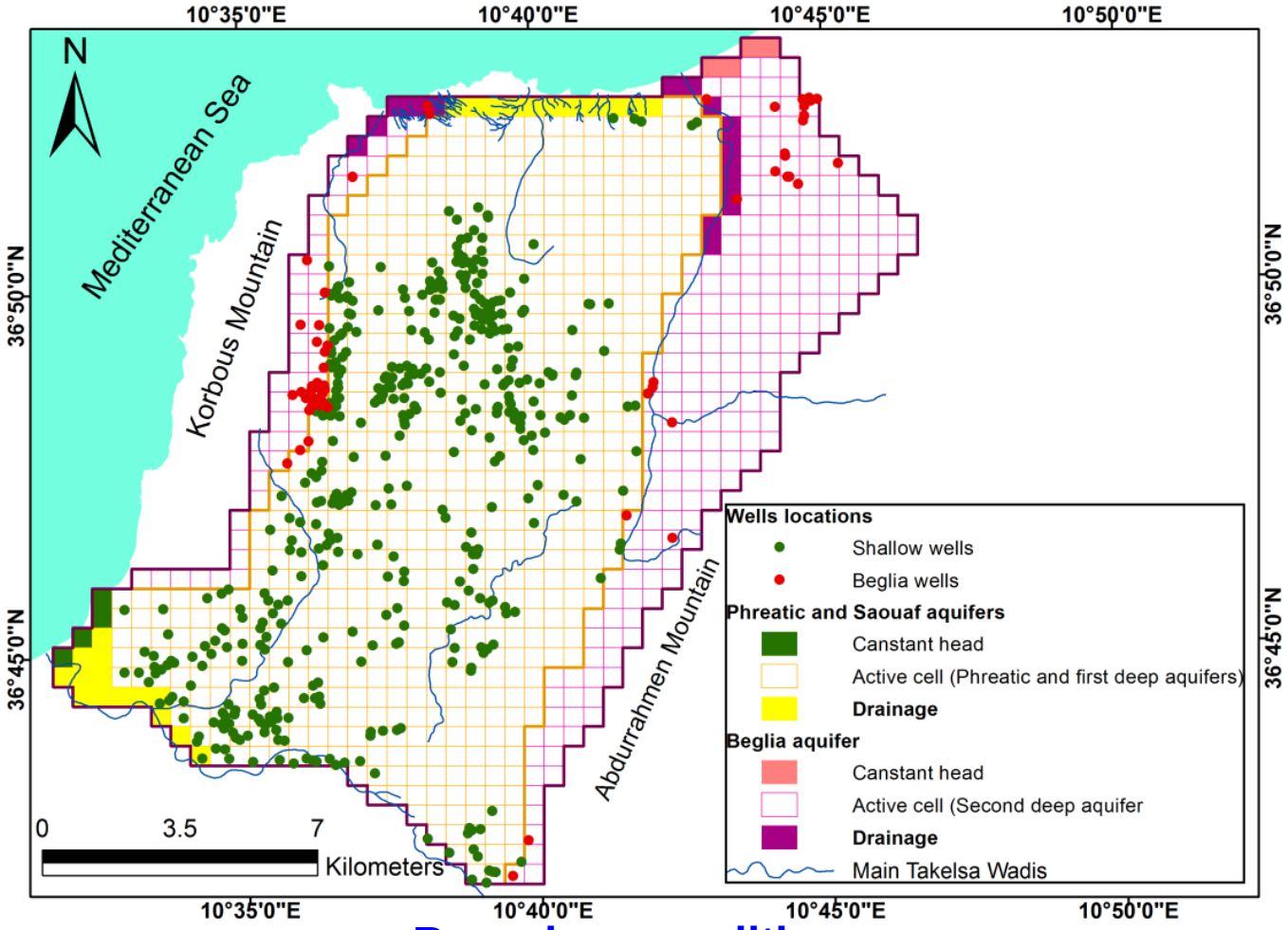
Simulated Recharge map



The groundwater recharge rate ranged from 0 to 168 mm/year with a mean value of 22 mm/year. The high values were observed in areas characterized by sandy loam and loamy sand soils, low slope and with intense vegetation cover.

In the forest and shrub areas lower groundwater recharge rates were obtained with all soil types.

