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The salt water encroachment along the Lamone river artificial estuary: an issue for the coastal management in the Southern Po Plain Adriatic Coast (Italy).

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Recently, the problem of saltwater intrusion in shallow aquifers has been recognized across Europe as one of the major threats for freshwater resources in coastal areas. Italy is indicated as one of the countries most severely affected. The problem of saltwater encroachment into the coastal water system attracted the public opinion attention during the last summers, when, due to low rainfall and low discharge rates, the ingression of seawater along the Po river branches was measured 12 kilometres upstream of the river delta. This situation caused a weakening of agricultural activities (inability to irrigate crops and orchards) and led, in same cases, to the shutdown of electric power generation plants due to the lack of freshwater used for cooling.

This study is carried out to quantify the saltwater encroachment along the Lamone river and to estimate its possible contribution to the salinization process of the shallow sandy aquifer in the area.
The Lamone River is typical for one of the many small low-discharge rivers flowing from the Appennines and reaching the Adriatic sea after a 88 km course through the southern Po Plain. Its estuary was artificially constrained to the actual position in 1960 and this is the reason of its artificially rectified shape.

The salt water encroachment phenomenon has been analyzed during 2008 with a monthly monitoring of electrical conductivity profiles in 31 stations along the terminal 8 kilometres of the river, from its upstream physical boundary (represented by an artificial dam built to collect water for the Ravenna city water treatment plant) and the sea. Measurements point out that the Lamone river estuary has sharp vertical water stratification. Bottom water conductivity values show the presence of saltwater (45 mS/cm) in the first 24 stations (starting from the sea) in almost all monitoring campaigns. At 6.5 km from the sea, the presence of a rocky sill protecting a pipeline represents an efficient threshold that blocks or in some cases just hinders the salt wedge traveling inland. The bathymetry of the river was also surveyed showing a very irregular bottom surface, characterized by the presence of deep holes. Saltwater remains trapped in these holes for a long time and this fact possibly represents the major source of salt in the interaction process between river and groundwater.

On the basis of the field data, a simple analytical model, based on the equation of Schijf & Schoenfeld (1953) describing the length of the salt wedge intrusion with no tides, was built and calibrated. This simple tool was useful to evaluate the physical friction coefficient of the system and to investigate the relationships between friction and river discharge. The aim of this part of the study was to use such a model to evaluate the theoretical values of river discharge to be maintained in order to keep the salt wedge away from those sections of the river in direct connection with the permeable phreatic aquifer.

We are currently evaluating some other analytical solutions proposed by Fisher (1974) and Savenije (1993), considering the influence of tides, to refine the values of the river's hydraulic parameters and to test the possibility of applying these more complex analytical models to small estuaries such as the Lamone river mouth, very different in spatial scale related to the study cases presented by these authors. The possibility of using these new analytical techniques will give us a tool for building a predictive model to be used in estimating the influence of different river management solutions and sea level rise scenarios in the salt wedge intrusion process.