

A controlling system (gate, soil dam) on the mouth of the main irrigation channel

Deliverable D_4.2.2

Contributing partners:

PP1 – CNR IGG

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1. Introduction

The Interreg Italy-Croatia project MoST (Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation) aims at testing solutions against saltwater intrusion in agricultural areas, a worldwide problem exacerbated by human activities and climate changes. The regions of interest of MoST project are the Veneto Region coastal plain south of the Lagoon of Venice (Italy) and the Neretva river mouth (Croatia).

MoST WP4.2 Action (Venice coastal plain) aims to test the efficiency of specific adaptation measurements to counteract and/or mitigate the effects of climate changes on the process of saltwater intrusion. Specifically, the increase of fresh-water volume stored in irrigation channels by controlling their outflow to the sea through new gates has potentially the effect to increase (i) the freshwater availability for irrigation and (ii) the freshwater seepage from the channel bed into the shallow aquifer of the nearby low-lying farmlands.

This document is the deliverable D_4.2.2 “A controlling system (gate, soil dam) on the mouth of the main irrigation channel” developed by PP1 CNR-IGG. D_4.2.2 includes data and observations collected and analyzed by PP1, which were required by LP and PP2 for proper investigation of the possible need to design new gates at the mouth of the Morto Channel in order to i) improve the control of freshwater flow in the Brenta and Bacchiglione rivers and consequently its dispersion into the sea.

2. Materials and methods

The dataset used in this report as hydro-geo-morphological knowledge background are included in DOC n. MoST-CNR 3.3-001, DOC n. MoST-CNR 3.1-004, DOC n. MoST-CNR 3.2-003, DOC n.

MoST-CNR3.4-001 and their updated versions. Additional electrical conductivity measurements have been recorded in three monitoring sites (Fig. 1) properly established at the bridge crossing the Canal Morto, Bacchiglione and Brenta rivers (MOR_PA, BAC_PA, BRE_PA) and at the intake and discharge of the pumping station (MOR_PS, and MOR_OR).



Fig. 1 - Location of the study area and monitoring sites.

3. Study area

The study area is located at Ca' Pasqua where the Morto Channel, Bacchiglione River and Brenta River join in a single path and form a single mouth at the sea (*Fig. 2*).



Fig. 2 - Image of the location where Bacchiglione river (on the right) and Brenta river (on the left) join and discharge to the sea in a single mouth.

Brenta and Bacchiglione rivers are highly affected by tide encroachment and in very dry season seawater can flow along the river courses for several km from the sea.

For example, during summer 2003, which was characterized by a severe drought, seawater flowed into the Brenta and Bacchiglione rivers up to about 20 km (*Fig. 3*).

