

10th International Symposium

**MONITORING OF MEDITERRANEAN COASTAL AREAS:
*PROBLEMS AND MEASUREMENT TECHNIQUES***

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Livorno (Italy) June 11th - 13th, 2024

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S. Sakthivel, L. Cappiatti

Coastal vulnerability assessment in relation to the Coastal vulnerability assessment in relation to the impact of different hazard sources on marine-coastal ecosystems in Sardinia (Italy).

L. Sinapi, A. Troccoli, A. Cardillo, M. Conti, S. Dastoli, R. Proietti, M. Zucchetta, L. Nicoletti

Gravel Nourishment & Breakwater: The Protection System of Marina Di Pisa
A. Zanella, A. Esposito, I. Simonetti, L. Cappiatti

SESSION

**FLORA AND FAUNA OF COASTAL
ECOSYSTEMS: PROTECTION,
MANAGEMENT, MONITORING**

ORAL PRESENTATIONS



**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

TITLE:

DEVELOPMENT OF A FRAMEWORK TO MODEL STAND EVAPOTRANSPIRATION AT A LOCAL SCALE IN A COASTAL MEDITERRANEAN FOREST UNDER CLIMATE CHANGE

SESSION:

FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Plant transpiration plays a pivotal role in terrestrial ecosystems, often constituting more than 80% of the annual surface water flux. The Mediterranean climate, particularly during dry spells coinciding with peak evaporative demand and elevated temperatures, pushes plant physiological limits, bringing them close to critical thresholds for resisting drought. This complex interplay underscores the significance of understanding and accurately estimating plant transpiration in water-limited ecosystems (Vincente et al., 2018).

This study introduces a methodology for the quantification of stand plant transpiration at the local scale, aimed at accounting for the diverse stomatal control capabilities exhibited by different species within the study area. The integration of top-down and bottom-up approaches is necessary to improve predictions about small-scale environmental systems. The workflow involves integrating leaf-scale gas exchange measurements, and meteorological and soil water content local (bottom-up approach) data with satellite data to up-scale results to stand-scale (top-down approach). (fig.1).



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

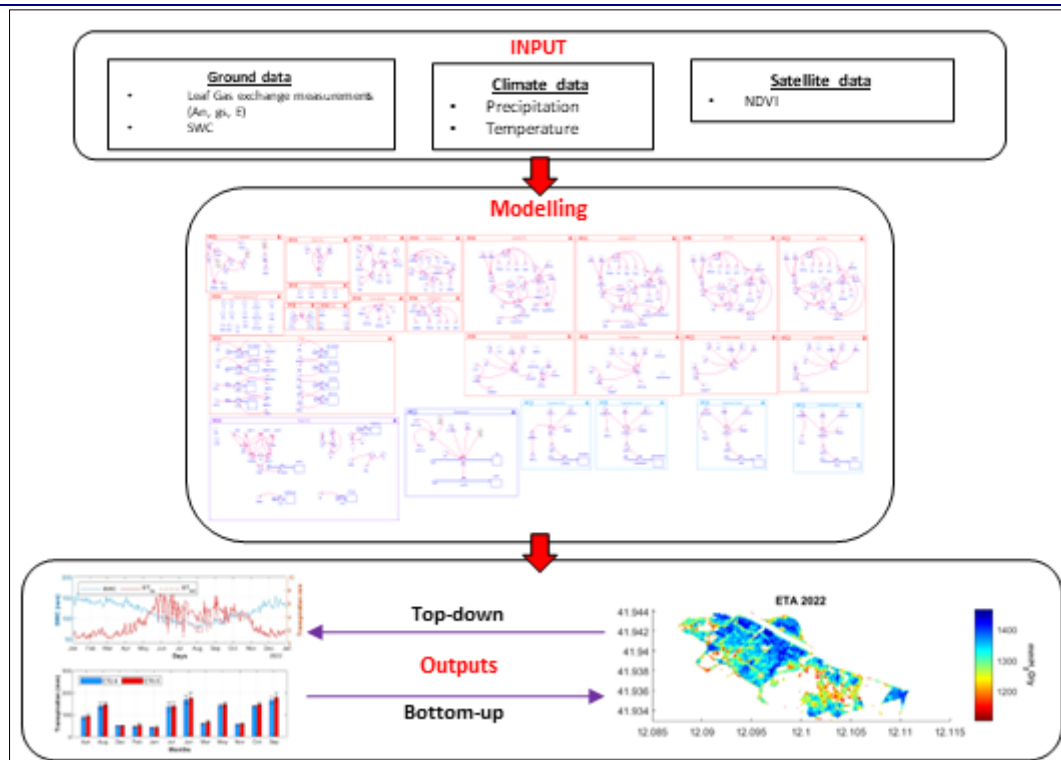


Figure 1. Workflow scheme.

