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Impact of changing climate in the Kairouan Hydrological basin (central Tunisia)

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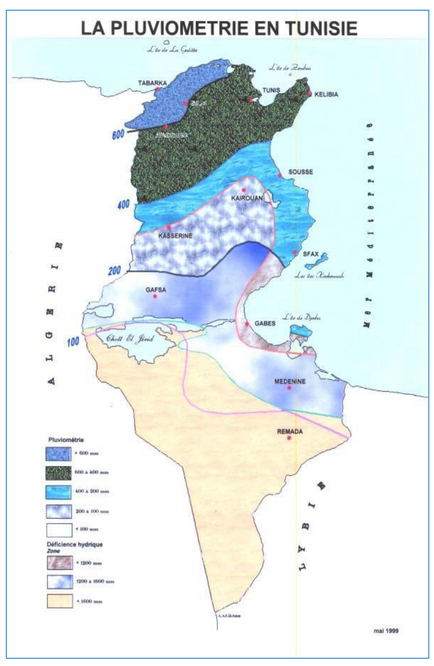
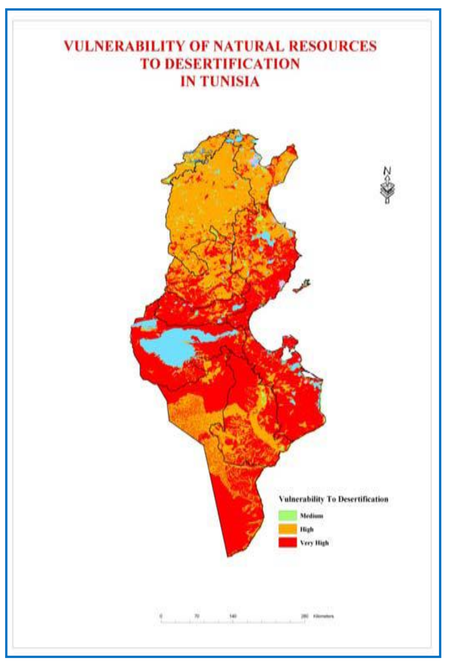
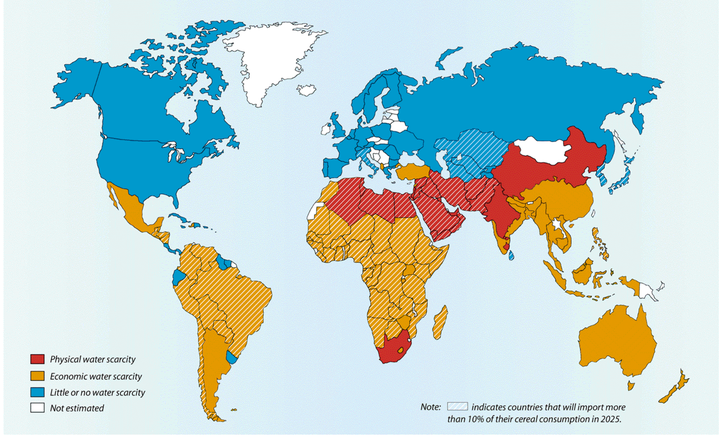
Abstract: The Merguellil catchment (central Tunisia) has undergone rapid hydrological changes over the last decades. The most visible signs are a marked decrease in surface runoff in the upstream catchment and a complete change in the recharge processes of the Kairouan aquifer downstream. Fluctuations in rainfall have had a real but limited hydrological impact. Much more important are the consequences of human activities such as soil and water conservation works, small and large dams, pumping for irrigation. Several independent approaches were implemented: hydrodynamics, thermal surveys, geochemistry including isotopes. They helped to identify the different terms of the regional water balance and to characterize their changes over time.



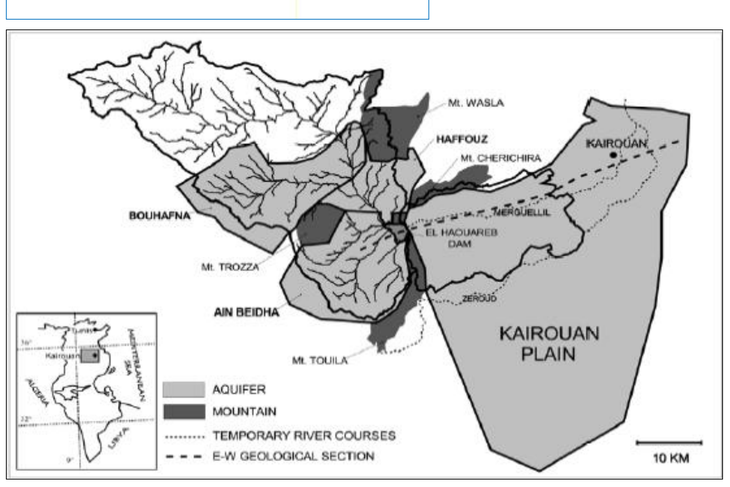
The climate of Tunisia is influenced by the Mediterranean and Saharan climate: it is in fact divided into 7 bioclimatic are as favourable for a great diversity of husbandries,
the great difference between the north and the rest of the country is due to the Tunisian dorsal which separates the areas influenced by the Mediterranean climate from those influenced by the arid climate engendered by the Sahara.

