

5<sup>th</sup> Barcelona | Catalonia, Spain  
june 13<sup>th</sup> | 16<sup>th</sup> 2006

European  
Congress  
on Regional  
Geoscientific  
Cartography  
and  
Information  
Systems  
Earth  
and  
Water



Proceedings  
Volume I

We express gratitude to M<sup>a</sup> Rosa Carles, Marieta Cartró, Laura Culí, Carlota Gurri, Pere Mas and Mònica Rivas for the enthusiastic assistance.

We thank also to Units of Cartography, Sistemes and External Projects of Institut Cartogràfic de Catalunya.

We thank to Artyplan for the proceedings.

Finally, thanks to Marta Gratacós of Carlson Wagonlit Travel for the technical assistance.

## **5<sup>th</sup> European Congress on Regional Geoscientific Cartography and Information Systems**

Earth and Water

**Proceedings Volume I**

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Dipòsit Legal: B-31.042-2006/1

Published by:

Institut Cartogràfic de Catalunya

Institut Geològic de Catalunya

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08038 Barcelona

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# SALTWATER INTRUSION IN THE SOUTHERN CATCHMENT BASIN OF THE VENICE LAGOON, ITALY

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**KEY WORDS:** Saltwater intrusion, hydrogeology, Venice Lagoon catchment.

## INTRODUCTION

The investigated area is the catchment located south of the Venice Lagoon, where multidisciplinary studies (ISES Project, Co.Ri.La. 3.10 Project)<sup>1</sup> provided evidence of a phreatic aquifer contamination due to saltwater intrusion from the sea and the lagoon.

The ground elevation of the territory, generally below the mean sea level up to -4 m, enhances the process especially in those sectors where land subsidence, mainly due to peat soil oxidation in close connection with the agricultural practices, is responsible for a subsidence rate varying between 1.5 and 2 cm/yr (Gambolati *et al.*, 2005).

## SALTWATER CONTAMINATION

The saltwater contamination was investigated by means of hydrogeological and geophysical surveys and a new monitoring network of surface water and shallow groundwater (ISES Network).

Geological studies pointed out that geomorphologic features and stratigraphic setting can favour or mitigate this process. In particular, well developed paleo-river systems and permeable sediments represent preferential environments of communication between waters characterized by different salinity, whereas thick silt-clayey layers can preclude the salty pollution from the lagoon and the sea.

Changes in river discharge, regulation of phreatic water levels by means of pumping stations, climatic conditions, fresh-water input for irrigation purpose, and riverbed seepage are important factors that cause saltwater contamination. The latter, influenced by tides and river discharges, takes place when sea and lagoon waters flow up rivers and channels (Fig. 1). For example, in summer 2003, when a severe drought

happened, salt water flowed up the Brenta and Bacchiglione rivers for more than 15 km (Fig. 2) (Carbognin *et al.*, 2005), inducing high soil salinization and consequently serious problems to agriculture.

The interpretation of the results obtained from the investigations allowed producing maps of the top and bottom of the saltwater intrusion (Fig. 3) (Carbognin & Tosi, 2003). The former indicates the depth of the fresh/salt water boundary and shows the thickness of the surface fresh water aquifer. Six classes were distinguished: the first one is related to a very critical situation because it represents areas where saltwater contamination can be superficial and so responsible for damages to agriculture. The second class includes the zones where soil salinization depends on seasons and climate variability.

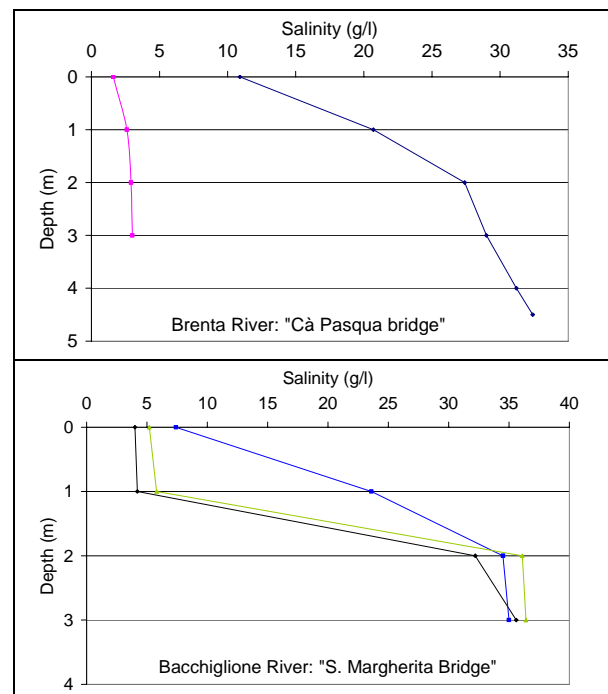


Figure 1 – Example of salt water encroachment variation along the Brenta and Bacchiglione rivers due to the combination of tide level and river discharge changes.

