MONITORING OF THE UNCONFINED AND CONFINED AQUIFERS CLOSE TO THE RIGHT-HAND RIVER BANK OF THE PO RIVER IN THE REGGIO EMILIA AREA

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INTRODUCTION

We focus on the analysis of the relationships between the groundwater system and the Po river in a selected area in the presence of recharge also due to rainfall. Recent geological investigations performed within a national program for the seismic study of the Po river embankment allow to confirm the geological model of the area. Hydraulic monitoring results support the underlying conceptual picture of the geological system.
Hydraulic monitoring stations are distributed within the Reggio Emilia and Ferrara districts, along sections normal to main river bed and covering a few kilometers. This work is mainly devoted to the presentation of some preliminary results related to the area of Reggio Emilia.

GEOLOGICAL-HYDROGEOLOGICAL SETTING

The deep aquifer system is hosted within a thick upper Pleistocene sandy layer which derives from a high energy fluvial environment, related to a past fluvial-glacial climatic age of the Po River. The bottom boundary of these Würmian sands can reach a depth of more than 50 m. The shallow aquifer is hosted within alternated sequences of sediments of fine and coarse Holocene materials for a thickness between 7 to 12 m near the top, deposited by a meandered fluvial system, similar to the present (Bondesan et al. 1974, Servizio Geologico d'Italia - Regione Emilia-Romagna, in press).
The conceptual hydrogeological model relies on the occurence of two different aquifers (named A0 and A1) of mainly sandy Pleistocene-Holocene deposits of the regional multilevel aquifer (Regione Emilia-Romagna & ENI-AGIP, 1998, Severi et al. 2002). These are in direct hydraulic contact with the main surface waters.

AVAILABLE DATA

The monitoring period under investigation is comprised between April and December 2011.

Here, we illustrate data collected along two sections within the Reggio Emilia area (Figure 1), where data related to a monitoring station located at a distance of about 2 km at the left-hand side of the Po river are also available (POM_c).

Monitoring stations comprise piezometers equipped with downhole transducers measuring hydraulic pressure, electric conductivity and temperature. Data are collected at hourly intervals and continuously sent through a GSM system to a web-controlled server.

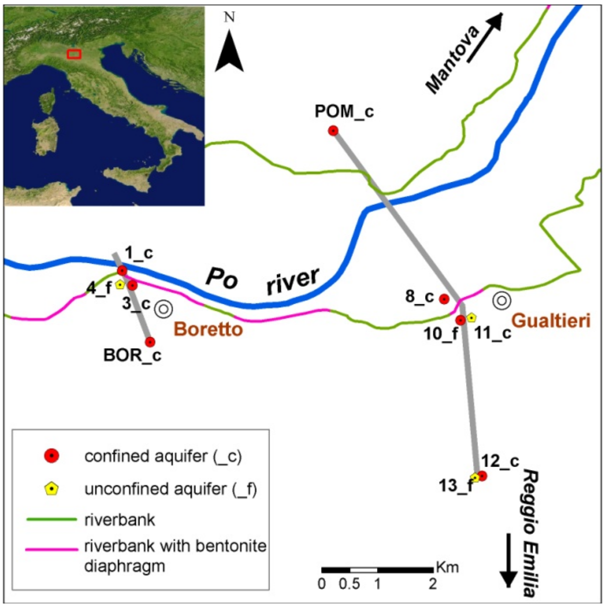

Figure 1 – Geographic setting of the study area.

Two kinds of piezometers are installed: type "c" is typically filtered along the 10-50 m depth interval to intercept the first confined aquifer starting from the topographic surface (A1); while type "f" is filtered at about 2-10 m deep to intercept the water table (unconfined aquifer – A0).
The confined aquifer is investigated in three locations: i) between the Po river and the right-hand embankment; (ii) in the external right embankment footstep; and (iii) at a distance of about 3 km from the right embankment.
The unconfined aquifer is investigated at two locations, beside piezometers "c": (i) in the external right embankment footstep and (ii) at a distance of about 3 km from the right embankment. The river level is monitored at a hourly rate through 4 hydrometers. Hydraulic modelling results providing predictions of the river stage are available.

