



## Wetland water and nutrient budget for improving irrigation performance in Caspian Low Lands, Iran

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Water scarcity and uneven distribution of rainfall are the most important limiting factors for the development of agriculture in Iran. Assessment of sources and seasonal variations of wetland water and nutrient budget are fundamental for improving water quantity, quality and its agricultural use. This study was carried out in the Southern Caspian lowlands, Iran to identify sources of wetland water and establish water and nutrient budget for thirty wetlands from 2010 to 2012. Water samples collected in autumn, winter, spring and summer from these wetlands were (i) analysed for nitrogen (N), phosphorus (P) and isotopic signatures of oxygen-18 ( $\delta^{18}\text{O}$ ) and hydrogen-2 ( $\delta^2\text{H}$ ) and (ii) constructed for water and nutrient balance. In addition, groundwater (10-20 meters) rainwater, snow and wetland water were collected in spring 2013 and analysed for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ .

Results showed that wetland water was enriched with  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  in summer (-1.15‰ and -12.11‰ for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ , respectively) and depleted in winter (-7.50‰ and -47.30‰ for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ ). This is probably due to spring snow melt, summer rainfall and evaporation of wetland water. As more water was used for irrigation in spring and summer, the water column depth reduced and accelerated evaporation leading to isotopic enrichment. Among various water sources, wetland water was enriched (-3.57‰ and -27.72‰ for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ ) compared to groundwater (-6.2‰ and -38.0‰ for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ ), rain water (-5.4‰ and -31.7‰ for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ ) and snow (-15.2‰ and -109.6‰ for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ ).

Water and nutrient balance based on rainfall, evapotranspiration and nutrient concentrations for wetlands showed that on average 7.6 million cubic meters of water along with 86 tonnes of nitrogen (N) and 17 tonnes of phosphorus (P) can be captured from an area of 10,400 ha. This water can be used to irrigate up to 1500 ha rice crops over a period of 130 days in spring and summer.

The isotopic signature and water balance in these wetlands showed that the seasonal variation of  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  in wetland water probably depend on the input of snowmelt in early spring and enriched rainfall (-3.0‰ and -16.22‰ for  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ ) in summer and evaporation in late summer.

The relationship between  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$ , established for rainwater ( $r^2=0.985$ ), snow ( $r^2=0.998$ ) and wetland water ( $r^2=0.995$ ) during spring season, suggested that wetland water during spring is derived from rainfall/runoff and snow melt.