COASTAL ENVIRONMENTAL ENGINEERING: POLLUTION, ENERGY PRODUCTION, MONITORING AND ECONOMIC ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

The coastal environment represents a complex natural context where an interaction of different factors, often heterogeneous, is present. So, a wide variety of disciplines and research activities are involved and developed in this particular context: the goal is to study different phenomena and, if it is possible, give solutions. Engineering science can provide contributes in a wide fields as, for instance, energy production, monitoring and evaluation systems, pollution phenomena, economic environmental assessment, regulatory context. In such fields different approaches for design, monitoring and evaluation, economic assessment are proposed and implemented.

It is important to underline that, from the engineering point of view, particular attention must to be done to national and international standards and reference regulatory framework. This session, with title **Coastal Environmental Engineering**, aims to study the mentioned aspects and includes topics as: plants and techniques for purification and desalination of water; systems and techniques for coastal and marine energy production; systems, sensors and instruments for measuring environmental parameters; techniques and procedures for coastal monitoring; evaluation of the reliability and performance of measurement systems; information acquisition systems and data for the coastal environment; economic assessments in the construction and management of plants; impact analysis of new production plants energy on local economic systems and climate change gas emission; analysis of the reference regulatory framework.

As in the past, also in this IX edition of the International Symposium on Monitoring of Mediterranean Coastal Areas, the Organizing Committee proposes the technical Session *Coastal Environmental Engineering*, that saw a large participation with works proposed by qualified Research Units variously distributed nationally and internationally, demonstrating a shared and widespread general interest for the topic. The variety of research activity and the papers presented in this section confirm the complexity of the topic of the coastal environment.

As below, many interesting contributions has been proposed by Authors, often as case study. Some of them focus on measurement system and instrumentation; others, take into account pollution, with particular attention to microplastic that represent one of fundamental aspect in the present

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environmental situation of pollution. Important considerations are made considering the regulatory framework in particular context. The contributions received in this regard are manifold and of considerable scientific interest, also due to the transversal nature that the topics covered in some of them cover in the broad theme of the Symposium.

In the follows, we propose a summary classification of the contributes in the fields of *Instrumentation and Environmental monitoring, Pollution monitoring of contaminants and microplastics, Energy production.* However, many research activities involve more than one topic of the Session, as demonstration of the interdisciplinary of the context of environmental monitoring.

Instrumentation and Environmental monitoring

- The paper *The ARPA FVG support to oil spill emergency response in the gulf of Trieste* proposed by **M.Bagnarol** from ARPA FVG in Palmanova et Al., focuses the attention on the North Adriatic area, in particular the Gulf of Trieste, where two important harbours Trieste e Monfalcone operate with activities increased fast in the last decade and a perspective to rise further in the next future. ARPA FVG gives support to the local authorities in managing the oil spill emergency in the Gulf of Trieste, so it has been developing and operationally implementing environmental services that are ready to be part of the decision chain, which is activated in case of accidental releases of oil in the sea. In the paper, an operational service that integrates weather and marine forecasts into a numerical model that simulates the dispersion of the oil slick is proposed.
- **F.Benincasa, M.De Vincenzi and G.Fasano** from CNR Institute of BioEconomy in Florence present a paper on *Sea level measurements in mediterranean coast*. Authors speak about how today the sea level is measured and its importance. Particular attention is given to modern ultrasonic altimeters that allow to establish the distance between the reflective surface of the water and an ultrasonic emitter/receiver device. Authors refer, also, to the new generation of radar altimeters and their implementation in more sophisticated approaches for satellite measurement systems. The relevance of such instruments for the sea level measurement, also considering climatic changes is well described in the paper.
- In the paper *The forgotten nautical astronomical instruments* **F.Benincasa, M.De Vincenzi and G.Fasano** from CNR Institute of BioEconomy in Florence, underline the role and the importance of nautical instruments in agriculture. In the paper some of them are reported, in chronological order, with a brief description of their functions. Authors refer to the Mediterranean regions context which, as said, is perhaps the most studied in the world, from a

prehistoric and historical point of view. The contribution intends to underline that in this context there is a *lesser-known history* of forgotten things, in the proposed case of instruments for forecasting and measure, some absurd, others more rational, which, however, are the basis of today's instruments.

