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GROUNDWATER - LAKE INTERACTION IN A MEDITERRANEAN COASTAL AQUIFER: THE *ALIMINI* LAKE CASE STUDY (SOUTHERN ITALY)

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STUDY AREA

The *Alimini* water system is located in the southernmost part of Italy (Salento peninsula), on the Adriatic coast (Fig. 1). It lies within an area of great naturalistic value that is also a renowned tourist destination. It consists of two shallow lakes, i.e., *Alimini Grande* and *Alimini Piccolo*, connected through a natural channel (*Lu Strittu*). A gate along the channel inhibits water exchange between the two lakes so that *Alimini Piccolo* is isolated from the open sea.

This freshwater lake (surface area: 0.8 km^2) is fed by a multi-layer porous aquifer through several springs located along the shore, and also by the Rio Grande channel. Since 1950, *Alimini Piccolo* has provided water for agriculture and domestic use through three intake structures, i.e., Fontanelle Est (FE), Fontanelle Sud (FS), and Casa Monsignore (S); the latter intercepts the main groundwater spring.

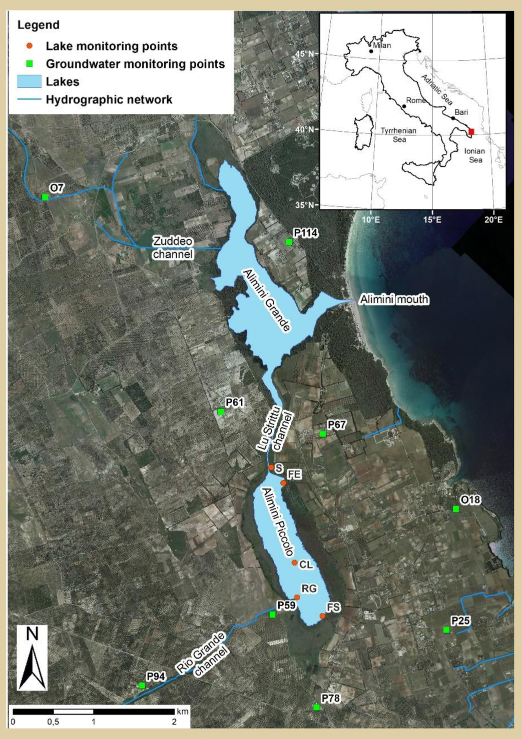


Figure 1

Many wells in the surrounding area are also exploited to meet water demand. Indeed, groundwater is the main freshwater resource of the area, and it suffers from intensive exploitation that rises dramatically during summer, owing to the increase of both visitors and the demand by agriculture.

AIMS

This study provides insight into the relationship between *Alimini Piccolo* water quality and that of the feeding groundwater, in view of the potential lake water exploitation for drinking purposes.

The analysis of water quality data was aimed at:

a) understanding the processes determining the chemical composition of groundwater and lake water, and its variation with time and space;

b) assessing the potential seawater intrusion in the aquifer, with special regard to seasonal variations caused by the increased seasonal withdrawal of groundwater during the summer season;

c) ascertaining the consequent potential variation of lake water quality.

DATA COLLECTION

Seasonal monitoring data were collected throughout one hydrological year for *Alimini Piccolo* lake water and groundwater from wells in the surrounding area. Groundwater was sampled from nine wells, four of which were close to the coastline (respectively, P67, O18, P114, and P25) whereas five were inland (respectively, P61, P59, P94, P78, and O7). Lake water was sampled in five points spread over the lake surface. One of them (S) was located at the main groundwater spring feeding the lake; the remaining points were those labelled, respectively, LC, RG, FE, and FS (Fig.1).

Sampling campaigns were performed four times for groundwater and seven times for lake water. To highlight seasonal variations of water quality, each campaign was associated with one of two seasons, i.e., dry (D) and wet (W), according to water level measurements performed for groundwater and lake throughout the monitoring period.