Gas exchange analysis was conducted using an infrared gas exchange analyser (Ciras-2, PPSystems), enabling the quantification of physiological parameters, including net assimilation, stomatal conductance, transpiration, apparent quantum yield, water use efficiency, and mitochondrial respiration for four species (*Quercus cerris*, *Fraxinus angustifolia* subs. *oxycarpa*, *Pistacia lentiscus*, and *Phillyrea latifolia*) collectively constitute 70% of a coastal wood undergoing ecological restoration project.

The field-measured data allowed the calibration of a biochemical model of photosynthesis, composed of three interconnected modules designed to simulate net assimilation rates, stomatal conductance, and transpiration rates (ET). Incorporating species-specific strategies of stomatal control involved applying a constraint grounded in the theory of marginal carbon cost of water use. According to this approach, optimal stomatal behaviour is achieved by maximizing carbon gain while minimizing water loss within a specific timeframe (Medlyn et al., 2011).

ET values calculated for individual species using a biochemical model were used to calibrate the forest stand evapotranspiration (ETA) model based on NDVI (Maselli et al., 2014). The final water balance was computed based on ET (bottom-up approach) and ETA values (top-down approach). Once the other inflow and outflow fluxes from the forest system were defined (precipitation, canopy interception, infiltration, runoff), the forest water balance could be calculated, and expressed as soil water content. Simulation accuracy was assessed by comparing simulated values with daily measured SWC values obtained from ground probes at the site. This workflow was employed to simulate the transpiration of climate change scenarios SCP 2.6 and 8.5 proposed by the IPCC.

Both models demonstrated high capability in simulating soil water content ($R^2_{\text{species}} = 0.98$, $R^2_{\text{satellite}} = 0.96$), further confirming the accurate estimation of evapotranspiration rates obtained through the application of biochemical and satellite models. The species-scale and stand-scale models yielded SWC values of 41225.01 mm/year and 41441.79 mm/year, respectively, closely aligning with the sensor-measured value of 42423.93 mm/year for 2022.

Simulated stand evapotranspiration for climatic conditions of 2022 (17.02°C Tavg, 468.70 mm Pcum) is 1387.73 mm. For SCP 2.6 (18.18°C Tavg, 757.6 mm Pcum) stand transpiration is 1216.49 mm, and for SCP 8.5 (19.23°C Tavg, 726.66 mm Pcum) is 1293.47 mm.



