Climate change and water availability in North-West Algeria: Investigation by dendrochronology and stable water isotopes

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Since the seventies, the rainfalls incomes are getting lower along the North African coast, while the demographic pressure increases, and such the water need. Here, we present the situation of the Tafna river basin, centre on the city of Tlemcen, in the North-West of Algeria. Outside the rainfall data and water level of the Béni Bahdel dam, the tree ring analyses as well as the water isotopic signature were used to better understand the climate change and the water circulation in this area.

The Tafna river is the last stream in the North West of Algeria, close to the border of Morocco, and take is source around the Tlemcen mountains (1400 m). The Tafna basin has a surface of 7250 km² (Dahmani et al. 2003). The basin is localised in sub-humid to semi-arid region and many of the Tafna river's tributaries are intermittent streams, with rainfall ranging from 300 to 700 mm/year. Two area can be described: the upper South part composed by chalk plateau and wetter condition due to the altitude, and the lower North part of low drier land. For the water need of the Oran city, a first dam were build on the Tafna river around 1940, just on the end of the upper plateau. The excess of water should have been used to irrigate the lower lands. In that time, the mean rainfall value was 560 mm/year and such could regulate a volume of 74 million m³ per year.
But since, the mean rainfall was only of 450 mm during 1940 and 1974, and after the dry period of the seventies, the mean rainfall lower at 342 mm for 1975-2005 (Adjim et al., 2005). Also, especially in the lower part of the Tafna river basin, since the seventies many wells become dry and important dye-back of poplars (*Populus alba* L.) were observed. At first, only the increase of insect attack were notice for these trees, before a study reveals that the original cause of this poplar sanitary degradation was due to the lack of water (Labiod et al. 2007).

Wider dendro-chronological experience have measure the growth rate and age of white poplar over the basin, no tree over 45 year was found. Even in the upper basin, high growth rate was found for trees growing very close to the river or close to irrigation canal, mean value from 0.5 to 1 cm/year. To really understand the possible climate change, we had to focus outside the riparian trees and on older trees as the Aleppp pine forest over the city of Tlemcen and more isolated trees as “Oxycedar Juniper” (*Juniperius oxycedrus*) and “Thuya de Berbéris” (*Tetraclinis articulata*), some of these trees being over 100 years old. Similar dendro-chronological and sanitary studies have been recently done on century old cedars in the Chréa forest in few hundred km more East (Sabadji et al. 2008). In all cases, a growth decrease was observed since 1975.
In parallel, stable isotopic studies ($^{18}$O and Deuterium) were undertaken to better understand the water characteristic and circulation of the Tafna basin. The first stable isotope sampling (Lambs and Labiod 2006) on $^{18}$O only, has shown that there was no seasonal effect. The same values were found for the water taken on the higher plateau and the spring around Tlemcen between winter and summer. This means that the karstic system is certainly big enough to store the water over 6 months at least. But the mean values for the two sites differ by about one unit, respectively $-7.52 \pm 0.26$ and $-6.51 \pm 0.25$.

This difference shows that the water coming out at the foot of the plateau around the city of Tlemcen is different from the water flowing in the river of this plateau. Interesting is the sampling in the Mansourah village, above the city of Tlemcen direction South-West, just on the edge of the plateau, where is produces mineral water. The agricultural well displays a delta $^{18}$O isotope value of $-6.52$, whereas the deeper drilling (70 m) were is pomp the mineral water has a more depleted value of $-7.52$, as the water in the higher Tafna. In this case a double ground water should exist.

The last isotope determination is looking on the $^{18}$O/Deuterium along the Tafna river course from the underground source until the sea estuary. The conductivity of the main spring and tributaries is very high since the beginning (around 600 µS), due to the time of residence and chalk soil, and increase downstream with the evaporation, pollution and salinity intrusion. The $^{18}$O value for the lower basin range between $-3.4$ and $-5.4$. Except the surface water of the Beni Bahdel dam, the water with the higher salinity (1100 to 2000 µS) have also the lower Deuterium excess ($2.4$ to $5.8$).

The upper Tafna river is not easy to study since it is formed by a wide karstic and cave system with up to 3.4 km long underground river. Even some water out come from this system have been found on the Maroc side. The total underground water of this system is estimated to
10 billions of m$^3$ and thus certainly buffer the seasonal rainfall fluctuation, but also delay the lack of water for the following years. The lower Tafna basin have now four additional water dams which increase the water evaporation and enhance the sediment retention. More hydrologic and environmental studies are needed to get more data in view to better manage the water resource.

References:


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