Water samples were analysed for all physico-chemical parameters related to drinking water production. For each sampling point, the mean values of each parameter were calculated over the dry and the wet seasons and then processed to calculate several hydrochemical indicators.

METHODOLOGY

Interpretation of water quality data was carried out by matching a set of hydrochemical indicators calculated from major ion concentrations. The Chadha plot, correlations between alkalinity and major cations, those involving the difference (Ca^{2+} + Mg^{2+}) - (SO_4^{2-} + HCO_3^-) versus (Na^+ - Cl^-), and the Ca^{2+} / HCO_3^- ratio vs. Cl^-, as well as the chloro-alkali indices (CAI), were used to assess the origin of dissolved ions and the mechanisms affecting groundwater composition[1-4]. To assess the occurrence of seawater intrusion in the aquifer, seawater fraction and a few relationships involving chloride concentration were analysed, i.e., correlations between chloride ion and, respectively, the ratios HCO_3^- / Cl^- (inverse of Simpson's Ratio), the Na^+ / Cl^-, and Mg^{2+} / Ca^{2+}. The above hydrochemical indicators (except those related to ion exchange) were also calculated for lake water, and the processes affecting the differentiation of lake water quality from that of the feeding groundwater were analysed.

RESULTS

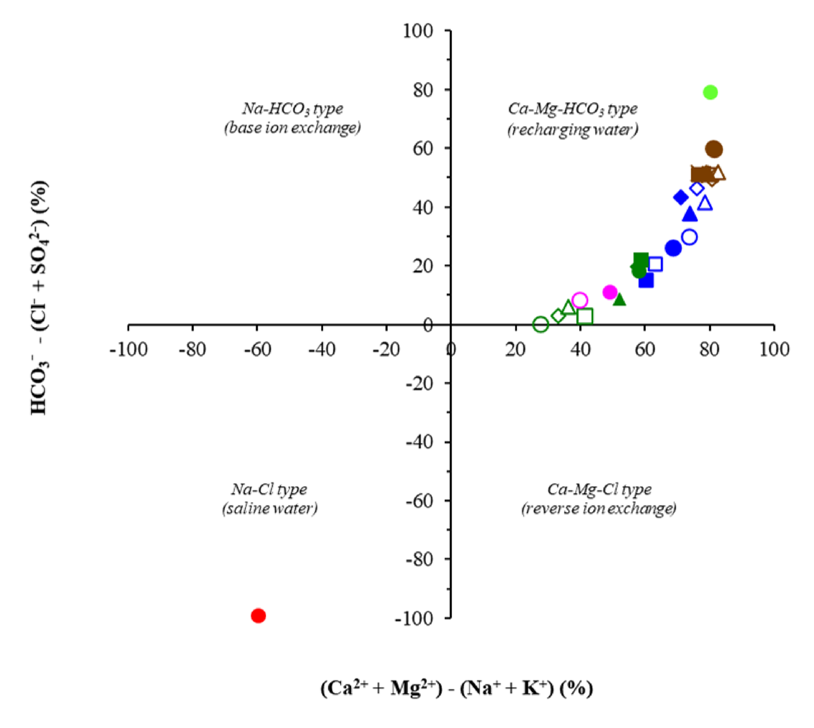
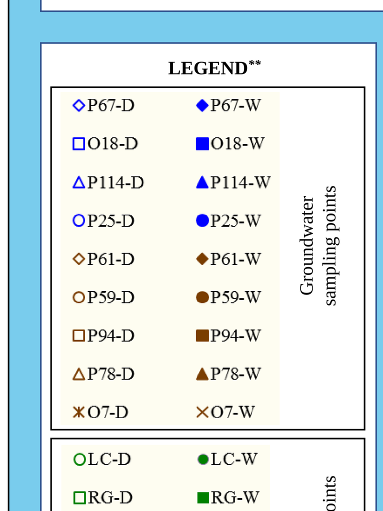


Figure 2



All sample points in Fig. 2 cluster within the subfield identifying bicarbonate-calcic freshwater. Main ions in groundwater originate from carbonate mineral dissolution, while either saltwater mixing or ion exchange apparently would not affect ion concentrations. Samples from coastal and inland wells form two distinct sub-groups, whereas no significant separation is detectable according to seasonality. Lake water data points grouped at the lower edge of the cluster suggested higher salinity compared to groundwater.