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

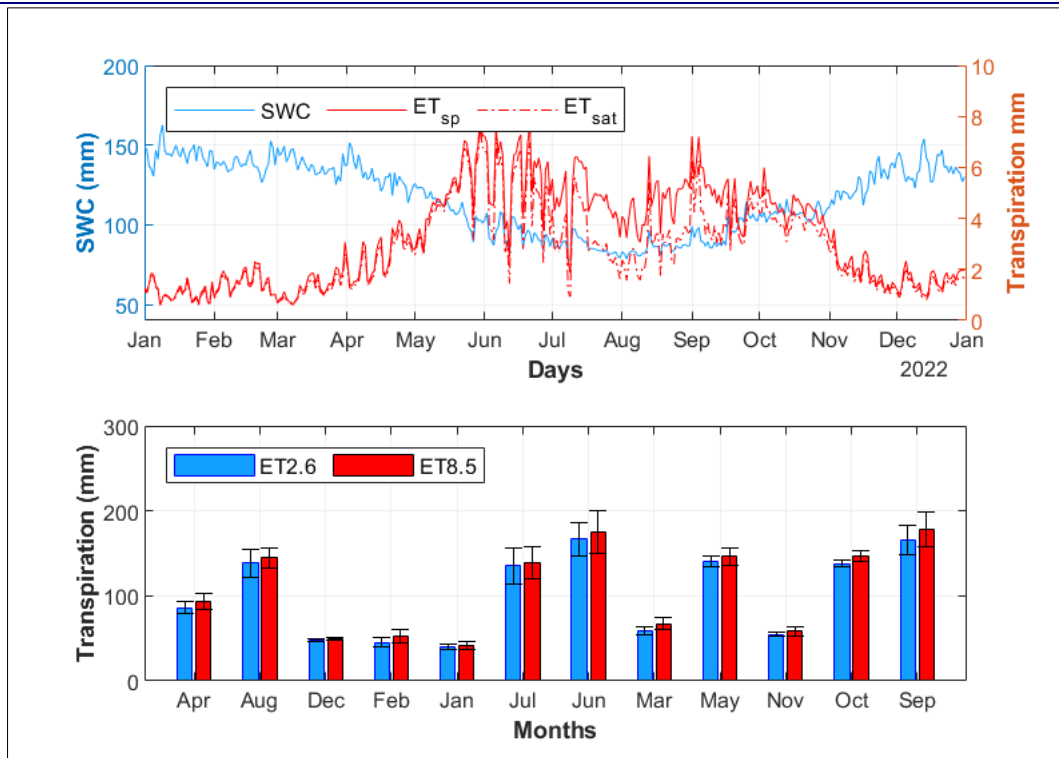


Figure 2. Result ET simulation for actual (up) and future scenarios (down).

The following work offers a methodology that can be replicated in any ecological context and offers the possibility of developing targeted strategies for monitoring and managing forest areas. The need for local-scale studies is necessary to expand the information useful for generalisation to a larger scale.

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KEYWORDS:

MEDITERRANEAN FOREST

BOTTOM-UP AND TOP-DOWN APPROACH

EVAPOTRANSPIRATION



Tenth International Symposium

MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: COMPOSITION SHIFTS IN A DECLINING HOLM OAK FOREST: SEASONAL INVENTORIES AND BIOGENIC VOLATILE COMPOUND EMISSIONS OVER FOUR YEARS

SESSION:

FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO

AUTHORS: *FRANCESCA ALDEROTTI*^{1,2}, ANTONELLA GORI^{1,2}, MARTINA POLLASTRINI^{1,4}, MAURO CENTRITTO^{2,3}, FRANCESCO FERRINI^{1,2,4}, DALILA PASQUINI^{1,2}, CECILIA BRUNETTI^{2,1}

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Extreme weather events, such as increasing drought spells and heat waves, are causing forest dieback and tree mortality in many forest ecosystems, including the Mediterranean ones. Recently, *Quercus ilex* L. (holm oak) dieback has been extensively documented in Southern Europe, particularly in the Iberian Peninsula and Italy. These dieback events, affecting a dominant tree species, have the potential to reshape the composition of understory shrubs and herbaceous plants. Moreover, Mediterranean flora is known to produce significant amounts of Biogenic Volatile Organic Compounds (BVOCs), the emission of which are highly sensitive to environmental conditions.

This study investigates the seasonal changes in holm oak canopy cover, herbaceous and shrub species richness, Shannon-Wiener and Pielou indices (alpha diversity) in two holm oak stands in the Maremma Regional Park in Tuscany, Italy. These stands are characterized by different degrees of crown defoliation: high defoliated (HD) and low defoliated (LD) stands. Seasonal field surveys aimed at characterizing stand compositional changes were conducted from 2019 to 2023. Plant species inventories were utilized to assess the biological spectrum of plants within the holm oak stands and estimate habitat explanatory factors using Ellenberg's indicator values. Additionally, relationships with BVOCs emissions at environmental level were also assessed.

Over the study period, both stands experienced a 50% reduction in holm oak canopy cover, resulting in increased light penetration through the canopies and subsequent growth in understory species richness in 2021. However, in 2022, species richness declined below the 2019 levels in both stands, possibly due to the accumulation of large amounts of dead wood on the forest floor in both stands the extreme temperatures recorded that year. By 2023, species richness returned to levels similar to those observed in 2020 and 2021. Notably, the Shannon-Wiener and Pielou indices did not significantly vary in the two stands, where the biological spectrum displayed a clear Mediterranean characteristic. Nonetheless, both stands showed an increasing enrichment of geophyte bulbs and therophytes, highlighting worsening water stress conditions. Starting in October 2020, the LD stand's biological spectrum was mainly characterized by scapose hemicryptophytes, scapose phanerophytes, and caespitose phanerophytes, while the HD stand was predominantly composed of nano phanerophytes. Notably, the environmental sampling of BVOCs accurately reflected the changes in vegetation cover and composition in both stands, showing a reduction in monoterpene emissions due to the increasing rates of defoliation and mortality of holm oak trees. The Mediterranean imprint of the vegetation composition was further confirmed by elevated Ellenberg's indicator values for temperature and light, revealing some anthropic disturbances in the HD stand. This was evident in the higher presence of nitrophilous species compared to the LD stand, likely influenced by the introduction of certain medicinal herbaceous plants (e.g., *Atropa belladonna* L. and *Datura stramonium* L.) during the Middle Ages, whose proliferation may have been exacerbated by the holm oak dieback (Pasquini et al., 2023). The widespread occurrence of nano-phanerophytes, combined with the significant defoliation of holm oak, suggests a portion of the forest is transitioning into a shrubland (Saura-Mas et al., 2015).

