

Long-term evolution of the salt balance in the Flumen irrigation district (Spain)

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Keeping an adequate salt balance is a must for the environmental sustainability of irrigated systems while the modernization of traditional irrigation systems is necessary for the economic sustainability of the farm enterprises. The effect of management practices (and irrigation system) on the salt balance at the district level is better assessed through the analysis of long-term series of irrigation management and water quantity and quality data. In Spain, the current transformation of the irrigation system in as much as 1,100,000 ha, urges for analysing the effect of this transformation upon the salt balance.

To this end, the salt balance of the Flumen irrigation district (45316 ha, NE Spain; currently being modernized by converting the old surface irrigation system into pressurized systems) was established for the hydrologic years 1993 to 2008 making use of the available information of the Ebro River Basin Authority (Confederación Hidrográfica del Ebro): daily outflows through the Flumen river, inflows through the upstream tributaries and records of irrigation volumes and precipitation; and monthly water quality records. The trends of the salt balance, the net load of the main ions and the outflow concentrations along this period were assessed.

Result show that salt leaching took place mainly (66%) during the non-irrigation season (October to March); while in June and July, salt inputs were slightly higher than outputs, pointing to a limited leaching in these months. Salt concentration in the drainage waters was lower during the summer, pointing to irrigation tail-waters with a diluting effect. These tail-waters may be raising the water level in the drainage system, thus hindering subsurface drainage and preventing salt leaching. The net mass of salts exported each year (191,898 Mg in the mean) was directly related to the irrigated area and especially to the area cropped to corn and rice. A decreasing trend was found in the net salt load, significant ($P < 0.05$) for the whole year (-2882 Mg/year) and for the months of July and August. The net loads of the main ions showed decreasing trends that were significant only for Cl^- and Mg^{2+} (and very close to significance for SO_4^{2-} and Na^+), suggesting that the mass of the most soluble salts removed from the irrigated area was decreasing while the mass of lime exported remained constant. This matched the fact that only Ca^{2+} and HCO_3^- concentrations among all main ions, showed a significant increase in the return flows (only in the non-irrigation season).

Salt leaching from the Flumen district was adequate for the whole year, though the reduced leaching during the irrigation season could increase soil salinity enough to reduce crop growth and yield (especially as the observed decrease in summer leaching continued). The on-going transformation process may reduce summer drainage (through irrigation doses better adjusted to the crops' needs) but will also reduce the volume of tail-waters, thus allowing for a better salt leaching during the summer months. Both processes would lead to reduced volumes of more concentrated return flows. The continued monitoring of the salt balance in the coming years will allow for assessing the effect of the new irrigation type on the salt balance.