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Pollutants Transfer Modelling under Agricultural Influences in the Coastal Aquifer of Rmel (Larache, Morocco)

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Abstract
Maintaining water quality within the watershed and catchment area requires the availability of powerful tools for assessing the risk of contamination. Recent advances in the fields of environmental transfer models and the availability of agronomic, soil and climate can now offer innovative tools that quantify the losses of pesticides from agricultural parcels. In this research we seek to improve the understanding of certain mechanisms for the transfer of nitrates and pesticides into water, based on a case study work, which provides measurement data, and all the information on crop and plant protection practices. The interest of this study is to provide diagnostic elements compared to the risk of groundwater contamination in order to offer more environmental friendly practices and to limit pollution. To achieve this purpose, we will assess how the model (GMS model) can bring supporting tools for the diagnostics of the most sensitive agricultural parcels. After the model calibration on site, we will simulate different scenarios to estimate the impact of the choice of product and the date of application depending on the weather and the unsaturated zone.
Keywords: Modeling; Contamination; Groundwater; Nitrates; Pesticides

1. Introduction
Human activities are often the main cause of degradation of water resources. This degradation is particularly pronounced in areas of semi-arid climate, as the case of the area "Loukkos" where the R'Mel aquifer is the main source of drinking water. The region is characterized by a total agricultural area of 147,300 ha. But this favorable farming has increased the exploitation of groundwater causing problems which threaten directly the water resources through seawater intrusion and contamination by nitrates and pesticides.
This study is a part of an optical simulation which provides a tool for modeling and a supporting decision that integrates the economic, institutional, agricultural and hydrological domains. Effective management of this water will be carried out through using a mathematical model to maintain adequate quality. The first stage will be devoted to an analysis of geological, hydrological and hydrogeological aspects to identify limitations and characteristics of the water. Once the conceptual model developed and the numerical code tested, we will determine the flow field of the water in steady and transient state, in order to establish a consistent model to simulate the transfer of pollutants in the coastal aquifer of R'Mel.

2. Methodology

We need sufficient data to model large-scale flow and transport of groundwater. This data, among which geological, such as maps and borehole data, and geophysical survey, should be used optimally to create the spatial discretization. Parameters such as hydraulic conductivity values, historical values of groundwater levels and the porosity of the different hydrogeological units are required for calibration procedures and model validation. This data will be gathered and presented in a hydrogeological database, and then will be imported to a GIS system (ArcGIS) [1-2]. The proposed procedure for data management is shown in Figure 1. Conceptual model will be implemented including the discretization of the various layers. After the calculation, visualization of results can be performed using GMS or ArcGIS [3].

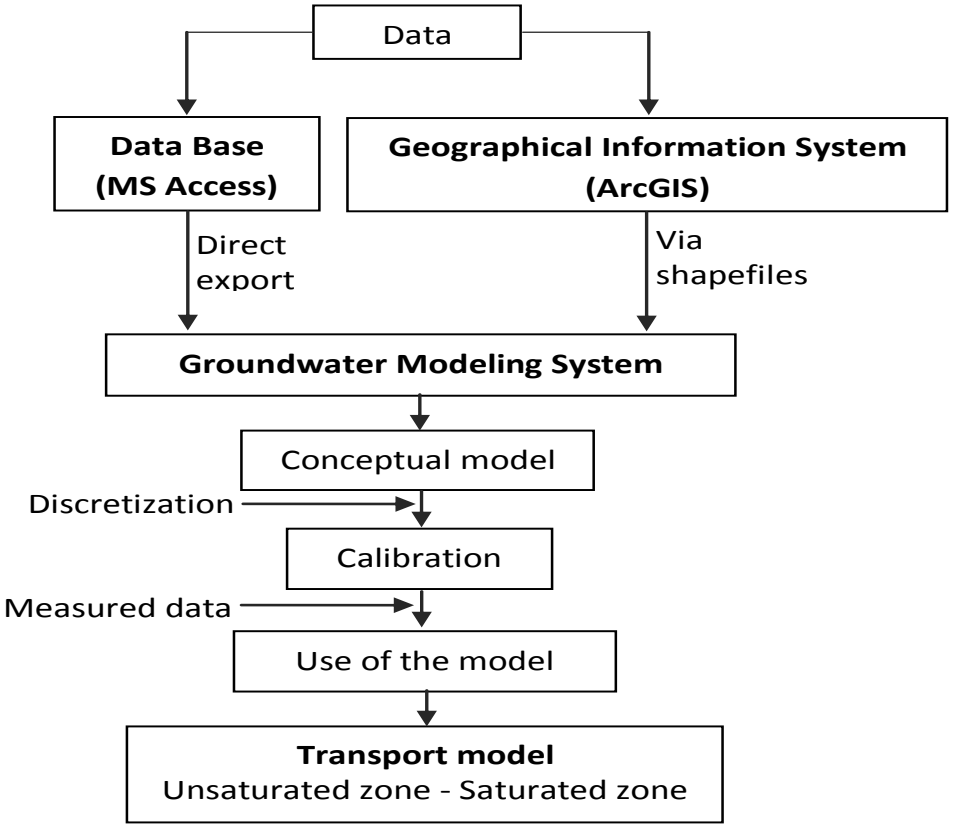

Figure 1: Diagram of the data management procedure.

