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Evidence of sea-storms impacts on the phreatic coastal aquifer the case of "La Nuit" Cesenatico

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INTRODUCTION

In the coastal area of Emilia-Romagna Region the unconfined aquifer is characterized by the proximity of fresh waters of continental and meteoric origin and the sea water.
The dynamics of these groundwaters are rather complex (Post V.E.A 2005) and any change in the interface between fresh and saline waters (F/S interface) could have negative effects on the delicate coastal ecosystems.
In this paper we present the first results of the piezometers monitoring at Cesenatico's beach area that highlights the possible influences of the sea-storm on the water quality and water

SETTING AND DATA ACQUISITION

In the study area the coastal unconfined aquifer is an outcropping sandy strip, parallel to the shoreline, consisting of strand plain deposits, with a thickness of about 8 meters and an inland extension of approximately 1 km (Bonzi et al. 2010).
The piezometer analysed is located in Cesenatico (Ex Nuit area - figure 1) at a distance of 100 meters from the shoreline and it is 8 meters deep; and filters the entire thickness of the aquifer.
The piezometer was equipped with a probe with sensors, placed 4.5 meters depth from ground level – corresponding to the F/S interface, for the monitoring of electrical conductivity, temperature and position of the water table.
The measures, started in June 2011, are hourly, and are currently in progress.
The data on wave height are referred to the Nausicaa buoy (http://www.arpa.emr.it/sim/?mare/boa), situated in front of Cesenatico (figure 1) where the seabed is 10 meters depth.Wave height data are collected every 30 minutes, from the ARPA (regional environmental protection agency) monitoring network.

Figure 1 - Location of the study area

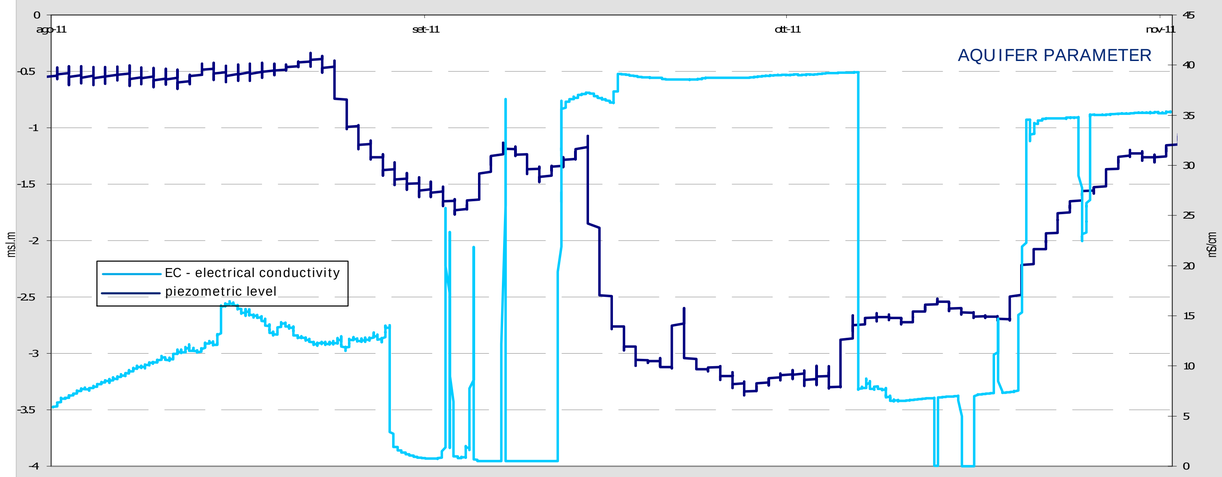

Figure 2 - water table position (dark blue line) and EC value (light blue line) at the probe from 1 August to 20 October.