Desertification is one of major problems for development in Tunisia, since about 75 % of national area is thretened by Land degradation



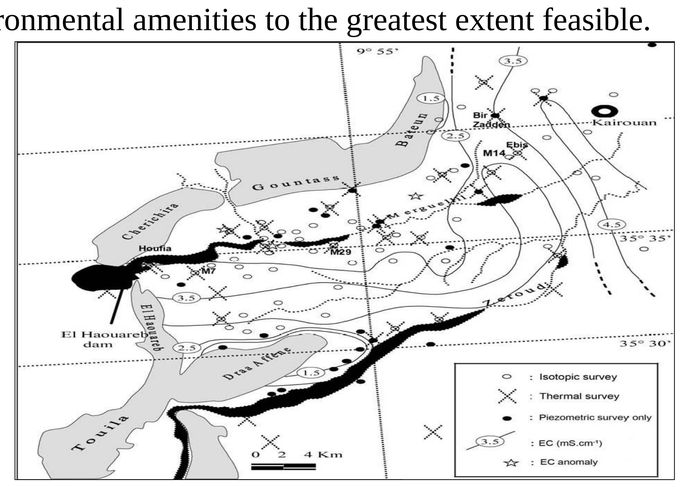


North Africa and the Middle East are among the most water scarce regions and that scarcity will continue to intensify as populations grow and economies develop. Tunisia exemplifies the general scarcity problem faced by most countries in these regions. The indigenous water supplies of Tunisia amount to about 435 m3 per person per year, roughly 25% of what is thought to be necessary to fully serve the water demands of each member of the population. This figure is typical of the countries of the Middle East and North Africa and will likely decline if the populations of these countries continue to grow. One of the major challenges of the future for these countries will be to manage intensifying water scarcity in ways that optimize the productivity of water and preserve and maintain environmental amenities to the greatest extent feasible.

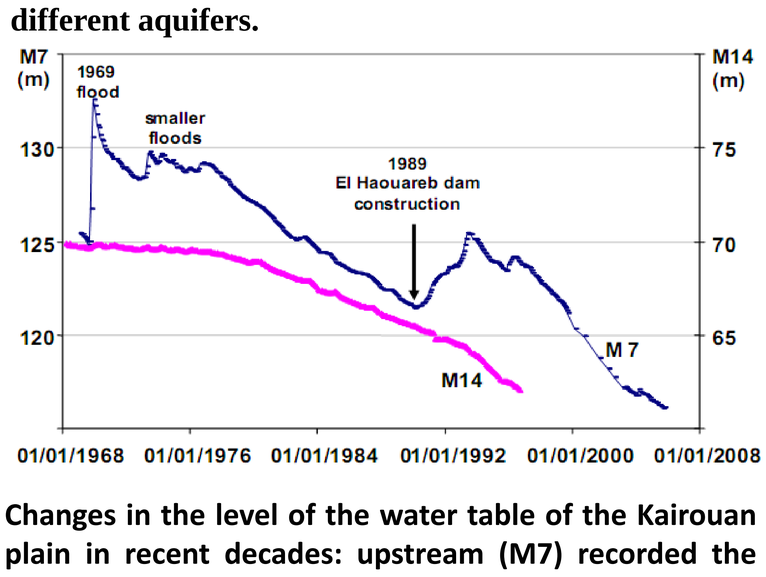


Location of the study area, limits of the upstream and downstream sub catchments and limits of the different aquifers.