Groundwater flow modeling (Modflow)



Boundary conditions

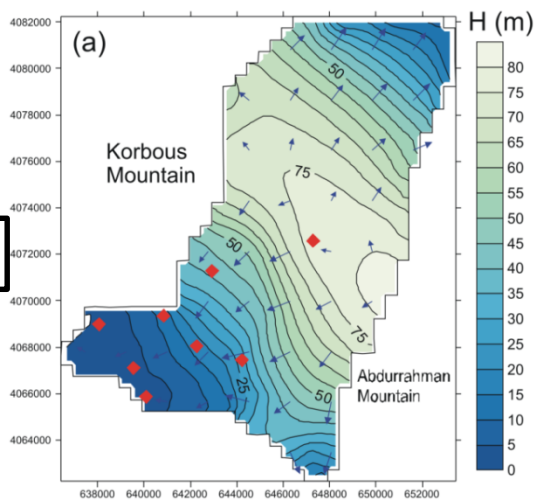
-In the North and the Southwest, the Mediterranean Sea is represented by a constant head equal to 0 m.

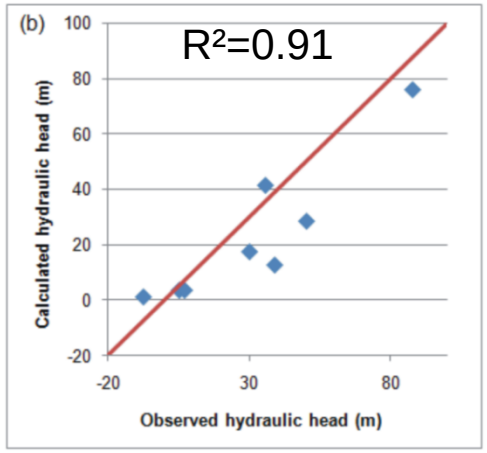
-The drainage by wadis was represented by a drain condition.

- A Neumann boundary condition is applied to represent the groundwater recharge and the pumping by wells.

Modflow results: Simulated hydraulic head maps

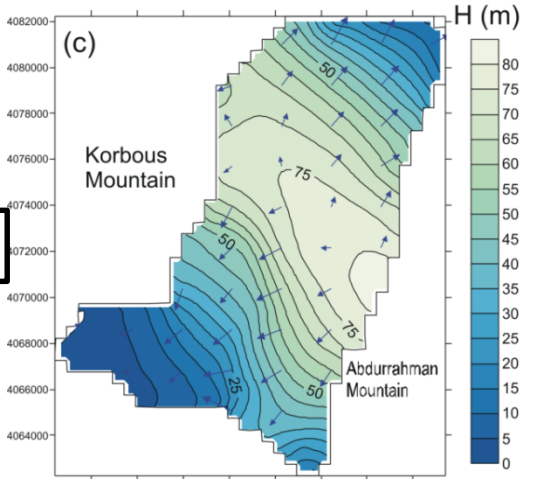
phreatic aquifer

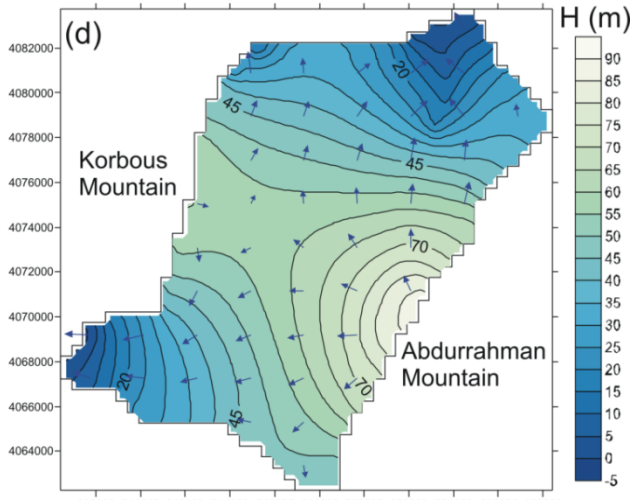




Scatter plot of observed and calculated hydraulic head of the phreatic aquifer .