- In the paper presented by **Diana Mance** et Al. from Faculty of Physics in Croatia a *Study of ^{2}H and ^{18}O isotopes as a basis for characterization of coastal Karstic aquifers* is proposed. In the paper the findings of a two-year sampling at three karst springs in Bakar Bay (Croatia), as well as rain gauge stations in their vicinity, is proposed. Based on the isotopic composition of the collected samples, Authors concluded that these karst springs are primarily fed by winter precipitation. The analysis of auto-correlation functions and time series show that there is a difference in the degree of karstification of individual springs, with a higher degree of karstification indicating a greater sensitivity to potential pollution.
- **P. Diviacco** et Al. from National Institute of Oceanography and Applied Geophysics in Trieste (OGS), speak about *Citizen science based marine environmental monitoring. The Moana60 experience.* OGS developed innovative technologies that, as said by Authors, can be used within a citizen science or crowdsensing approach to monitor marine environmental parameters. These technologies consist of an acquisition and transmission device that sends data to the central OGS data collecting facility. The simultaneous installation of multiple such devices on boats of opportunity allows to create a network of mobile monitoring platforms and data management infrastructure able to acquire, store, process, validate and display in quasi-real-time georeferenced data on a web portal.
- In the paper *Application of statistical analysis to estimate the costal hazard. A case study in Liguria region,* **G.Lombardini** et Al. from Scuola Politecnica di Genova, take into account the phenomenon of coastal flood in Liguria region as damage produced by the loss of soil and an indirect damage correlated to the impact on tourism activity, social aspects and damage to heritage buildings. For the Authors the preliminary study put in evidence the impact that the rise of mean sea level caused by climate change (even in the most conservative assumptions), that is significant for the coastal area analyzed. An hazard analysis based on the index Sea Level Rise (SLR) is proposed. Further development considers the action of the wave motion run-up starting from the new mean sea water level modified by the expected SLR as a consequence of the climate change.
- The research proposed by **D. Malcangio** et Al. involve units from Politecnico di Bari, University of L'Aquila and Regione Puglia. The paper concerns *Biodiversity smart monitoring guided by historical analysis of coastal evolution.* It is described the architecture of the smart environmental monitoring system

installed within the frame of the project BEST (Addressing joint Agro and Aqua-Biodiversity pressures Enhancing SuSTainable Rural Development) funded by the INTERREG VA Greece-Italy 2014/2020 Program. Particular attention is paid by Authors to the criteria behind the scene: the selection of the locations of monitoring stations, as well as the identification of the instrumentation and type of sensors. The use of low-cost sensors while keeping the smart features of the system management (i.e. the minimization of the role of human presence at the sensing stations) is also investigated e represented in the paper.

- **Davor Mance** et Al. from Croatia propose the paper *Managing water commons using mediator variables to bridge the gap between environmental factors and anthropogenic pollution indicators,* Authors analysed the rainfall $\delta^{18}O$ data from hinterland locations that might potentially coincide with the locations where anthropogenic pollution originates, and subsequently they analysed $\delta^{18}O$ data from wells and springs at several locations near the beaches. Without $\delta^{18}O$ as a mediator variable, no statistically significant results were obtained by Authors. With $\delta^{18}O$ as a naturally occurring tracer as a mediator indicator variable, Authors were able to obtain acceptable and expectable results. Some consideration concerning policies and regulating prices or imposing taxes are made by Authors in the paper.
- The research proposed by **F.Serafino** et Al. from CNR Firenze and ISPRA Roma, concerns the *Analysis of the limits for the detection of Small Garbage Island immersed in clutter radar.* The aim is to show the limits of the detection capacity of X-band radars, as the sea state changes, in order to identify, discriminate, characterize and track small floating aggregations of marine litter (Small Garbage Island - SGIs) consisting mainly of plastic. Two distinct radar measurement campaigns were conducted by Authors with controlled releases at sea of SGI modules assembled in the laboratory. The measurement campaigns were carried out respectively in conditions of calm sea and almost no wind, in order to test the system in ideal conditions, and in rough sea conditions and presence of wind. The analysis of the data acquired during the experiments confirmed the ability of the X-band radars to detect the aggregations of floating waste on the sea surface, also demonstrating that the state of the sea that characterized the two measurement campaigns identifies the limits within which radars can be used for monitoring plastic marine litters.