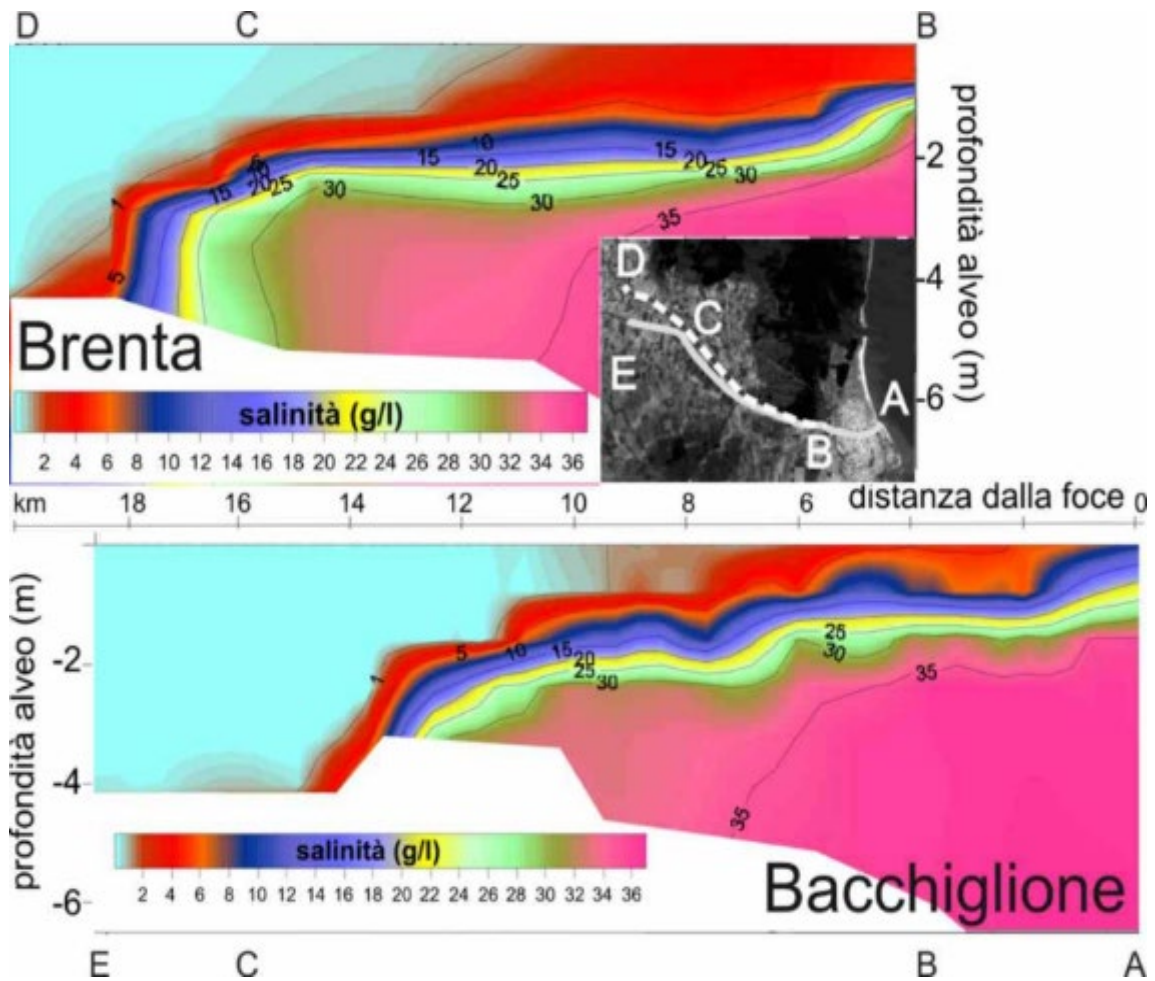


Fig. 3 - Saltwater encroachment along the Brenta (a) and Bacchiglione (b) rivers in the dry and hot July 2003; in the satellite map, white dashed line and grey continuous lines show the survey paths.

Regarding the Morto Channel mouth, two flap gates suddenly close when tide begins to rise avoiding the seawater encroachment (Fig. 5). When tides prevail on the river discharge, the seawater located on the deepest layer of the water column infiltrates through the bed of the watercourses in the nearby lowlands. Conversely, when the river discharges counteract the

seawater encroachments, the watercourses exert a significant role in mitigating the salt contamination in the aquifers (Fig. 4).



Fig. 4 - The two gates at the mouth of the Morto Channel.

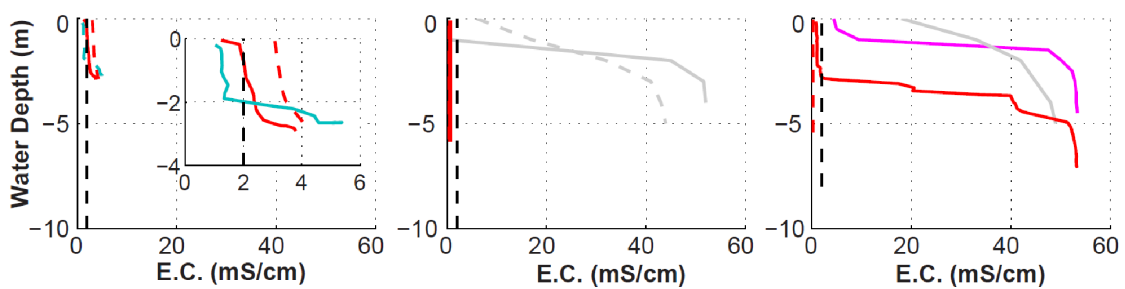


Fig. 5 - Electrical conductivity logs showing the freshwater-saltwater dynamics in the Morto Channel, Bacchiglione River and Brenta River at Ca' Pasqua bridge. The dashed line represents the maximum EC value for irrigation use.

