Luca Brocca: Director of Research at the Research Institute for Geo-Hydrological Protection - National Research Council of Italy.

Presentation title: The 2022 drought in the Po River basin: meteorological and hydrological framework

Luca Brocca received the PhD in Civil Engineering in 2008, since (2009) 2019 he is (Researcher) Director of Research at the National Research Council, Research Institute for Geo-Hydrological Protection (CNR-IRPI) in Perugia. He is author of 200+ journal papers (20000+ citations), and 20+ regional\global datasets, he is the head of the Hydrology Next Group at CNR-IRPI and he is involved as PI (and co-PI) in several projects funded by the European Commission and Space Agencies (ESA, EUMETSAT). His research interest lies in the development of innovative methods for exploiting satellite observations for hydrological applications (e.g., SM2RAIN, irrigation from space).

Abstract

During the first seven months of 2022, a significant meteorological drought was observed over a large part of the European continent, associated with the presence of a prolonged anomalous anticyclonic circulation over its northwestern region. Northern Italy in particular was affected by an exceptional lack of rainfall, contributing to a prolonged hydrological drought that threatened the security of water resources and riverine ecosystems. The River Po, the longest watercourse in Italy, reached critically low levels, reducing the availability of irrigation water and leading to record levels of seawater intrusion.

The presentation will describe the meteorological and hydrological conditions that occurred in the Po basin, using both ground and satellite observations of precipitation, snow, soil moisture, groundwater storage and river discharge. Simulations from a distributed hydrological modelling system specifically designed to simulate the management of water resources in the Po basin will also be considered. The system is currently being used to build a digital replica of the terrestrial water cycle and is part of the Digital Twin Earth Hydrology projects (https://explorer.dte-hydro.adamplatform.eu/). The ultimate goal is to develop advanced and detailed decision support systems that address the current challenges we face due to the increase in frequency and magnitude of extreme events.

Nicolò Colombani: Associate Professor at the Università Politecnica delle Marche Italy.

Presentation title: Modelling salinity origins and residence times in the unconfined coastal aquifer of the Po River lowland

Nicolò Colombani is an associate professor in applied hydrogeology at the SIMAU Department of Università Politecnica delle Marche (IT). He received a PhD in hydrogeology in "Sapienza" University of Roma (2011) and a PhD in geochemistry at the University of Bologna (2015). His main research activities focus on: (i) groundwater resources management of coastal alluvial plains affected by salinization processes via variable density numerical modelling; (ii) delineation of groundwater residence times and salinity origins via environmental tracers; (iii) the characterization and monitoring of groundwater pollution via different assessment methods (hydrogeological, geophysical and hydrogeochemical) and via groundwater flow and solute transport modelling.

Abstract

The groundwater salinity changes of the coastal unconfined aquifer of the Po lowland from 2010 to 2020 were assessed via a density-dependent numerical model realized with SEAWAT 4.2. The monthly variable stress periods allowed obtaining insights in the evolution of salinity stratification within the aquifer and on the vertical fluxes induced by the reclamation drainage network. The validated model was used to quantify the extent of the groundwater paleo salinity versus the ongoing seawater intrusion. The simulation highlighted that deeper aquifer layers experienced a salinity increase due to the presence of hyper saline low permeability lenses, while the shallow aquifer layers experienced both increasing and decreasing salinization trends, depending on the temporal and areal distribution of local factors such as: variable recharge and evapotranspiration rates, the connection between the shallow aquifer and the drainage network, and the seawater wedge along the coastline. Moreover, two detailed local scale models were built via the telescopic mesh refinement technique and calibrated using environmental tracers (Cl^- and ^3H). The high-resolution multi-level sampling approach was crucial to correctly estimate groundwater residence times and to prove that the hypersaline groundwater was sourced from the underlying hypersaline aquitard via upward fluxes triggered by the reclamation drainage network.

Debora Bellafiore: Researcher at the Institute of Marine Scienze – National Research Council

Presentation Title: Surface saltwater intrusion in the Po river delta in the present and future climates

Debora Bellafiore is researcher at CNR-ISMAR since 2011. She is specialized in physical oceanography and modeling of coastal and interaction processes. In recent years her studies addressed sea level rise and extreme event, such as storm surge and drought, on river sea systems in different regional seas (Mediterranean and Black Sea), investigating effects of the main drivers, such as tides, wind, river discharge. She is leading the Modeling Node in the ESFRI European Research Infrastructure DANUBIUS-RI (International Centre for Advanced Studies on River-Sea Systems) and her research is dedicated to interdisciplinary studies on river-sea systems.

Abstract

Our study focuses on the identification of peculiar dynamics along the Po River branches and the delta lagoons due to saltwater intrusion (SWI) phenomena under low discharge conditions, investigated through modelling. In this study, we utilize the SHYFEM model over an unstructured mesh to simulate and analyze SWI in the Po River Delta, investigating also different vertical discretization schemes. The model successfully reproduced the observed salinity variations along main river branches and in the delta lagoons and investigated fresh and saltwater dynamics during summer 2017. The modelling system was applied to investigate also the severe 2022 drought which strongly affected the Po River basin and caused marine waters to intrude up to 40 km upstream along the river branches. Finally, the numerical model is used to explore the hydrological response of the delta system to climate change (sea-level rise, air-sea fluxes, and reduction of river discharge). Results suggest that changes driven by climate and SLR will exacerbate SWI in the surface waters of the Po Delta system. Extent of SWI in the major river branch is projected to increase up to 80% further into the river. Persistence of SWI at the same site is expected to increase 100% longer.

Gerardo Sansone (Presidency of the Council of Ministers, Italy), public officer

Presentation Title: The new anti-salt barrier at the mouth of the Adige. An example of Climate change adaptation

Gerardo Sansone is a public officer, with a managerial role in the unit which supports the National Commissioner appointed from the Italian government for the adoption of urgent measures to tackle water scarcity. He graduated in environmental engineering at the Federico II-University of Naples in 2008. From 2010 to 2023, he worked at the Civil Protection Department - Presidency of the Council of Ministers primarily dealing with natural and anthropic risk prevention and emergency management activities. He is currently involved in: (i)managing the implementation of the technical interventions entrusted to the commissioner; (ii)policy proposals on water resource management;(iii) policy proposals on climate change adaptation measures, actions and governance, with particular reference to drought.

Abstract

The National Commissioner appointed to oversee urgent interventions addressing the issue of water scarcity has been tasked with implementing a series of critical measures. One key initiative is the construction of a new anti-salt barrier at the mouth of the Adige River, which serves as a strategic adaptation to climate change. Additional projects focus on improving water supply infrastructure and regulating reservoir management.

Over the past two decades, the phenomenon of the rising salt wedge has intensified, exacerbated by challenges encountered during maintenance activities of the existing barrier, as well as issues that have emerged during "exceptional" low-water events in the Adige River. These events, which are occurring with increasing frequency, often coincide with flood events, further highlighting the need for improvements to the current system.

In response, the 2018 Final Project proposed two operational configurations for the barrier. The first, referred to as the "winter" configuration, involves opening all the barrier's gates, which effectively nullifies its retention capacity. In the event of a flood, the only obstacles to water flow are the two piles, the two partitions, and the shoulders of the walkway, which occupy a small portion of the floodplain. The second, or "summer" configuration, involves closing the retention gates and adjusting the operational gates to maintain a specified upstream water level, ensuring effective management during drier months.