In summary, despite changes in species abundance observed over the course of the study, no statistically significant alterations were detected in the Shannon-Wiener and Pielou indices. However, the holm oak dieback has led to shifts in species composition, particularly in the HD stand. The substantial reduction in holm oak canopy cover and the spread of medicinal herbaceous plants and nano-phanerophytes in the understory vegetation indicate that the HD stand is undergoing a transition from a forest to a shrubland. Additionally, our findings indicate that increased holm oak dieback could significantly impact BVOC emissions from the forest, with substantial implications for the ecosystem's functioning and atmospheric chemistry.

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KEY WORDS (MAX 4) HOLM OAK FOREST, DROUGHT-INDUCED DIEBACK, COMPOSITION SHIFT, UNDERSTORY VEGETATION



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: A methodological approach to assessing the conservation status of coastal habitats: the case study of Calabria (Southern Italy).

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT:

In the Mediterranean area, sandy coastlines are threatened by human activities that cause habitat changes, with consequent alteration of the vegetation and loss of typical species. To protect these distinct and exclusive environments, several stretches of the Italian coast are designated as Special Areas of Conservation (SACs) and included in the Natura 2000 Network. Active management is always necessary in areas that are crucial for the conservation of global biodiversity, such as the sites of Natura 2000 Network and protected areas in general. Defining the conservation status of dunes is crucial to preserve these vulnerable environments through planned policies. This study aims to assess the impact of urbanisation on the conservation status of psammophilous habitats of Community interest of Directive CEE 43/92. The study focuses on the coastal dunes of Southern Calabria and has two goals: 1) to evaluate the habitat conservation status by applying diversity indices to the species composition of the phytocoenosis; 2) to investigate the impact of urban areas on the conservation of habitats and their typical species. We used the Carta Natura habitat map of Calabria to identify all polygons within the 0-200 m a.s.l. range. With the QGIS software (version 3.23.3), we calculated the precise distance in metres between psammophilous habitat vegetation relevés and the centre of urban-coded polygons. For the interpretation of the psammophilous habitats, both the ISPRA manual for Carta Natura and those for the interpretation and monitoring of habitats of community interest in Italy (1) were used. A total of 128 vegetation relevés were carried out using the Braun-Blanquet phytosociological method, covering the following Directive habitats: 1210* Annual vegetation of drift lines ; 1240* Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp. ; 2110* Embryonic shifting dunes; 2120* Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes'); 2210* *Crucianellion maritimae* fixed beach dunes, 2230* *Malcolmietalia* dune grasslands; 2240* *Brachypodietalia* dunegrasslands with annuals; 2250* Coastal dunes with *Juniperus* spp. ; 2260* *Cisto-Lavanduletalia* dune sclerophyllous scrubs; 2270* Wooded dunes with *Pinus pinea* and/or *Pinus pinaster*. The total diversity of plant species per habitat was measured with the Hdune index (2) according to Pinna et al., (3) and Caldaresi et al., (4). The Hdune index was used to assess Naturalness (N), but unlike Grunewald and Schubert (2), in addition to considering native and alien species we also considered disturbance species. $N = Hdune$ (without alien and disturbing plant species) / $Hdune$. The N index ranges from 0 to 1, where 0 indicates that the plant diversity consists entirely of alien and disturbing species, while 1 indicates the absence of the latter in the phytocoenosis (2, 3,4). To correlate the N index with the distance to urban centres, a statistical analysis was carried out (PAST version 4.13). The analysis showed that the



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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highest values of Hdune are found in the habitats 2250*, 2210*, 2110*, while lower values were observed in habitats 2270* and 2240*. From the results, we found a significant correlation (pvalue < 0.05) between naturalness values (N) of the habitats and distances from urban centres. It was found that habitats 2270* and 2240*, which are closer to urban centres, show a lower naturalness value than habitats 1210*, 1240* 2110*, 2210* and 2250*, in which we found higher naturalness values and thus low disturbance. This methodology can be used by managers to identify the most sensitive coastal dunes and to monitor areas affected by human activities. It can serve as a useful tool for the implementation of a conservation strategy compatible with the integrated management of Mediterranean coastal dune systems.