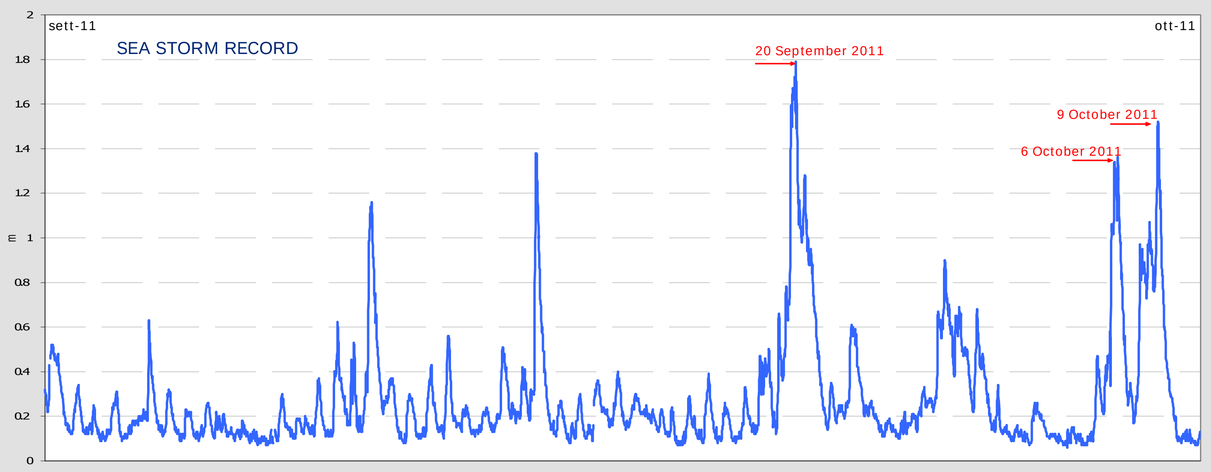

Figure 3 - Wave height of the Nausicaa buoy (from august 2011 to september 2011): red arrows indicate the two storm events

THE SEA STORM IMPACT ON THE AQUIFER

In the monitoring period (1 August 2011-20 October 2011) there were two episodes of major sea-storm (September 20, 2011 and 6-9 October 2011) with a maximum wave height of 1.79 meters registered on 20 September 2011 (figure 3), with a sea level of 0.52 recorded by tide gauge at Porto Corsini; in association with the storms event weak precipitation occurred.
Figure 2 shows the data log of the piezometer during these particular events.
The values of EC and the groundwater level both underwent a temporary decrease due to the action of neighboring well-points (Esca and Venturini, 2006) that extracted salty waters from the bottom of the aquifer, from September 8 and for all period considered. For that reason, the F/S interface dropped down and the probe were then located within the fresher water.
During the storm events (20 Sept. and 6 Oct.) this trend was interrupted by a relative rise of groundwater level and by a even more marked rise of the EC.
That caused the occurrence of a strong hydraulic gradient due to a lowering of about one meter of the water table due to the well-points (from -0.5 to about -1.5 m m.s.l.) and a sea level rising more than 0.5 m m. s. l..

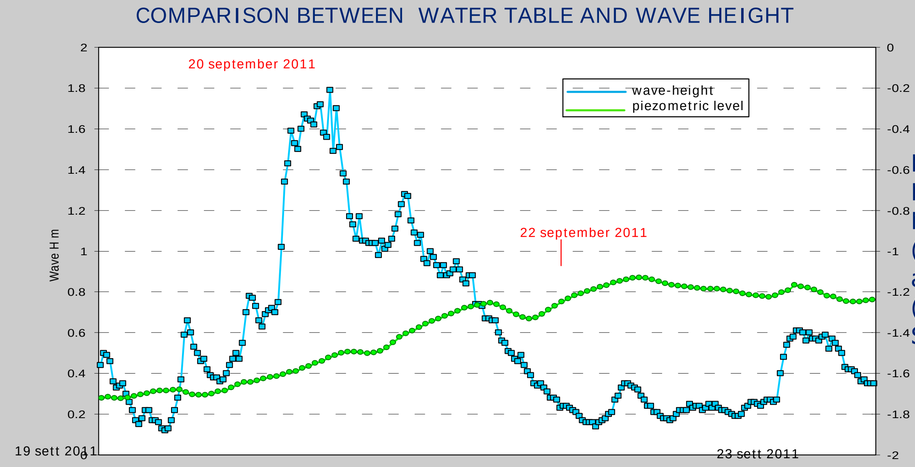

Figure 4 - Data log from the Nausicaa buoy record (wave-heght) and piezometric level (from 19 to 23 September 2011)

