The Estimation of Groundwater Recharge by Using Surface-Subsurface Hydrological Model

ISMAIL CHKARA, KARIM EL MORABITI

Department of Geology, Abdelmalek Essaadi University, B.P. 2121 Tetouan, Morocco

ismailchkara@gmail.com

Groundwater is a source of drinking water which becomes an urgent demand in Morocco. For this reason the accurate estimation of the natural recharge of an aquifer is very important for sustainable management of water resources. The recharge is a fundamental component of aquifer systems, because it represents the link between the atmosphere and the processes of surface and subsurface. The groundwater recharge is, then, a key element in the flow model or the transport of the contaminants .

The objective of this study is the modeling with SWAT and MODFLOW the groundwater recharge, which is based on land use, soil, rainfall and groundwater levels fluctuations. This method is applied to the R'Mel aquifer in Morocco for a more precise estimation of the spatial groundwater recharge.

Methodology

STEP 1 : CREATION OF A GEODATABASE

(a) GIS geodatabase for storing, managing and using all the spatially distributed information required for groundwater flow modelling.

- Developed under Microsoft Access with the ability to be used with GIS.
- Geological data such as maps, borehole data.
- Parameters such as values of hydraulic conductivity, specific yield, and porosity of the different distinguished hydrological units are needed to constrain the calibration of the model.

STEP 2 : CALCULATION OF THE GROUNDWATER RECHARGE

(b) SWAT model was applied to calculate the groundwater recharge.

(c) The characteristics of hydrological response units (HRU) in the SWAT model are exchanged with cells in the MODFLOW model GMS.

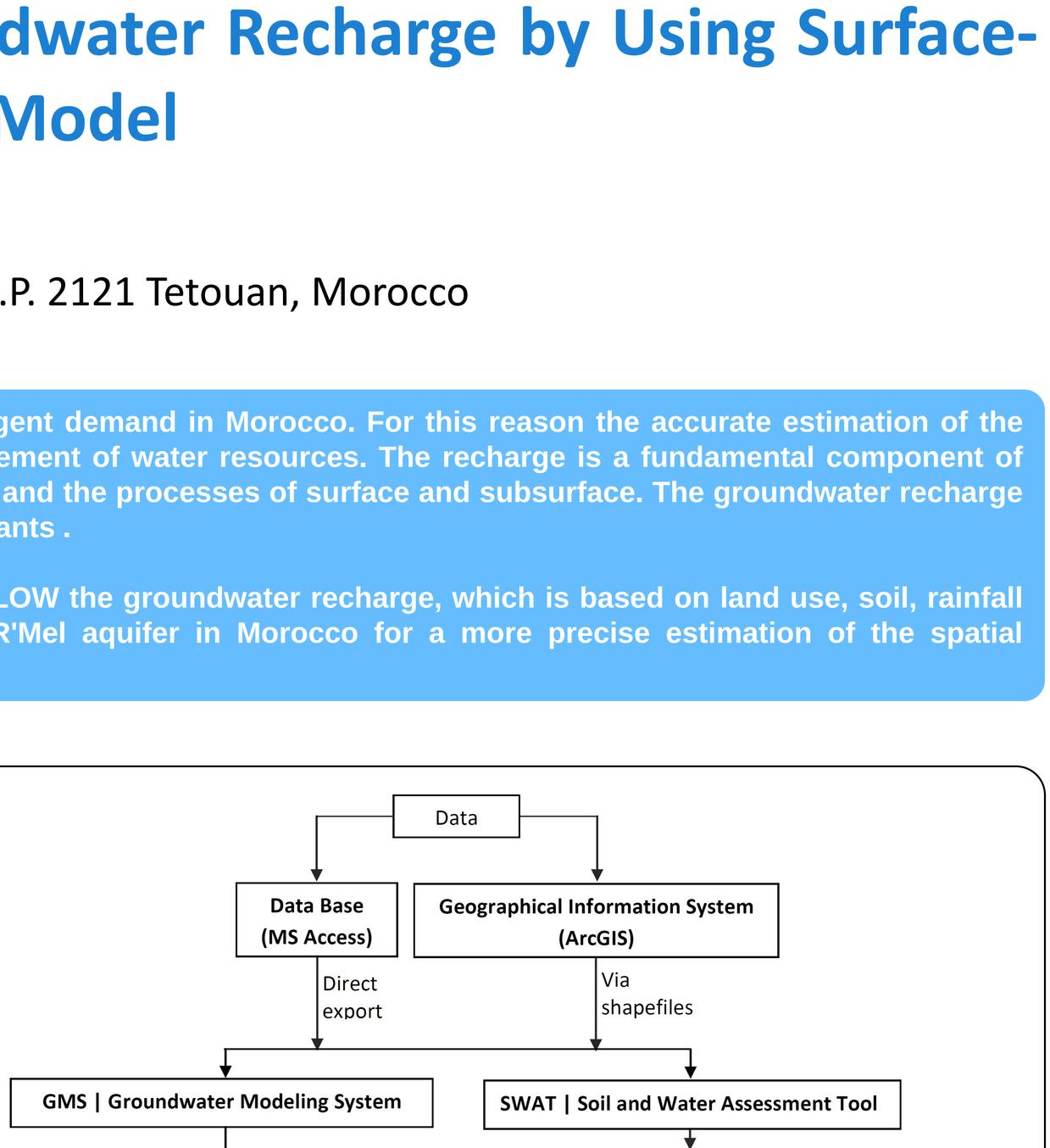
STEP 3 : MODELLING OF GROUNDATER FLOW

(d) Geometrical model provides a three-dimensional representation over the entire study area.