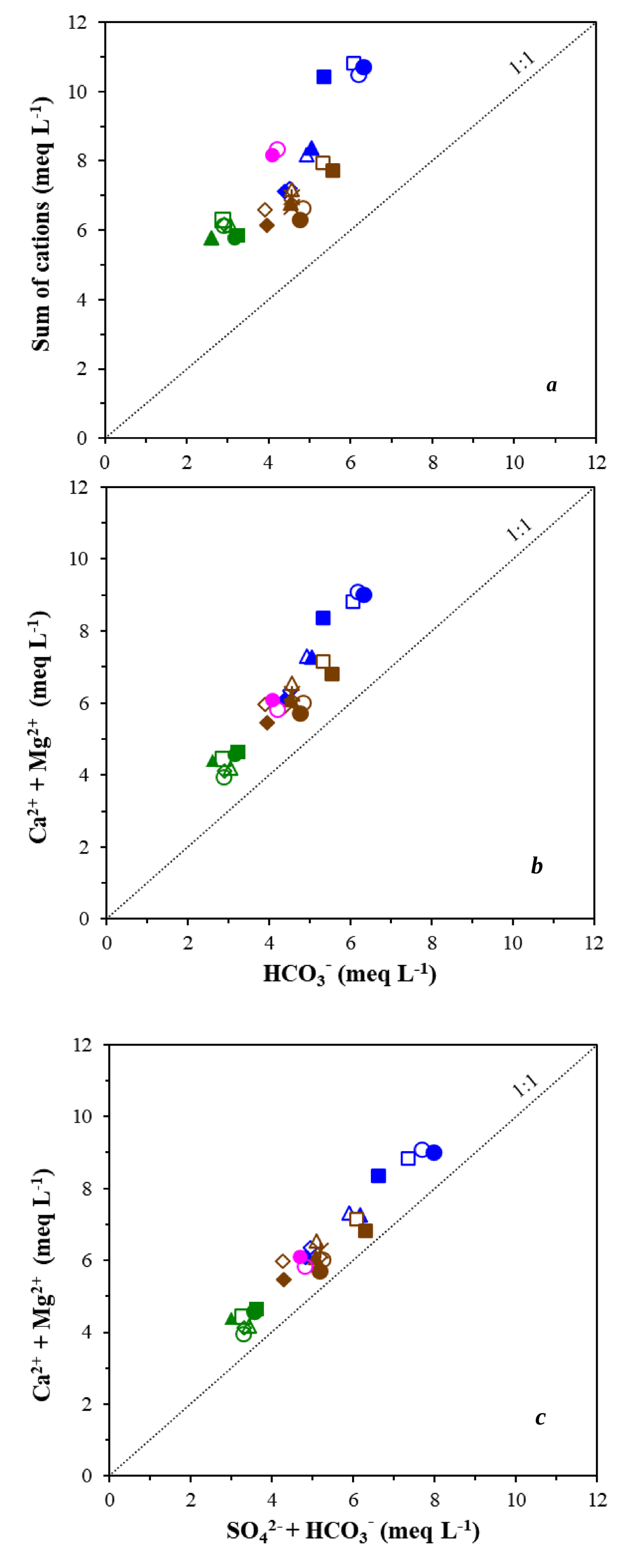


Figure 3

Correlations between bicarbonate and major cations (Fig. 3) confirmed that the dissolution of carbonate minerals governs groundwater composition, but also suggested that a slight influence of reverse cation exchange might exist, possibly triggered by seawater intrusion. The indicators in Fig. 4 finally support the assumption that reverse cation exchange may only have a marginal role in groundwater.