The impact of sea-storm is particularly evident by comparing the groundwater data with the trend of the wave height.
With regard to the water table level, we observe that, throughout the course of the storm of September 20, it rise rapidly of about 40 cm and continues to rise more slowly (20 cm) during the next 48 hours. For the next hours it's remained constant, except for some minor increases still connected to the secondary peaks of the wave height (figure 4).
Considering the electrical conductivity, it can be noted, comparing the EC log and the wave height about the event of 20 September 2011, that during the peak of sea-storm does not have variations in the value of EC, probably because of the probe position, while a significant increase of conductivity values from 0.82 mS / cm to 25.75 mS / cm, takes place in a period of 48 hours, in correspondence of the higher position of the water table (Figure 5).

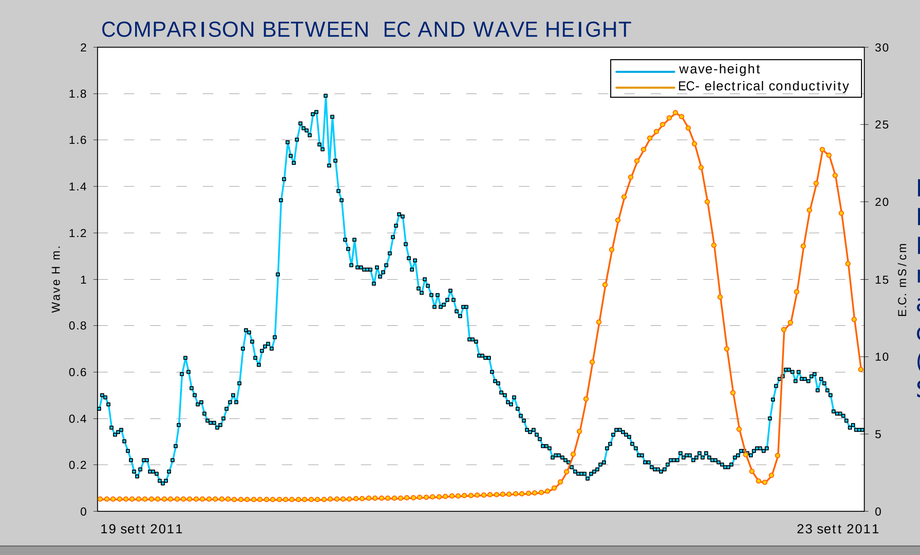

Figure 5 - Data log from the Nausicaa buoy record (wave height) and electrical conductivity (EC) (from 19 to 23 September 2011).

CONCLUSION

Continuous monitoring of the Cesenatico La Nuit piezometer has showed a direct response of unconfined aquifer to sea-storm events, especially the wave and then the set-up on the shore. The rising of the water table is concomitant with increase of the wave height and is influenced by the increased hydraulic load by the sea. An important mass transfer of marine water must be considered because of a strong increase of the EC values and the stability of the groundwater level after the main pulse of the sea-storm.

REFERENCES
Bonzi L, Calabrese L., Severi P., Vincenzi V., 2010. L'acquifero freatico costiero della regione Emilia-Romagna: modello geologico e stato di salinizzazione. Il Geologo, X, 39, pp.21-34.
Esca S., Venturini L., 2006. Hydrogeological impact of wellpoint dewatering upon unconfined coastal aquifer of the municipality of Cervia (Ravenna – Italy). Proceedings 1st SWIM-SWICA Joint Saltwater intrusion Conference, Cagliari-Chia Laguna, Italy – September 24-29, 2006, 71-77.
Post V.E.A., 2005. Fresh and saline groundwater interaction in coastal aquifers: Is our technology ready for the problems ahead? Hydrogeol J, 16: 120-123.