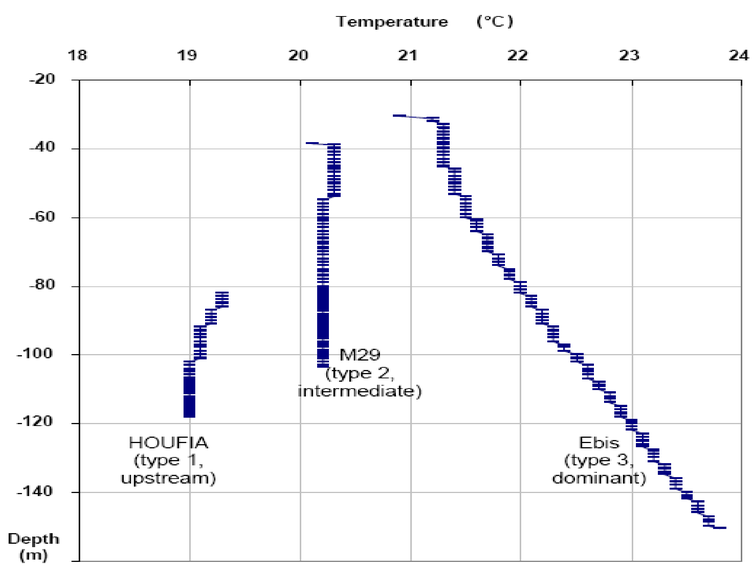
Wadi Merguellil is one of the three main temporary rivers reaching the Kairouan plain Fig. 1. The Merguellil upstream catchment (1200 km2) is defined by the big El Haouareb dam built in 1989 over a rocky sill. It presents a hilly topography (altitude between 200 and 1200 m with a median elevation of 500 m) and has diversified conditions of geology, morphology, vegetation and land-use. The Merguellil downstream catchment is part of the very large and flat Kairouan alluvial plain that extends over about 3000 km2. Our research in the downstream part covered an area of 300 km2 close to the dam, west of the city of Kairouan.



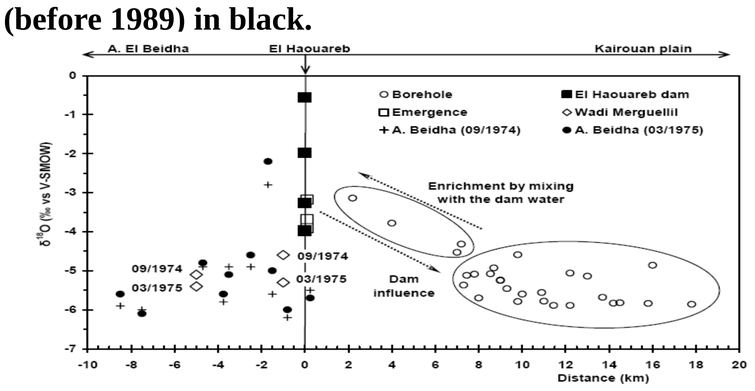
Wells of the Kairouan plain aquifer surveyed for piezometry, geochemistry and thermics. Isolines of electrical conductivity (EC). river courses indicated by dotted lines, with areas usually covered by floods (before 1989) in black.



Changes in the level of the water table of the Kairouan plain in recent decades: upstream (M7) recorded the main regional events while downstream (M14) seems to be only affected by pumping for irrigation



Thermal gradients measured in piezometers in the Kairouan plain. Most of the profiles show increasing temperature with depth (type 3).



Isotopic content ($\delta^{18}O$) of groundwater before (left, Aïn el Beidha aquifer), in (Km 0) and after (right, Kairouan plain aquifer) the El Haouareb karstic sill

The Kairouan aquifer, by far the largest regional resource, is not managed at present. The official ban on wells deeper than 50 m is rarely respected and groundwater is in fact a free-access resource. For social and political reasons, authorities do not want to increase measures limiting overexploitation. The present development of irrigated agriculture is unsustainable. As technical solutions will not be sufficient to really solve the problem, other approaches need to be developed that include social and economic factors. This could be achieved through negotiations between stakeholders at local and regional levels in order to combine better general welfare (including equity between upstream and downstream inhabitants), increased efficiency of water use, and preservation of natural resources. A sense of common interest will need to be developed between the different parts of the catchment, and between farmers and other protagonists; in other words, it is a long-term task.

All the problems described in this study (uneven distribution of water resources in a semi-arid region, methodological problems in the acquisition and interpretation of data, diverging interests between communities at various scales leading to general overexploitation, etc.) are typical of the Mediterranean context. The Merguellil catchment is thus representative of a regional situation. Among many other similar cases in Algeria, we could cite the Mitidja plain or the Ghriss plain, close to Oran, reported by [2]. In Morocco, the aquifer of the Haouz plain near Marrakech studied by [1] has experienced both a decrease in the water-table (up to 12 m in 6 years) because of pumpings and an increase in other areas (up to 15 m in 10 years) because of the return of irrigation water, brought in excess by large channels from remote mountain rivers. As in the Merguellil catchment, the conjunction of different approaches significantly improved the estimation of the regional water budget that has been drastically changed by human activities.

In all cases, many drastic modifications have occurred. The changes in the last decades, which involve a combination of human activities and environmental responses, affect both internal and boundary conditions over a large range of time scales. The construction of management models is therefore risky when information is not available at sufficient density.