4. Selection of data representing the initial conditions

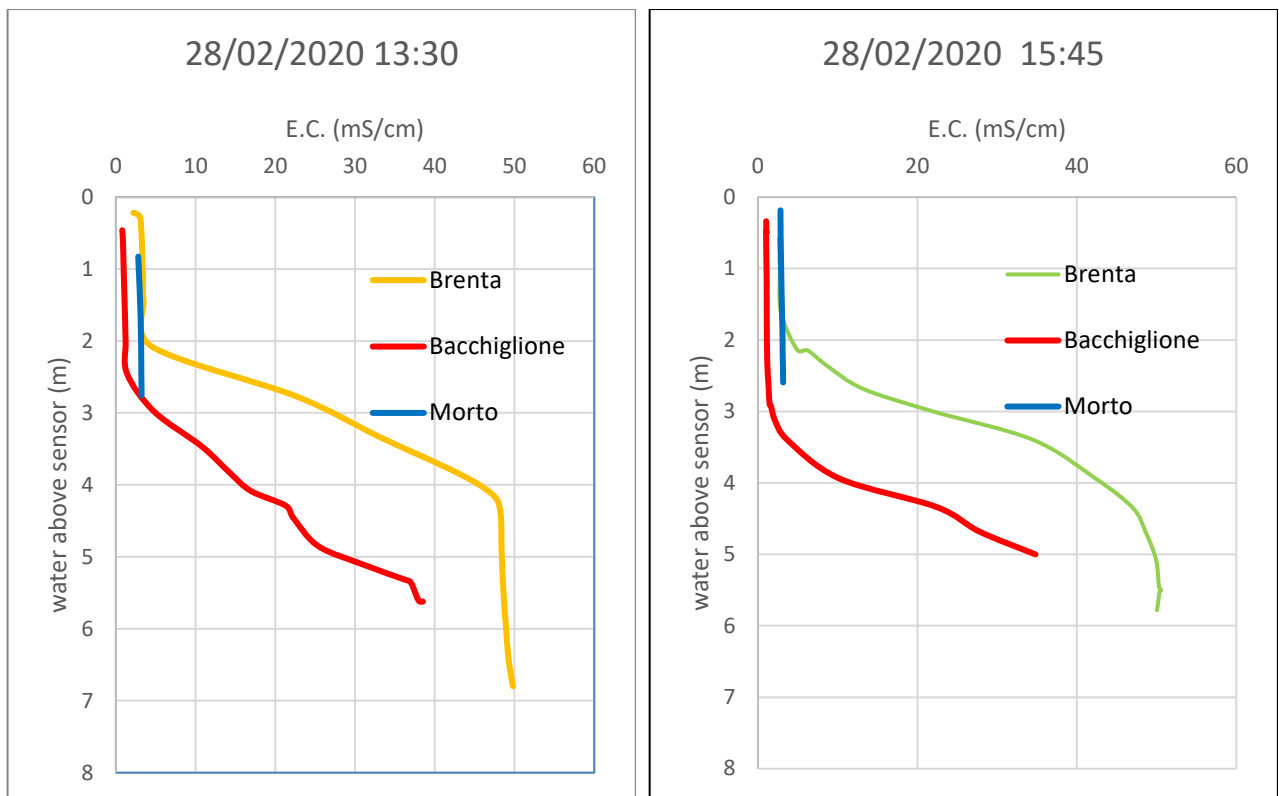
Within MoST project new data have been acquired during winter, spring, summer, and autumn seasons to get a picture of the tide encroachment along the Bacchiglione and Brenta rivers under different conditions and the state of the Morto Channel before and during irrigation seasons.

Three specific monitoring sites have been set up on the Ca' Pasqua bridge, which crosses the three waterways (Fig. 6; MOR_PA, BAC_PA, BRE_PA), and two along the Morto Channel (CA_PS, CA_OR).



Fig. 6 - Monitoring at Ca' Pasqua bridge.

The followings graphics show measurement taken from the three stations on the Ca' Pasqua Bridge between February and October in high and low tide conditions (Fig. 7-Fig. 11).



a)

b)

Fig. 7 - Example of winter condition under different tide levels at MOR_PA (Morto), BAC_PA (Bacchiglione), BRE_PA (Brenta) monitoring sites.