Saouaf aquifer



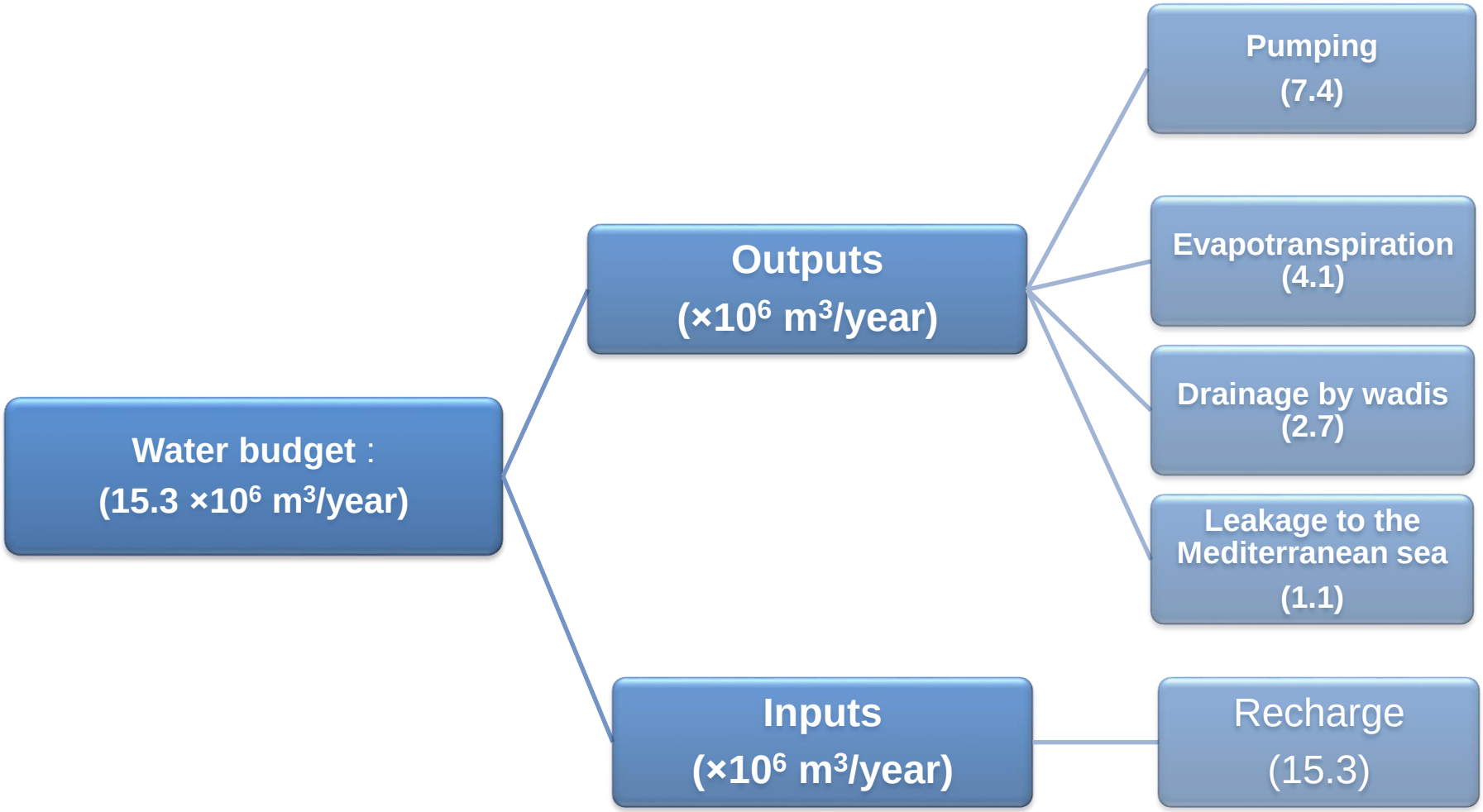


Beglia aquifer

For the phreatic aquifer, the calculated hydraulic heads in steady state fit well to the observed ones .

The main flow direction comes from the East and from the West draining Abdurrahman and Korbous Mountains and the discharge area is mainly in the Mediterranean Sea in the North and the South-West.

Total water budget



Conclusions and recommendations

The coupling of WetSpass and Modflow models allowed the calculation of :

- ❖The evapotranspiration, surface runoff and groundwater recharge
- ❖The rate of groundwater recharge, surface runoff and evapotranspiration
- ❖The groundwater flow and resources of the Takelsa multilayer aquifer

	Evapo-transpiration	Surface runoff	Groundwater recharge	Groundwater resources (10^6 m^3/y)
Average (mm/y)	461	92	22	**15**
Rate (%)	89	18	4	Withdrawals:**21×10^6 m^3/y**

➢We recommend to reduce the wells pumping to safeguard the groundwater resources.

➢Further studies are now in progress to understand and provide an effective groundwater management of the Takelsa multilayer aquifer.

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Thank you for your attention

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