Pollution monitoring of contaminants and microplastics

- **V.Mesnage** et Al., from Tunisie and France research centers, propose the paper *Assessment of trace metal contamination and phosphorus dynamic in sediments of Monastir bay.* The case study concerns the environment of Monastir bay.

Such area, located in Tunisia, is considered as fragile due to its weak water renewal and its high anthropogenic discharge, which influence the physico-chemical quality of the water as well as the sediment. In particular, such sediments contain polluting substances, as classified by Authors. The purpose of the research is to evaluate the contamination of the surface sediment and to discuss the sediment phosphorus dynamic. A correlation with the presence of aquatic plants (Posidonia meadow) in the sediment and the residual organic Phosphorous is also proposed.

- **C.Montigny** from the University of Montpellier et Al. present a paper on *Status of water quality and impact of dredging activities in four ports of the Gulf of Aigues Mortes (France)*. In this case study, concerning pollution phenomena, is to carry out a diagnosis of the chemical and microbiological contamination of the waters of the 4 ports located in the Gulf of Aigues Mortes. Regular water sampling was done before, during and after dredging operations. Water column quality/contamination was characterized by major physicochemical water parameters, trace metallic elements and organotin compounds.
- **Dalle Mura** et Al. from ARPA Puglia present the work *A first assessment of microplastics in the sea waters off the Puglia region.* Plastic materials persist in the marine environment with different timing depending on their nature but atmospheric agents contribute to their degradation into smaller fragments, the so called microplastics (MPs). To meet the objectives of the EU Marine Strategy Framework Directive (MSFD, 2008/56/EC), the Puglia Regional Agencies for the Prevention and Protection of the Environment (ARPA Puglia) performed a quantitative and qualitative analysis of the MPs on the basis of the data collected during 2015-2017 monitoring program. A total of 90 samples in 5 campaigns were collected using a manta net. The results represent a first assessment of microplastics at Apulian regional scale, that can be useful for the implementation of predictive circulation models in order to estimate the fate of plastic litters released at the sea.
- In *Assessment of the chemical quality of sediments in the maritime port of reunion. Concentrations in trace metals and natural geochemical backgrounds*, **J. Droit** et Al. from CEREMA – France, propose an analysis of marine sediments sampled in the port and coastal areas of Reunion. The research show, for certain metallic trace elements, significant variations in their contents and regular overruns of the regulatory thresholds for the management of dredged sediments. The goal of this study is to define, based on existing data, whether the observed exceedances of the management thresholds for dredged sediments (N1 and N2) are due to the geology of the island or to contributions of anthropogenic origin.

- **M.Esposito** et Al., from different Research units, present the paper *Environmental investigations in the Gulf of Pozzuoli (Naples) in relation to pahs contamination.* In this research the use of molluscs is considered in order to monitor the pollution phenomenon and the presence of contaminant in the sea water of the Gulf. The study confirms the use of bivalve molluscs as good bioindicators to assess levels and trends of seawater contamination, due to their filter-feeding behaviour and sedentary life, that lead to the accumulation of pollutants in their tissues. The results of sediment analysis seem to confirm the hypothesis that the contamination of molluscs could be attributed to contaminated sediments in the Gulf. As said by Authors, the proposed study highlights the need for in situ current data along the water column, in order to test the model performances as well as the need for a higher frequency of the biological sampling.
- The work presented by **H.Jaziri** from the INSTM in Tunisia, reports a study on microplastic pollution. The title is: *First investigation of microplastic pollution in Monastir sea surface water (Eastern Tunisia).* Authors state that the proposed study is the first to investigate the microplastic abundance and composition in Monastir Sea water. In the framework of COMMON MED-project, a sampling campaign was carried out during the month of December 2020 along two radials located in front of two tourist areas with different characteristics. The results showed different size for the particles of microplastic. This preliminary study should be consolidated by other surveys in time in order to study the effect of the season and in the space with the objective of covering the whole area and mapping the distribution of microplastics in the bay of Monastir.
- Also the research activity of **M.Palazot** et Al. is focused on the microplastic pollution. The title of the paper is *Chemical composition of microplastics floating on the mediterranean sea surface* and involve different research units. The objective of this work is to evaluate the chemical nature of the microplastic pollution at the surface of the Mediterranean Sea. The samples were collected by manta net during the Tara Mediterranean expedition, carried out between June and November 2014. Microplastics from 54 sites were analysed by FTIR spectroscopy, and size, concentrations in mass and in number were measured. New studies involving more geographically targeted samplings, temporal monitoring or numerical modelling are needed to confirm, invalidate or refine some of the hypotheses made here. Authors affirm that further investigations need to explore the potential of infrared spectroscopy to study the fouling of microplastics at sea.
- The research groups of CNR of Naples and CNR of Taranto, with **A.Milia** et Al., present the paper *Grain size, nutrients and heavy metals analysis to evaluate natural vs anthropogenic sources in the sea environment (Naples bay, eastern Tyrrhenian sea).* The study area is located in the Naples Bay, offshore the Sarno