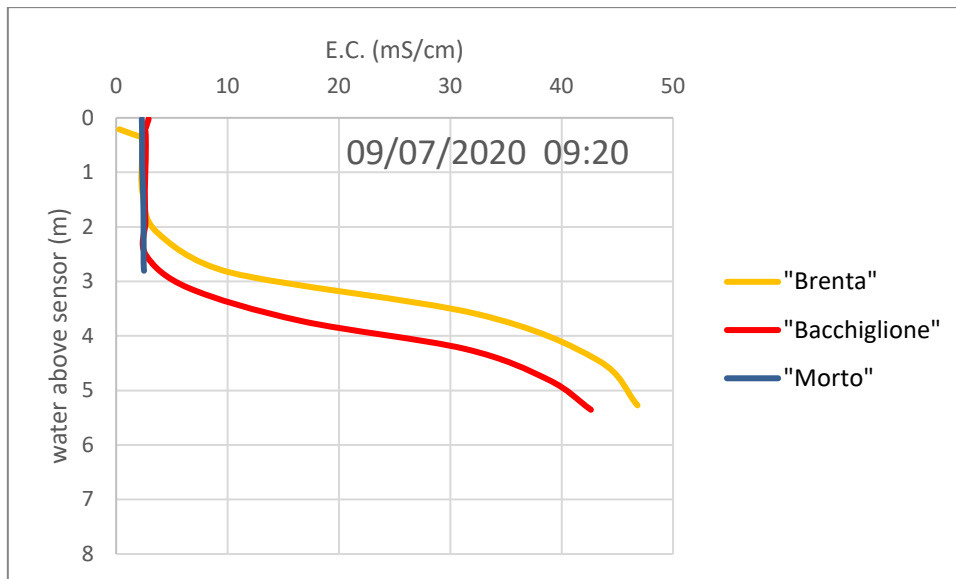


Fig. 8 - Low tide condition in summer season at MOR_PA (Morto), BAC_PA (Bacchiglione), BRE_PA (Brenta) monitoring sites.

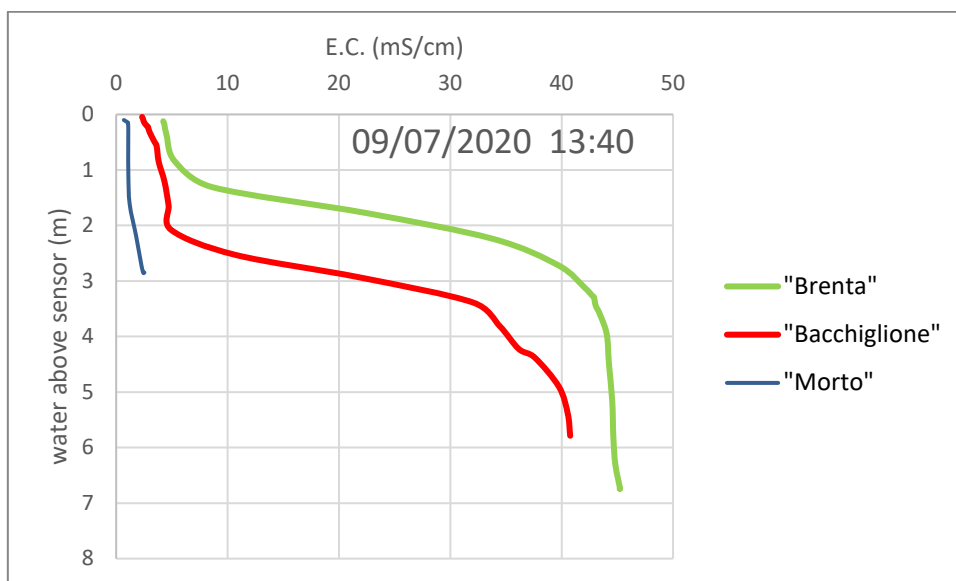


Fig. 9 - High tide condition in summer season at MOR_PA (Morto), BAC_PA (Bacchiglione), BRE_PA (Brenta) monitoring sites.

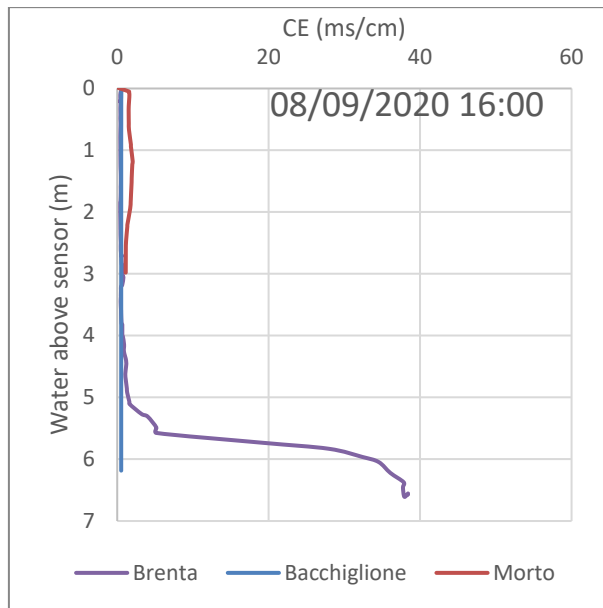


Fig. 10 - High tide condition at MOR_PA (Morto), BAC_PA (Bacchiglione), BRE_PA (Brenta) monitoring sites.