(e) GMS with MODFLOW in finite differences used for groundwater flow in saturated zone.

(f) MODFLOW model represents the raster file recharge (spatial values) by importing the initial recharge (monthly average value of each cell).

(g) The model was validated by comparing the simulated piezometric levels with those observed.



Application

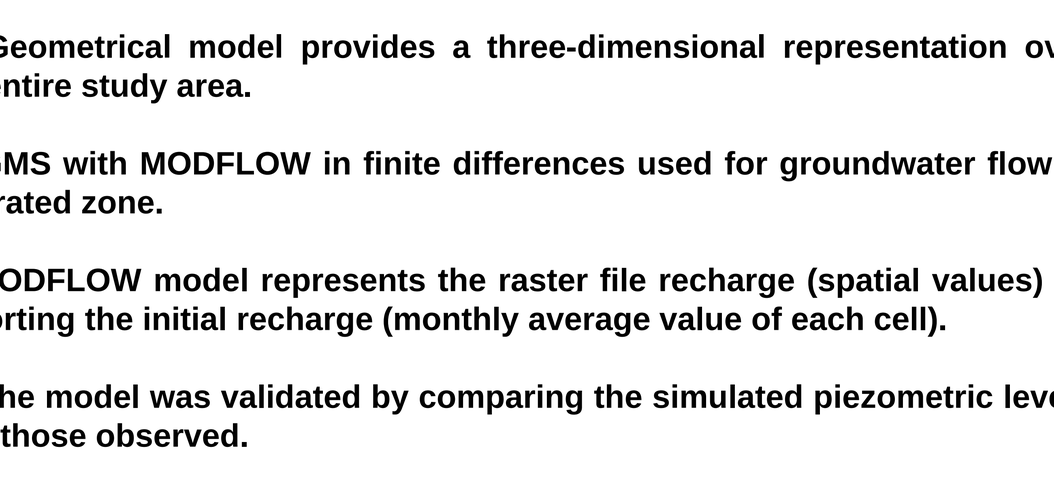
The R'Mel aquifer “Sandstones-sand and sand dunes for the Plio-Quaternary and the bedrock is a blue marl Mio-pliocene” has been chosen because is characterized by 147,300 ha of the total agricultural areas, this favorable farming has increased exploitation of groundwater.

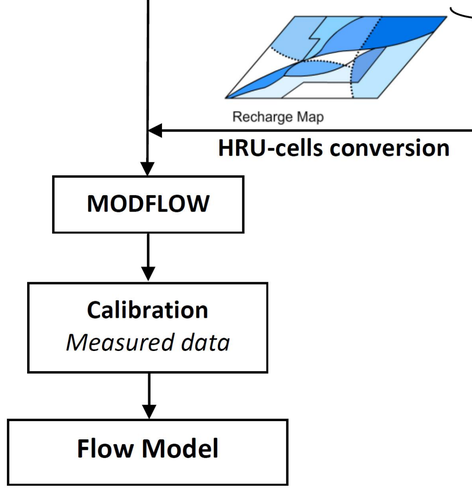
- The R'Mel aquifer extends over an area of 240 sq meters, located in the basin of the Lower Loukkos south of the city of Larache.
- The model was validated by comparing the simulated piezometric levels with those observed.
- SWAT and GMS Modflow used to perform groundwater recharge and flow simulations using finite differences.

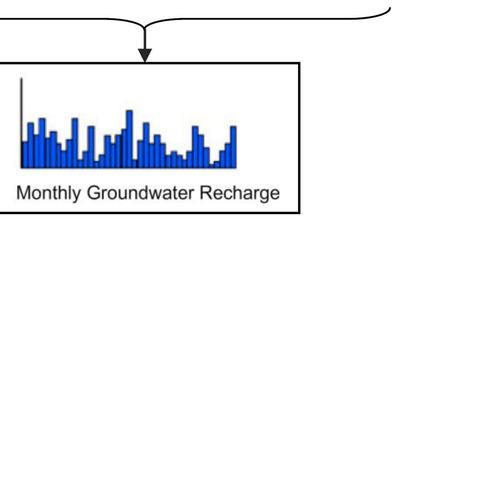
✖ The supply of the aquifer which is estimated at 62 Mm³ / year is mainly provided by the infiltration of rainwater and the return of irrigation water.

✖ Flow is generally from the Southwest to the Northeast.

✖ The average annual recharge groundwater is estimated at about 183 mm / year, which represents about 25% of the average annual rainfall (730 mm / year).







Conclusions

✖ The modeling of groundwater resources has become essential, because the phenomena that take place in the basement are not observable.

✖ The results provided by the hydrogeological models are an approximation of reality, but they constitute very useful information for the management of groundwater.

✖ This work has developed a digital terrain model and, thus, the combination of SWAT and MODFLOW has demonstrated an ability to simulate groundwater recharge.