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KEY WORDS: Biodiversity, Monitoring of coastal ecosystems, Threatened species, Beach-dune ecosystems.



**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Flora and vegetation of coastal sands and salt marshes in Croatia – Case study from Northern Dalmatia (Croatia)

SESSION:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

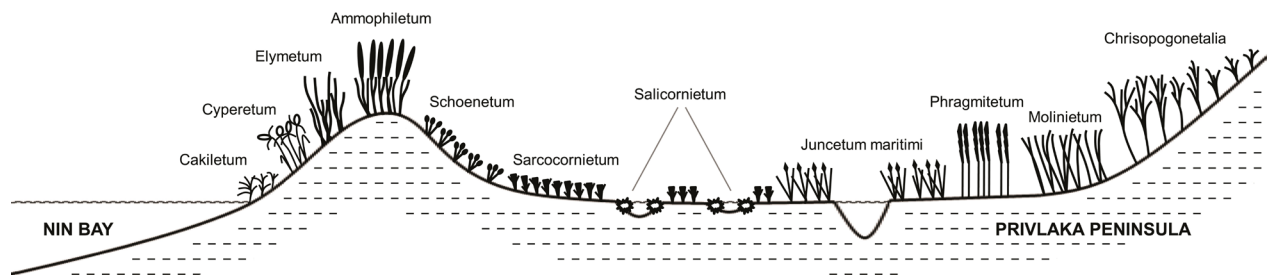
Natural sea coasts are very diverse and also highly threatened habitats throughout Europe. Since the eastern Adriatic Coast in Croatia is predominantly karstic, the psammophytic and salt marsh vegetation are very rare. Due to its natural attractiveness and easy accessibility, this vegetation is under increasing pressure of tourism industry. The Kraljičina Plaža Beach near the small town of Nin in Northern Dalmatia is one of the last areas along eastern Adriatic with structured and preserved mosaic of different plant communities, which are distributed along gradient of salinity and moisture from sea towards inland. The aim of this study was to provide an inventory of vegetation and flora encountered in the Natura 2000 protected area of Privlaka-Ninski Zaljev-Ljubački Zaljev. The vegetation was studied during 2016 following the Braun-Blanquet method and resulted in total 35 relevés. The belt closest to the sea is species poor and belongs to the pioneer halo-nitrophilous short-lived vegetation of the class Cakiletea maritimae Tx. et Preising in Tx. ex Br.-Bl. et Tx. 1952. The scattered patches of *Cyperus capitatus* Vand. appear within that belt. The following band are primary sand dunes overgrown with species rich vegetation of the class Ammophiletalia Br.-Bl. et Tx. ex Westhoff et al. 1946, which has high conservation value as a rare habitat type and as the only recent site of the critically endangered species *Ammophila arenaria* (L.) Link in Croatia. Behind the dune, in small, shallow depressions vegetation of pioneer vegetation of annual succulent halophytes (Thero-Salicornietea Tx. in Tx. et Oberd. 1958) is developed. In deeper water and on larger surfaces occur temporarily flooded succulent chenopod scrub vegetation of the class Salicornietalia fruticosae Br.-Bl. 1933. Further inland, there are extensive stands of salt-marches of the class Juncetea maritimi Br.-Bl. in Br.-Bl. et al. 1952. The transitional type of vegetation from halophilic to freshwater consists of extensive stands of *Schoenus nigricans* L. in slightly brackish slacks. The last two belts, wet meadows of order Trifolio-Hordeetalia Horvatić 1963 and reed swamps of order Phragmitetalia Koch 1926 are fed by fresh water filtered through deposits of loess from the inland and have been salted only by salt spray brought by the wind. This vegetation complex, unique in Croatia, deserves a high level of protection because it represents a unique combination of plant communities that include a large number of endangered species. As many as 333 plant taxa have been registered in the studied area, among which critically endangered (*Lathyrus ochrus* (L.) DC., *Calystegia soldanella* (L.) Roem. et Schult., *Cyperus capitatus* Vand., *Elytrigia juncea* (L.) Nevski, *Glaucium flavum* Crantz, *Triglochin barrelieri* Loisel., *Triglochin maritima* L.), endangered (*Hainardia cylindrica* (Willd.) Greuter, *Carex divisa* Huds., *Carex extensa* Gooden., and vulnerable taxa (*Suaeda maritima* (L.) Dumort., *Parapholis incurva* (L.) C. E. Hubb., *Salsola soda* L., *Serapias vomeracea* (Burm. f.) Briq., *Orchis papilionacea* L., *Orchis coriophora* L., *Ophrys bertolonii* Moretti and *Alopecurus rendlei* Eig). In addition, several nationally rare species were recorded e.g. *Allium telmatum* Bogdanović, Brullo, Giusso et Salmeri, *Juncus gerardi* Loisel., *Samolus valerandi* L., *Scorzonera parviflora* Jacq.,



