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Hydrogeochemical characterization of the phreatic system of the coastal wetland located between Fiumi Uniti and Bevano rivers in the southern Po plain (Northern Italy).

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A hydrogeochemical study has been undertaken on the phreatic system of the coastal area included between Fiumi Uniti and Bevano rivers (in the southern part of the Po plain, near the city of Ravenna) within the framework of the CIRCLE-ERANET project WATERKNOW on the effects of climate change on the mediterranean catchments. It is one of the first attempt in the area to characterize the shallow groundwater water system and to investigate if the arsenic anomaly, known in deeper groundwater (about 100 [U+F020]μg/l according to recent Annual Groundwater Quality Reports of Emilia-Romagna Region), occurs also in the phreatic system.
The coastal part of the Po plain consists of a low-lying and mechanically-drained farmland further from the sea and of a narrow belt of dunes and pine forests in the backshore area. The study area is recognized as a protected area at european (ZPS and SIC, site code number: IT 14070009), national and regional level (Po delta Park area).
As a result of an intensive exploitation of coastal aquifers for agricultural, industrial, and civil uses, both the phreatic aquifer and the surface waters (drainage ditches and ponds) have been contaminated by seawater and by deeper groundwater.
Samples representative of the top of the water table were collected in Summer 2008 in 22 auger-holes and in 3 shallow piezometers (6 m deep) documenting the deeper layers of the phreatic groundwater system. Temperature, electrical conductivity, pH and Eh of the groundwater and of the surface water were measured on site using portable instruments. Samples were filtered directly in the field, an aliquot was acidified with diluted HCl for metal analysis. Cations were determined by Flame Atomic Absorption (thermo S-series spectrometer), anions by ion chromatography (Dionex ICS-90), Fe, As, Si, B by ICP-OES (Thermo iCAP6000).
The data collected in the field show that a fresh groundwater lens is still present at the top of the phreatic aquifer in the backshore area and that the surface water is all brackish to salty and characterised by negative values of Eh, which is probably due to the low hydraulic gradients of the area. Hydrochemistry indicates that a simple mixing model does not completely account for the observed groundwater chemistry, thus a more complex and dynamic system must be invoked. The interaction between saltwater and freshwater could be possibly complicated by contributions from deeper and older connate waters and, considering the type of water sample, by precipitation-dissolution reactions taking place in the vadose zone.
Application of the BEX (Base Exchange Index, Stuyfzand, 1993), corrected for the occurrence of dolomite in the aquifer, indicate that a salinization processes is taking place in the largest part of the studied area and only in few locations close to the Fiumi Uniti river mouth there are geochemical evidences of freshening probably because there is a different geological situation: silt-clay lenses containing exchangeable minerals are intercalated and/or overlying the sandy aquifer. However an influence of the river on groundwater chemistry cannot be at present completely excluded for the proximity of these sites to the river.
Apart groundwater salinization another major environmental problem concerning water quality is represented by elevated Arsenic concentrations. The element display a good negative correlation with Eh but no evident sign of correlation with other measured parameters. Observed arsenic concentrations reach a maximum of 42 μg/l in an auger-hole close to a pond, which is characterized by abundant precipitation of iron hydroxides in the hyporheic zone as well as most of the others surface water bodies. Other relatively high concentration (about 60 μg/l) are observed in a piezometer (screen depth of 5 m) in the southern area. The ongoing salinization process and the detected anomalies in Arsenic in the phreatic aquifer and in surface water are jeopardizing this wetland ecosystem,

which poses a major environmental issue for phreatic water management in the coast.

Stuyfzand, P.J. 1993. Hydrochemistry and hydrology of the coastal dune area of the Western Netherlands. Ph.D Thesis Vrije Univ. Amsterdam, KIWA, ISBN 90-74741-01-0, 366 p.