



## **Multi-modeling assessment of recent changes in groundwater resource: application to the semi-arid Haouz plain (Central Morocco)**

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The Haouz plain (6000 km<sup>2</sup>) is a part of the Tensift basin located in the Central Morocco. The plain has a semi-arid climate (250 mm/y of rainfall) and is bordered in the south by the High-Atlas mountains. Because the plain is highly anthropized, the water resources face heavy demands from various competing sectors, including agriculture (over than 273000 ha of irrigated areas), water supply for more than 2 million inhabitants and about 2 millions of tourists annually. Consequently the groundwater is being depleted on a large area of the plain, with problems of water scarcity which pose serious threats to water supplies and to sustainable development.

The groundwater in the Haouz plain was modeled previously by MODFLOW (USGS groundwater numerical modeling) with annual time steps. In the present study a multi-modeling approach is applied. The aim is to enhance the evaluation of the groundwater pumping for irrigation, one of the most difficult data to estimate, and to improve the water balance assessment. In this purpose, two other models were added: SAMIR (Satellite Estimation of Agricultural Water Demand) and WEAP (integrated water resources planning). The three models are implemented at a monthly time step and calibrated over the 2001-2011 period, corresponding to 120 time steps. This multi-modeling allows assessing the evolution of water resources both in time and space. The results show deep changes during the last years which affect generally the water resources and groundwater particularly. These changes are induced by a remarkable urbanism development, succession of droughts, intensive agriculture activities and weak management of irrigation and water resources. Some indicators of these changes are as follow: (i) the groundwater table decrease varies between 1 to 3m/year, (ii) the groundwater depletion during the last ten year is equivalent to 50% of the lost reserves during 40 years, (iii) the annual groundwater deficit is about 100 hm<sup>3</sup>, (iv) the renewable water resources per capita are around 500 m<sup>3</sup>/year, (v) the agriculture takes 80% of the total water demand (vi) the net consumptive use of groundwater by agriculture represents 55 % of the total water consumed by agriculture. Consequently a strategy for water management for sustainable use is a pressing concern. In this frame, the multi-modeling system is expected to be a decision support system for present and future water resources management alternatives in the Haouz plain.