<sup>1</sup> ISES Project: Intrusion of Saltwater and Land Subsidence. Co.Ri.La. 3.10 Project: Groundwater discharge in the Lagoon of Venice derived from isotopic tracers and geoelectric tomography.

The map of the bottom of saltwater contamination indicates the depth of the aquitard, which represents a natural obstacle to saltwater intrusion in the deeper deposits. It depends on the presence and characteristics of clayey layers (permeability, thickness, extent) and deepens southward, ranging from 15-30 m to 60-75 m depths.

The maps of saltwater contamination show that on the southern Venetian littoral a system of sand dune ridges contains a reservoir of freshwater up to 15 m thick (Rizzetto *et al.*, 2003). In the mainland the thickness of the surface aquifer is frequently reduced up to 1 m because of the critical ground elevation of the area, the pumping to maintain drainage, and particular local sedimentological and geomorphologic features, that enhance the saltwater intrusion landward.

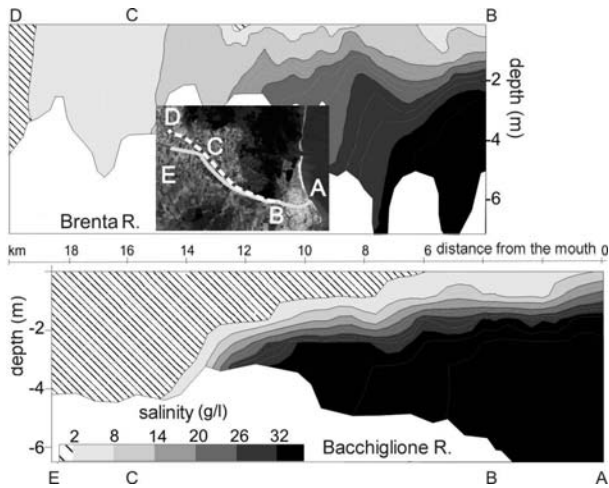


Figure 2 – Salt water encroachment along the Brenta and Bacchiglione rivers in summer 2003 (from Carboognin *et al.*, 2005).

Patterns of saltwater contamination (Fig. 3) show that only the area between the Brenta and Bacchiglione rivers, where Piove di Sacco and Codevigo towns are located, is not affected by soil salinization process.

### ACKNOWLEDGEMENTS

This work was performed in the frame of the ISES Project and the Co.Ri.La. 3.10 Project.

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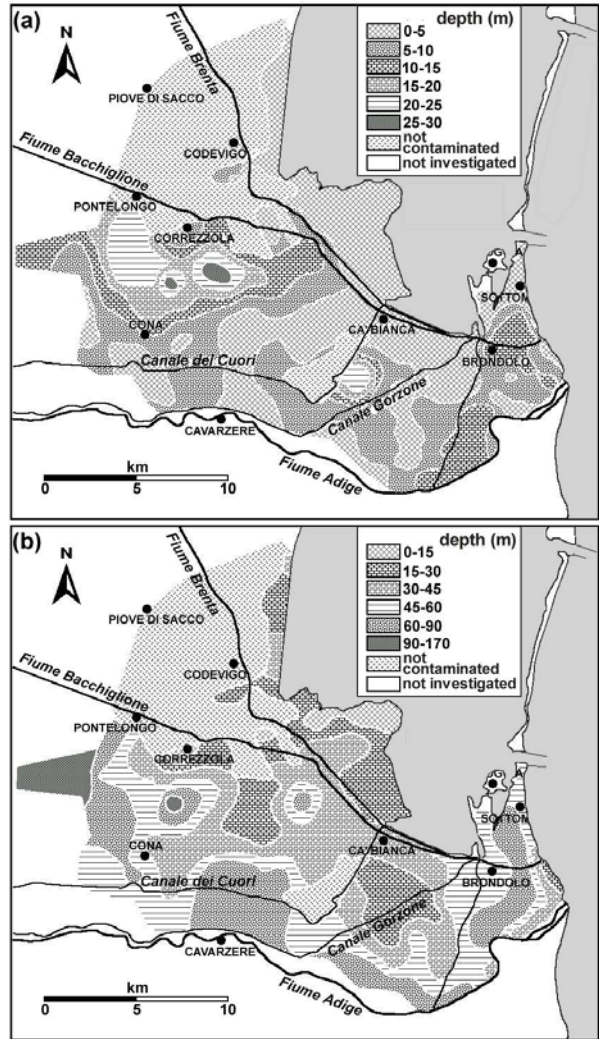


Figure 3 – Maps of saltwater contamination: (a) top and (b) bottom.

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