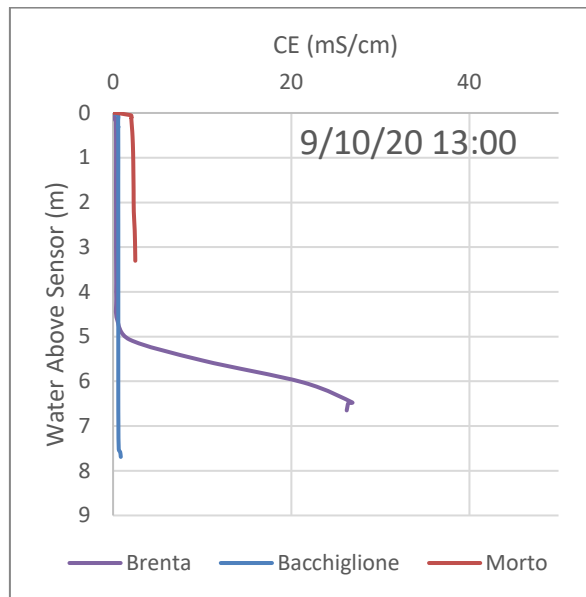


Fig. 11 - Low tide condition in autumn season at MOR_PA (Morto), BAC_PA (Bacchiglione), BRE_PA (Brenta) monitoring sites.

Tab. 1 reports the EC values taken along the Morto channel (MOR_PS and MOR_OR) between spring to winter seasons.

Site		27/05	05/06	10/06	29/07	14/10	28/10	04/11	18/11	16/12
MOR_PS (pumping station)	top	0,99 (2,6	3,16	1,38	2,7	2,11	1,84	3,02	3,5
	bottom	2,23	2,6	3,16	1,64	7,53	2,36	9,68	4,48	8,16
MOR_OR (oratory)	top	1,00	1,02	1,30	1,07	2,15	2,24	1,40	2,95	1,79
	bottom	1,00	1,05	2,5	1,08	2,22	2,23	1,93	2,96	2,57

Tab. 1 - EC Measurements (mS/cm) taken in the Morto Channel between May and December 2020 at the pumping station MOR_PS and next to the pilot site MOR_OR (see Fig. 1 for their locations).

5. Data interpretation

The data collected in the monitoring points located in the Morto Channel (i.e. MOR_PS, MOR_OR) show EC values relatively low, generally lower than 2.5-3 mS/cm, even though occasionally 3-4 mS/cm and exceptionally up to 9-10 mS/cm, have been recorded.

The highest EC has been generally detected at the monitoring site MOR_PS, which represent the farthest station from the Morto mouth, where the Casetta pumping station discharge the drainage water. In concomitance of the occurrence of higher EC, the water column is layered with significant difference between the top and the bottom. Moving to the east next to the pilot area, at the MOR_OR station the EC values are generally low, between 1 and 3 mS/cm.

At MOR_PA, representing the closer station to the mouth, EC values are never higher than 3 mS/cm. To be noticed that the EC values do not seem to increase with high tide, contrary to what was expected.

The increasing of the EC values at MOR_PS could be explained considering the water discharged from the pumping station: such water has been pumped from the aquifer, normally presenting a high salinity due to the sea-water intrusion.

In conclusion: the EC in the Morto Channel show relatively low values, with periodic slow increasing next to the pumping station, depending on the pumping station activity.

Surprisingly it does not show increasing related to the tide, meaning that the existing gate already prevents the tide encroachment.

For that reason, the construction of a new controlling system or the work implementation for reinforcing the Da Vince gates already present at the mouth of the Morto Channel, both aimed at better counteracting the seawater encroachment during high tides, have been abandoned.

However, the installation of EC sensors which for a continuous monitoring of the Morto Channel water, both at the MOR_PS and in the nearby of the intake of the sub-irrigation system, is strongly necessary. This will serve as a warning system for the presence of high salinity water, necessary for the correct management of the mitigation measure adopted in the pilot area.