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

Medicago marina L., *Juncus littoralis* C. A. Mey., *Ornithogalum sibthorpii* Greuter and *Lotus preslii* Ten. Indigenous plants growing in coastal sands and salt marshes are essential to the stability of the coast in trapping and binding sediments, they play an important role in the aquatic food web. These ecosystems are suffering an accelerating process of degradation and urge for active protection measures.



REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4): CROATIA, ENDANGERED TAXA, PSAMMOPHYTIC VEGETATION, SALT MARSHES



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Mapping *Yucca gloriosa* in coastal dunes: Evaluating the cost and time efficiency of photointerpretation, machine learning and field detection approaches

SESSION: FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Biological invasions represent one of the primary threats to biodiversity, potentially leading to major economic and ecological challenges. Effectively managing the expansion of invasive species is crucial to minimize these risks [1]. The European Community has adopted a specific Regulation on Invasive Alien Species (IAS, N. 1143/2014), recommending different management measures based on the invasion state and associated control costs [2]. In the present work, we focused on coastal dune ecosystems, widely recognized as among the most invaded and vulnerable ecosystems. Our aim was to assess the time and cost-effectiveness of three commonly employed monitoring approaches to detect and map alien plants: photointerpretation, machine learning classification, and field monitoring. Specifically, we conducted a comparative analysis using *Yucca gloriosa* L., an invasive species native of North America, known to spread on fixed dunes within the Regional Park of Migliarino-San Rossore-Massaciuccoli in Tuscany (Italy). For photointerpretation and machine learning classification, we collected the images obtained by two drones, RGB DJI Phantom 4 Pro v. 2.0 and Multispectral DJI P4, with bands: Blue, Green, Red, Red Edge and NIR. In the photointerpretation process, an operator manually delineated *Y. gloriosa* polygons in the QGIS environment. For the machine learning process, we first calculated vegetation indexes, after we applied a Geographic Object Based Image Analysis (Large Scale Mean Shift algorithm), followed by classification and training phases using Random Forest algorithm. Field detection data were extracted from those used in the LIFE project "DUNETOSCA" (2005-2009). Each of the three methodologies exhibited elevated precision and reproducibility in the cartographic delineation of *Y. gloriosa*, albeit at varying costs:



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approximately 1000€ for photointerpretation, 2000€ for machine learning classification, and 7500€ for field detection. Comparing the two UAV methods employing orthomosaics, approximately 1 hour was required for flight planning and execution in a 3-ha area, followed by approximately 1 hour for orthomosaics generation. This process involved limited operator effort and incurred reduced costs. Photointerpretation, on the other hand, proved to be a time-consuming image analysis procedure for delineating invaded areas (approximately 40 hours) with higher associated costs. The subjectivity problem arises due to the human operator's analysis [3]. In contrast, machine learning classification requires minimal human effort, and the creation of prediction maps is a more objective process (3 days for prediction maps creation). However, machine learning methods necessitate high computing efforts and the selection of accurate variables to discriminate alien plants by native species. Visual detection in the field can yield maps with higher accuracy but demands substantial human effort for mapping the alien distribution (about 15 days of human work with higher costs). This method, widely used previously, faces competition from new technologies that allow the capture of high-resolution images in less time [4]. Visual detection in the field also introduces challenges related to unreachable areas, which can be easily detected using UAVs. In conclusion, this study recommends the application of UAVs for the monitoring of *Y. gloriosa*, considering its morphological and spectral distinctive characteristics within the context of dunal coastal areas [4]. This suggestion arises from the need to utilize a cost- and time-effective method, such as a machine learning approach. Adopting UAVs in this context ensures both high accuracy and replicability in the monitoring of *Y. gloriosa*, providing an efficient and effective tool.

