Geophysical Research Abstracts
Vol. 13, EGU2011-879, 2011
EGU General Assembly 2011

Isotope techniques and flow modelling for the assessment of groundwater-wetland interactions in the Pampa Plain, Argentina. "La Salada" Pond as a study case

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The Pampa in Argentina is a large plain of about 1,500,000 km2, characterized by a geomorphological environment which corresponds mostly to that of gently sloped plains (<0.5%) crossed by a block mountain system ("Tandilia Range"). This plain is covered by a sedimentary sequence of loess-like sediments forming an aquifer system known as Pampeano Aquifer. Shallow lakes are common in the area due to the slow slopes and drainage density that dominate the landscape. La Salada is a permanent shallow lake, with an area of 5.8 km2, located near La Dulce Town on the SE of Buenos Aires Province, close to the Quequen River. The aim of this paper is to assess the water origin of the wetland and its relationship with the Pampean aquifer and the waterbodies near to it, by assessing hydrogeological, hydrochemical and isotopic information. Moreover, a flow numerical modeling including the obtained information was performed in order to validate the conceptual model. A total of 30 wetland water samples and 20 groundwater samples were collected for both hydrochemical analysis and environmental stable isotope determination. Water table depths were measured in mills, domestic and irrigation wells closed to La Salada wetland. The piezometric map shows the influent-effluent behavior of the wetland, the groundwater flow toward the Quequen River and the different piezometric line slopes indicate a spatial distribution of transmisivities in the basin. The high salinity of the wetland, of about 6800 μS/cm, suggests that the origin of its waters corresponds to the discharge of groundwater subject to evaporation. Hydrogeochemical model indicates that the evaporation factor is 11.4; for each 1000 g of water, 88 g remains in the wetland and 922 g evaporates. The Local Meteoric Line (LML) (δ2H‰ = 8.0 δ18O‰ + 9.8) is similar to the GMWL. The isotopic content of rainfall water is affected by both the quantity effect and enriched rainfalls. Groundwater samples appear grouped on the LML, suggesting a well-mixed system and that rainfall is the main recharge source to the aquifer. Water evaporation process within La Salada is also corroborated by its isotopic composition. Wetland samples are located on an evaporation water line, considering the mean groundwater composition as the starting point. The spatial discretization of the numerical model by the method of finite elements included 863 elements and 417 nodes. Transmisivity zonification was previously obtained from geomorphologic differences observed on land surface and it was then calibrated with the model. The permanent regime simulation shows a surface water/groundwater interaction according to the observed piezometric map. The transient regime has a good fit when compared to a daily record phreatimeter (2007-2010) that is installed in the zone. The annual global water balance indicates for each hydrological component the following values: rainfall 103.3 hm3, evapotranspiration 90.6 hm3, runoff 1.7 hm3, groundwater recharge 11 hm3, groundwater discharge to the wetland 1.3 hm3, groundwater discharge to the river 9.2 hm3, urban extraction 0.5 hm3 and wetland evaporation 1.2 hm3. Integrated analysis of hydrochemical and isotopic information helped to calibrate the groundwater flow model, to validate the conceptual model and to quantitatively assess the global water balance.