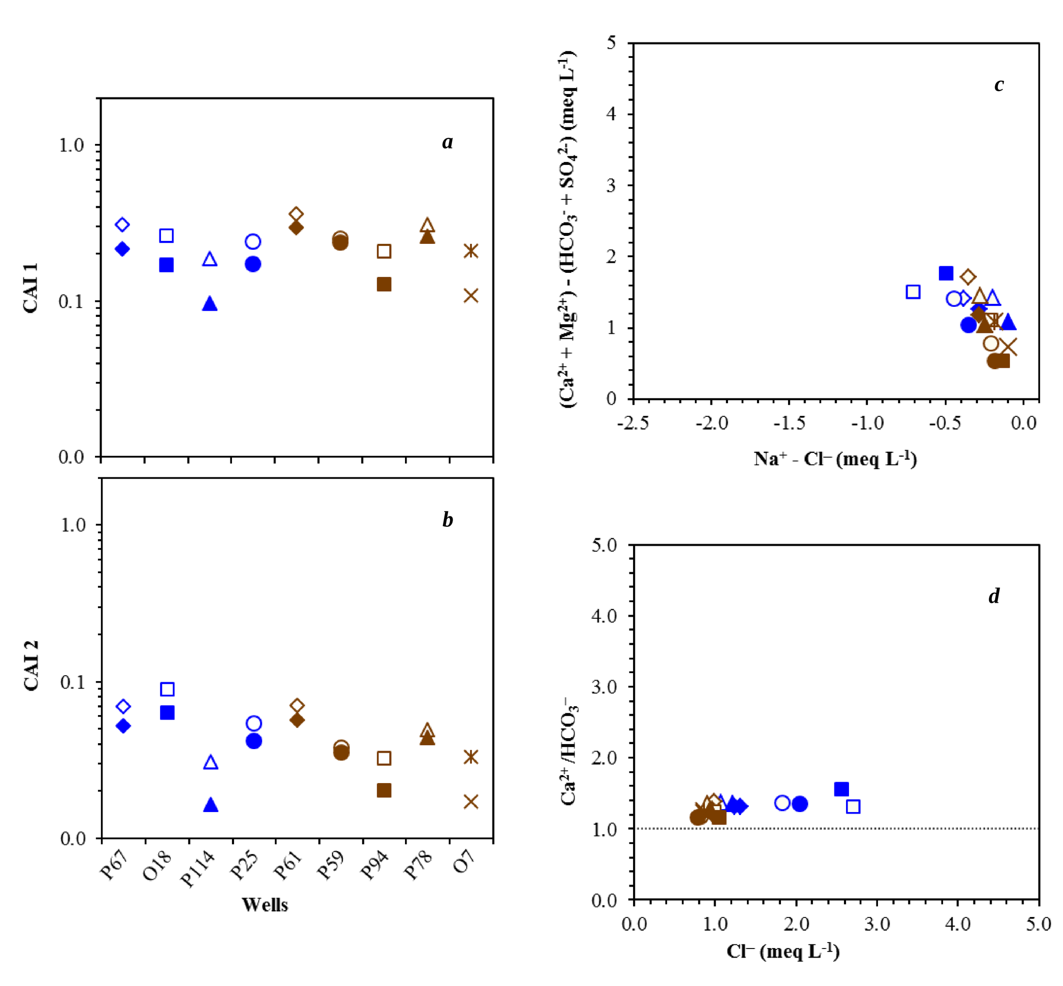


Figure 4

The not negligible contribution of sulphate to ion balance (plot 3c) might be ascribed to sea salts reaching groundwater. As for lake water, the lowest concentrations of bicarbonate, matched with high values of conductivity and dissolved solids, also suggested direct intake of sea salts.

Correlation plots involving chloride in Fig. 5 confirmed the poor impact of seawater intrusion on groundwater. However, a neat separation between coastal and inland wells data points is detectable. The higher relative concentrations of chloride ions in coastal wells suggested that a minimal input of seawater can affect only the area of the aquifer close to the coastline.