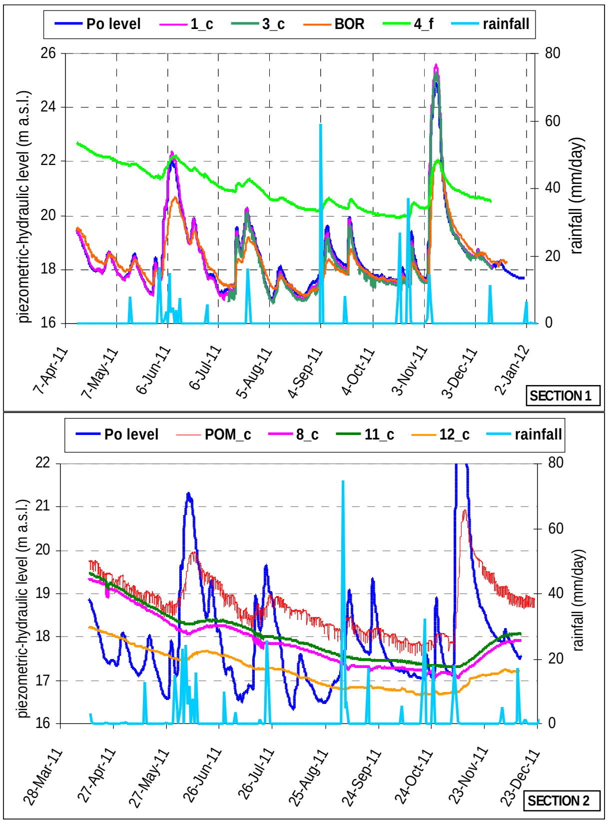

Figure 2 – Monitoring results of groundwater level and water level in the Po river. Precipitations are also reported.

CONCLUDING RESULTS

Monitoring results (Fig. 2) reveal that the confined aquifer is typically characterized by a piezometric level which is about 1-2 m lower than that of the unconfined aquifer. This scenario is reversed during significant flooding events (e.g. the November flood). These data area consistent with previous observations (Regione Emilia-Romagna, 2007).

The river drains the unconfined aquifer. Even if the unconfined aquifer level is higher respect to the river level most of the times, it follows river trend. During floods this relationship is inverted.

The piezometric levels of the confined aquifer are influenced by the river up to a distance of about 2 km. Piezometric level of the confined aquifer closely match those monitored within the Po river at locations close to the river. The piezometric level of the confined aquifer can be influenced by local effects, such as riverbank bentonite diaphragm (11_c), coverage litology (8_c), and groundwater wells (POM_c). If the riverbank is protected with bentonite diaphragm, the river influence is strongly reduced both in the unconfined and in the confined aquifer, even though the diaphragm does not reach the bottom of the aquifer.

Electric conductivity and water temperature show significant trend for the comprehension of the interaction of aquifers with river and rainfall.

The electric conductivity in the confined aquifer strongly decreases in the proximity of the river during flood events. This is an important indication of the occurence of river-aquifer mass exchanges (Colombani et al, 2007). The electric conductivity in the unconfined aquifer displays sharp peaks during some heavy rainfall events, probably due to the dissolution of salts located in the soils.

The temperature of the confined aquifer is not influenced by the seasonal variations and by the effect of floods. It displays a relatively constant value of about 14.5° C. The unconfined aquifer has a 2°C temperature gradient from spring to autumn. Temperature data allow identifyng the confined/unconfined nature of an aquifer system. Note that the temperature values typical of unconfined conditions can be recorded within deep piezometers (c) due to the occurrence of sandy sediments above the aquifer that do not provide a complete insulation of the system from athmosferic effects.

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REFERENCES

BONDESAN, M., DAL CIN, R., MANTOVANI, M.G. (1974) - Würmian fluvioglacial deposits along a water well, drilled near to Ferrara. Annals of the University of Ferrara, Sect. IX, Geological and Paleontological Sciences, vol. V, n. 8, 147-163. (in Italian).

Regione Emilia-Romagna Servizio Geologico Sismico e dei Suoli (2007) INTERREG IIIB MEDOCC BASSINS VERSANT MEDITERRANEES – *Guida Metodologica. Individuazione di risorse idriche alternative. Progetto Pilota.*

COLOMBANI N., GARGINI A., MASTROCICCO M., MESSINA A. (2007) – L'acquifero di Settepolesini di Bondeno: una risorsa idrica potenzialmente alternativa per l'attingimento idropotabile della provincia di Ferrara. In: Risorse idriche sotterranee della Provincia di Ferrara. Regione Emilia-Romagna, 80 pp.

SEVERI, P., GUERMANDI, M., LARUCCIA, N., FRASSINETTI, G. (2002) - Cartography of the aquifers vulnerability: contributions of geology and soil sciences. In: Proceedings of the III Seminar on geological cartography, Bologna 26-27 Feb 2002. Regione Emilia-Romagna, Bologna, 36-43. (in Italian).

SERVIZIO GEOLOGICO D'ITALIA – REGIONE EMILIA-ROMAGNA (in press.) - CARTA GEOLOGICA D'ITALIA in scala 1:50.000 – Foglio 182 Guastalla.