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## Extended Abstracts

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**Interactions of surface and ground waters**

title: **The influence of surface waters (ponds and drainage ditches) on the salinization of a coastal aquifer in the south-eastern Po plain (Italy)**

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The south-eastern Po plain consists of a subsiding coastal lowland, where the phreatic aquifer has been extensively contaminated by seawater (Antonellini et al., 2008; Giambastiani et al., 2007).

Prolonged dry seasons, natural and men-induced subsidence, dunes and beaches erosion have been indicated as the basic salinization causes by most of the authors.

This study has the objective of investigating the role of surface water-groundwater interactions on the phreatic aquifer contamination by salt water.

In 2008, we performed a preliminary surface water and top groundwater monitoring and we have identified ponds and drainage ditches as an additional factor contributing to the salinization process of the area (Marconi et al., 2009). In the early stage of the project the distribution of the chemical-physical parameters and of some minor elements (e.g. arsenic and iron) confirmed that a seepage of deep groundwater was taking place in the surface water bodies, which are located in the main depressions of the area.

We are now testing the hypothesis that the presence of surface water bodies enhances the salinization of the phreatic aquifer through a double seasonal mechanism. During the dry seasons, the surface water bodies are almost dried up and the seepage of deep salty groundwater is allowed by the lowering of the groundwater head falling below sea level. At the same time evaporation of the surface water in the Summer induces the precipitation of salt solid phases at the bottom of ponds and ditches. During the fall, the rainwater, which recharges the surface water bodies is contaminated by the salts deposited at the bottom and in the hyporeic zone of ditches and ponds during the Summer. The infliltration water, therefore, is already brackish before reaching the aquifer. The low hydraulic gradients and the scarcity of rainfall that characterize the study area, do not allow the salt minerals flushing during the rainy seasons.

In order to have a better understanding of this phenomenon, we planned a detailed survey focusing on surface water-groundwater interactions, which is still ongoing. Temperature, electrical conductivity, redox potential, pH, and dissolved oxygen of the surface water bodies are measured each month in selected monitoring stations located in the proximity of fully screened observation wells, which are totally penetrating the phreatic aquifer. The chemical and physical parameters of the groundwater are measured at the top and at the bottom of the aquifer (5 m thick on average) by means of a multilevel sampler. In addition, we obtained seasonal electrical conductivity and temperature cross sections of the main ponds.

In the Summer 2009 we also collected a number of vertical chloride concentration profiles, which were performed in the subsoil below the bottom of ditches and ponds and in the aquifer close to the surface water bodies. This survey was made by means of a T-EC probe that measures the electrical conductivity of the whole saturated system (composed by sediments and groundwater) with a spacing of 0.1 m. Chloride concentration in the groundwater was deduced through the analyses of detailed lithological descriptions collected at each T-EC probe measurements point.

Our first results show that in the observation wells located close to ditches and ponds, the salinity of the top aquifer groundwater is higher than that measured at the bottom of the aquifer; this is in contrast with what is commonly observed in coastal aquifers. Chloride concentrations gradients in the hyporeic zones of the surface water bodies also decrease with depth in both seasons (Figure 1).

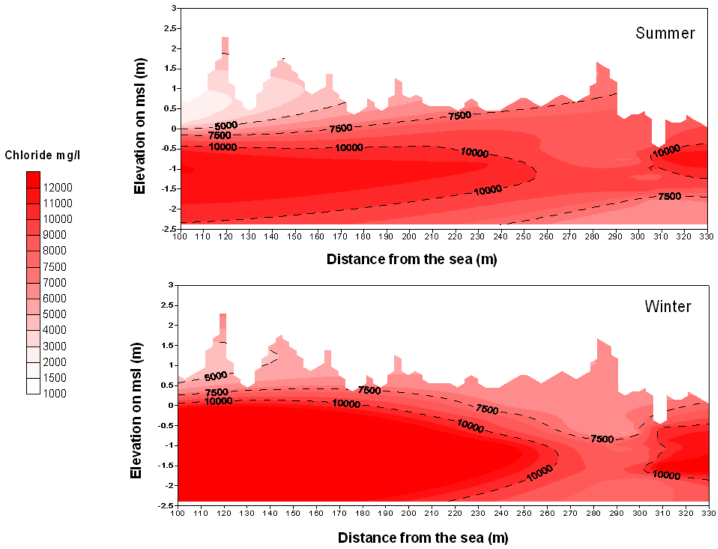


**Figure 1.** Seasonal chorides distribution in a 2D profile across the study area. The lowest topography correspond to a drainage ditch, where saline water is upconing.

The salinity of the surface water bodies increases with depth in the case of very shallow ponds, where the strong evaporation rates induce a stratification of the water column during the summer and the precipitation of salts (Fig. 2). On the contrary, salinity pattern does not show any correlation with water depth in the case of deeper surface water bodies, which do turn into hypersaline solutions (Fig. 3).

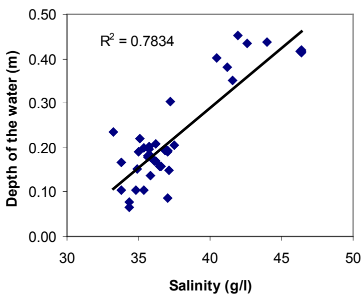


**Figure 2.** Positive correlation between salinity and water depth in very shallow and hypersaline ponds.

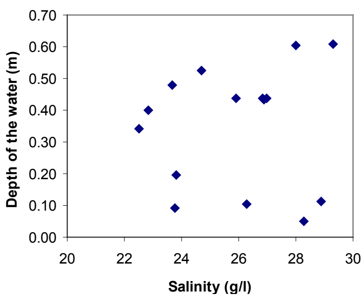


**Figure 3.** Salinity and water depth show no correlation in brackish-saline shallow ponds.

These observations indicate that the occurrence of stagnant surface water bodies in semi-arid climate conditions may enhance the salinization of coastal phreatic aquifers prone to seawater intrusion.

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