EGU26-7210, updated on 11 Nov 2026
https://doi.org/10.5194/egusphere-egu26-7210
EGU General Assembly 2026
© Author(s) 2026. This work is distributed under
the Creative Commons Attribution 4.0 License.

Monitoring of the saline wedge in the rivers of the Ferrara province (Emilia Romagna region,Italy).

Francesca Fongo and Enzo Rizzo
Ferrara, Department of Physics and Earth Science, Ferrara, Italy (fngfnc@unife.it)

Saltwater intrusion threatens coastal ecosystems and water resources globally, intensified by climate change. Rising sea levels and reduced river flows disrupt the water balance in estuarine zones, allowing seawater to penetrate upstream into rivers and coastal aquifers. Studies predict a 9.1% global average increase in saltwater intrusion under high emissions scenarios, with extreme events becoming up to 25 times more frequent [2]. The Po River Delta exemplifies this vulnerability. The Ferrara area, characterized by minimal slopes and elevations mostly below sea level, is particularly exposed. Projections indicate the Po di Goro estuary could experience up to 63% annual increase in saltwater intrusion, reaching 120% in summer [6]. The 2022 drought demonstrated system fragility, with saltwater compromising irrigation and domestic water supplies. Groundwater aquifers face additional stress from excessive extraction and reduced natural recharge [1], affecting drinking water quality, agriculture, natural habitats, and soil integrity. Traditional monitoring relies on point measurements of electrical conductivity using boat-mounted probes, providing inadequate spatial and temporal resolution. Geophysical methods—particularly electrical resistivity tomography (ERT) and electromagnetic (FDEM) surveys—offer rapid, high-resolution alternatives. Previous research demonstrated the effectiveness of combined ERT-FDEM approaches in the Po di Goro for monitoring saltwater wedge advancement [4]. Integration of multiple geophysical techniques enables multi-scale characterization [3].
This PhD project develops an integrated monitoring and predictive modeling system for saltwater wedge intrusion in Ferrara, combining advanced geophysical methods with machine learning. Building on long-term FDEM monitoring (2022-2025) in the Po di Goro, the project extends to other Ferrara rivers and incorporates additional methods (ERT, GPR).
Expected outcomes include: (1) precise mapping of saltwater wedge extent, depth, and temporal evolution; (2) machine learning-based predictive tools to forecast intrusion evolution; (3) decision-support tools for sustainable water resource management, agriculture, and territorial planning, with methodologies transferable to other estuaries globally.

The project addresses a critical gap: the absence of systematic monitoring systems and reliable predictive tools. Increasing salinization frequency underscores the urgency for robust predictive capabilities enabling preventive interventions. The project responds to the 2022 Po River basin water crisis, offering practical solutions through informed policy on coastal defense, flood mitigation, subsidence reduction, and intrusion control [5].

References

[1] Crestani, E. (2022). Large-Scale Physical Modeling of Salt-Water Intrusion. Water, 14(8), 1183.
[2] Lee, J., et al. (2025). Global increases of salt intrusion in estuaries. Nature Communications, 16, 3444.
[3] Mansourian, D., et al. (2022). Geophysical surveys for saltwater intrusion assessment. Journal of the Earth and Space Physics, 48(3), 331–341.
[4] Rizzo, E., et al. (2023). DC and FDEM salt wedge monitoring of the Po di Goro river. EGU23-5297.
[5] Simeoni, U. (2009). A review of the Delta Po evolution. Geomorphology, 107(1–2), 64–71.
[6] Verri, G., et al. (2024). Salt-wedge estuary's response to rising sea level. Frontiers in Climate, 6, 1408038.