3. Case study

The R'Mel aquifer covers an area of 240 sq. km and is located in the basin of Lower Loukkos, south of the Larache city (figure. 2a). The area is bordered by the Atlantic Ocean from the west, by Wadi Loukkos in the East and by the Mio-Pliocene marl outcrops in the South. It is drained by wadis Sakh Sokh, Smid El Ma and El Kihel. The depth of this aquifer is between 20 and 120 m. The thicknesses of bodies of water are found in the center of the Rhamna's bowl (120 m). The supply of this aquifer is estimated at 62 Mm3/year, provided particularly by the infiltration of rainwater and the irrigation water. The flow is generally runs from south-west to north-east towards the Loukkos plain and towards the ocean. This direction is changed along the wadis and banks where the aquifer is drained continuously and in some cases are sources and Merja [4].

GMS solid model is used to convert any data encoded borehole and cross-sections of an element representing 3D geometric model as a whole (figure. 2b). This 3D model can be used for the geometry visualization of the

study area and for the visualization of each layer. It allows automatic vertical cuts through the solid at any point and in all directions. Finally, it assesses the simulation of groundwater flow from 2D or 3D mesh of mathematical model.

In this study, we point out that it is a question of building a simple hydrogeological model from which we visualize the migration routes of contaminants. We consider the modeling of flows in the scale of a hydro-system which includes complex and heterogeneous geology. On the ground of this modeling system, we find that the coastal aquifer is subject to saltwater intrusion and contamination by nitrates and pesticides. Groundwater levels and flows are calculated using a groundwater flow model (GMS) (figure. 2c), which simultaneously applies Darcy's law and the equation of conservation of matter. The calculated and observed values are then compared.

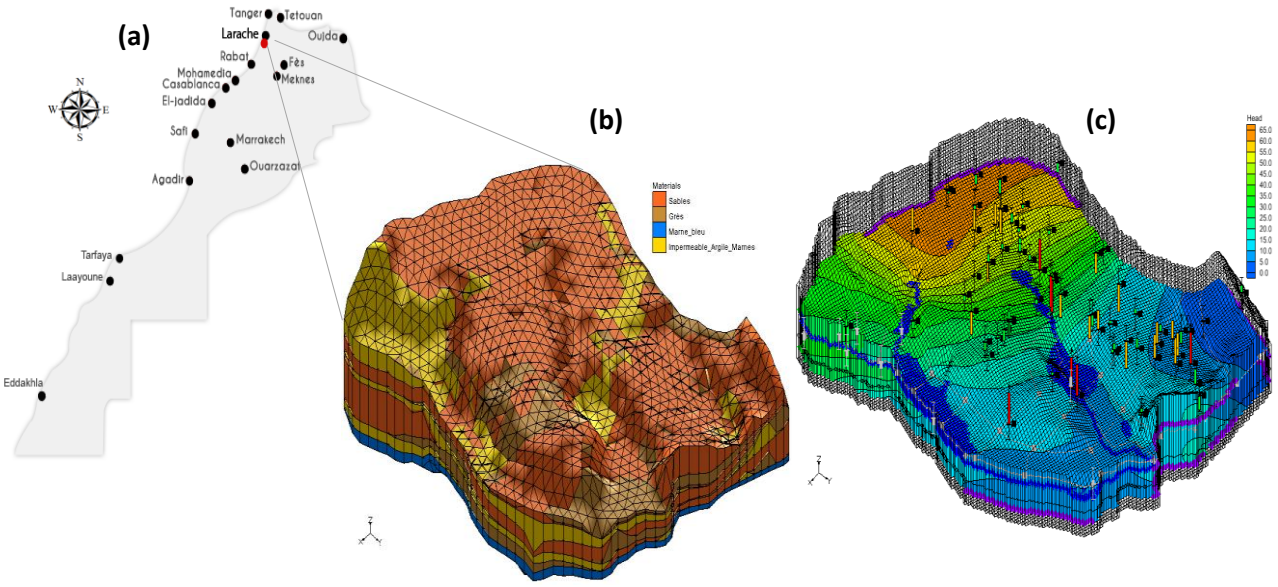

Figure 2: (a) localization of study area, (b) 3D representation of borehole encoded in GMS and (c) piezometry calculated over the entire modeled area

Conclusions

The model will permit us to consider pollutants that have very different behaviors and to deduce some farming practices which are environmentally friendlier, including the application of the products when the level of the shallow aquifer is near the surface soil. This initial assessment will identify and quantify contributions of the agricultural pollutants on the site. Moreover, the estimation of transfer will be achieved on the basis of a general knowledge of the behavior of atrazine. Such information, partially, can define for us what are the molecules and the monitor of the annual flow of these possible products in the water. The detected comparison of pesticide reaching the water molecules will actually show the consistency of our model.

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