River plain, an area affected by metals contamination as a result of the geogenic nature and the outflow of industrial vaste and the high demographic pressure. Grain size distribution coupled with organic matter, nutrients and metals content were analysed in order to explore how the onshore documented contamination affect the offshore counterpart. Aiming at assessing the natural vs anthropogenic origin of the contaminant, a comparison with the published data analysis conducted onshore in the Sarno Plain was implemented by Authors. Such results allow to characterize different submarine area in the Naples bay.

- **S.F.Ozmen** and other Researchers in Turkey speak about *Determination of natural radioactivity levels of sludges collected from wastewater treatment plants of Antalya/Türkiye.* Authors said that the urban wastewater sludge, end product of urban wastewater treatment, can contains pollutants left over from wastewater treatment. In recent years, the use of sewage sludge in agriculture has been made safer with legal regulations regarding the use of sewage sludge in agricultural lands. However, studies on radioactive contamination of sewage sludge are very limited. In the proposed research, sludge from treatment plants in Antalya region will be evaluated in terms of radioactivity pollution. In particular, Radionuclide concentrations of waste water sludge samples around Antalya were determined and presented in this work.
- **L.Saccalingame** et Al. from IRDL UMR CNRS 6027 in France, speak about *Extraction and characterization methods for microplastics from estuarine and coastal samplings – example of the 2019 Tara expedition.* The Tara Microplastics 2019 project aimed to investigate plastic pollution in rivers across different scientific fields of study: plastic chemistry, physical oceanography and marine biology. In this context, Authors affirm that microplastic extraction and infrared polymer identification were carried out using similar protocols in 9 European rivers. Thus, this investigation presents the advantage to apply a consistent methodological framework to very different sampling sites. Preliminary results showed that the extraction and characterization of plastic particles collected from rivers were significantly more arduous than marine plastics. Indeed, high amounts of organic and inorganic matter were found, making the extraction steps necessary to isolate the microplastics.

Energy production

- In *Optimization model for a hybrid photovoltaic/cold ironing system: life cycle cost and energetic/environmental analysis,* **D.Colarossi** et Al., from the Università Politecnica delle Marche, an optimization model for a hybrid photovoltaic/cold ironing system is proposed. As said by Authors, such system can limit the environmental pollution produced by berthed ships, replacing the

on-board diesel generators with a PV plant located in port area and supported by the national grid. The ferries traffic of the port of Ancona (Italy) has been taken as case study. The model investigates the match between the energy production (photovoltaic plant in port area) and the energy demand (auxiliary engines of berthed ships). Results on the trend are shown in the paper. The approach allows to involve in the analysis the entire life of the plant, considering both the initial costs, the operation and maintenance costs and the residual value at the end of the life.

- **P.Ventura** et Al. from Roma speak about *New artificial reef in coastal protection reconversion and electric power production*. In the paper, Authors focus on the sea energy characterized by the conversion of offshore pulsing vertical wave energy into inshore horizontal current energy in the seabed transition of shallow coastal waters. Coming from the offshore deep sea, Authors found that the wind energy produces vertical pulsating waves only until the seabed reaches 10 or 12 m depth. Consequently, a great number of water particles start moving horizontally to the coast, triggering a very strong horizontal current, just below the sea surface, which causes flooding and erosion, accentuated on the seabed by return currents. The proposal is to dampen the currents by means of artificial reefs positioned in the "calm belt zone". This makes it possible to overcome the delicate problem of maintenance of the new reef, which is situated far from the storm area.

As conclusion, after this brief presentation of the papers, we can confirm that the wide and varied works proposed by the researchers for this Session is a valid demonstration on the high interest for the Coastal Environment. Many open points are present, many further developments are proposed by Authors, demonstrating the fact that the environmental engineering and physics need to research activities able to study complex phenomena.

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