All lake water data in Figs. 2, 3, and 5 revealed that water quality at the main spring resembled that of groundwater sampled in coastal wells. This led to hypothesize the direction of discharging groundwater. The higher chloride content of lake water, if compared to the spring, suggested a direct input of seawater, whereas the distinguishable seasonality of lake data could be associated only with the effect of evaporation.

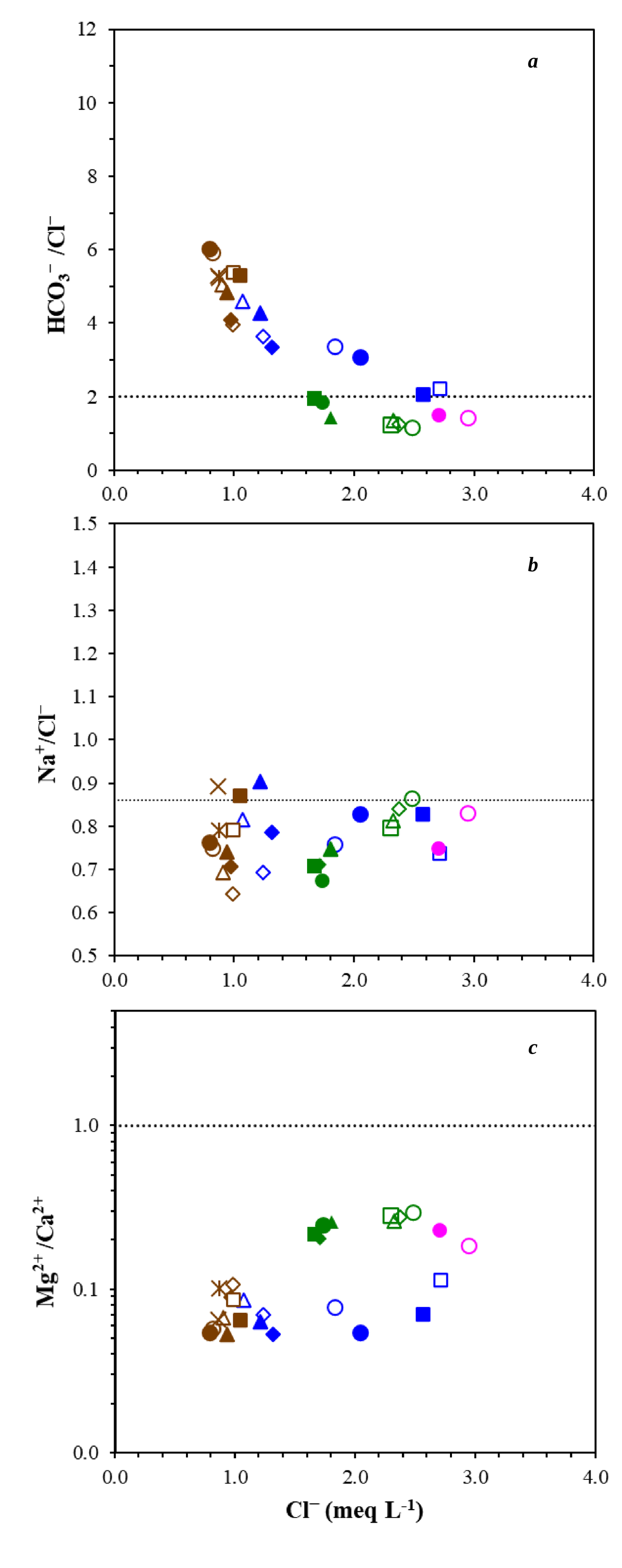


Figure 5

**in all plots: open symbols = dry season (D); full symbols = wet season (W); blue = coastal wells; brown = inland wells; dark green = lake sampling points; pink = spring sampling point; SW = Seawater; FW = freshwater

ACKNOWLEDGEMENTS

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