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KEY WORDS (MAX 4): MAPPING, MANAGEMENT, ALIEN PLANTS, DRONES



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FORM FOR ABSTRACTS PRESENTATION

TITLE: CONTROLLING THE EXPANSION OF INVASIVE *HALIMEDA INCRASSATA* IN THE CABRERA NATURAL PARK USING MARINE ROBOTS AND PHOTO-MOSAICS.

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT AND MONITORING.

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Marine invasive macroalgae are of special concern in the Mediterranean Sea since they can alter the environment in which they settle, changing food chains, generating structural variations and, sometimes, displacing native species. *Halimeda incrassata* (Bryopsidales, Chlorophyta) is a Caribbean seaweed that settles mostly on sandy substrates colonizing seagrass habitats. *H. incrassata* was detected in 2011 in the Balearics, and from then to nowadays, it has expanded almost sevenfold in the south-west. Impacts of *H. incrassata* on the Balearic ecosystem communities have been already reported [1] [2]. Measuring the coverage and expansion rate of this species has become crucial to plan effective eradication actions. In the last years, the Marine Robotics team of the Systems, Robotics and Vision (SRV) group (University of the Balearic Islands) has collaborated actively with biologists in the observation of sensible marine habitats [4] [3] using an Autonomous Underwater Vehicle (AUV), as one of the strategic lines for research and innovation. AUV equipped with cameras, combined with advanced image processing techniques have been applied already to automatically detect *H. incrassata* in the sea bottom and measure its coverage [3] in an attempt to evolve traditional diver-based methods. Our AUV is torpedo-shaped, it can submerge up to 200 m, it is 1.6 m long, it has a diameter of 32 cm, and it weighs 60 kg. It is propelled by 2 surge and 1 heave thrusters, it has about 8 hours of autonomy, and it incorporates a pressure sensor, a stereo rig looking downwards, a global positioning system (GPS), a Doppler velocity log (DVL), an inertial measurement unit (IMU), an acoustic link and global positioning USBL system, an eco-sounder probe pointing down and, finally, two led lights. In the context of the INVHALI project [3], the subarchipelago of Cabrera was a prior scenario to test Artificial Intelligence in the study of *H. incrassata*. Cabrera is a protected National Park located in the south-east of Mallorca and a representative location free of anthropogenic disturbances. Several marine areas located in Cabrera were surveyed by the AUV in transects 60 m long, at a constant speed of 0,18m/s, from an altitude between 1 and 1.5 meters, and at depths between 13 and 20 m. The objective was to estimate variations of *Halimeda* coverage as the distance to the shoreline increased and the depth reached 20 m, using robots instead of quadrats. The process consisted in: a) the AUV recorded video sequences of each mission, b) images of each video were decimated by 4 and placed in a geo-localized photo-mosaic, according to the AUV self-estimated trajectory, c) *H. incrassata* shoots were hand labeled in each image with a graphical image annotation tool, d) labeled images were binarized automatically, colouring bounding boxes containing *Halimeda* in black, and the background in white, e) the same photo-mosaic was build again but with the binarized images, e) the coverage was automatically computed as the proportion of black pixels with respect to the total number of pixels in the photo-mosaic, that is, the proportion of *Halimeda* with respect to the total surface of the survey. Time, extension and depth of data collection campaigns increases, offering also measurements more precise and accurate, and with higher temporal and spatial resolutions than those obtained with traditional techniques based on divers and quadrat



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frames. Figure 1 shows, on the left, a sample image hand-labeled and on the right, its corresponding binarized counterpart, with the Halimeda marked in black. Figure 2 shows, on the left, the color photo-mosaic of a mission located between the two geo-coordinates (39.1490931024, 2.9331163042) and (39.1491206846, 2.9331514981), 2 meters wide, 20 m away from the shore, 16 m deep, and 1.5 meters to the seabed. On the right, its binarized photo-mosaic. The coverage estimated from the mosaic was $9.4055 \cdot 10^{-5} \%$.

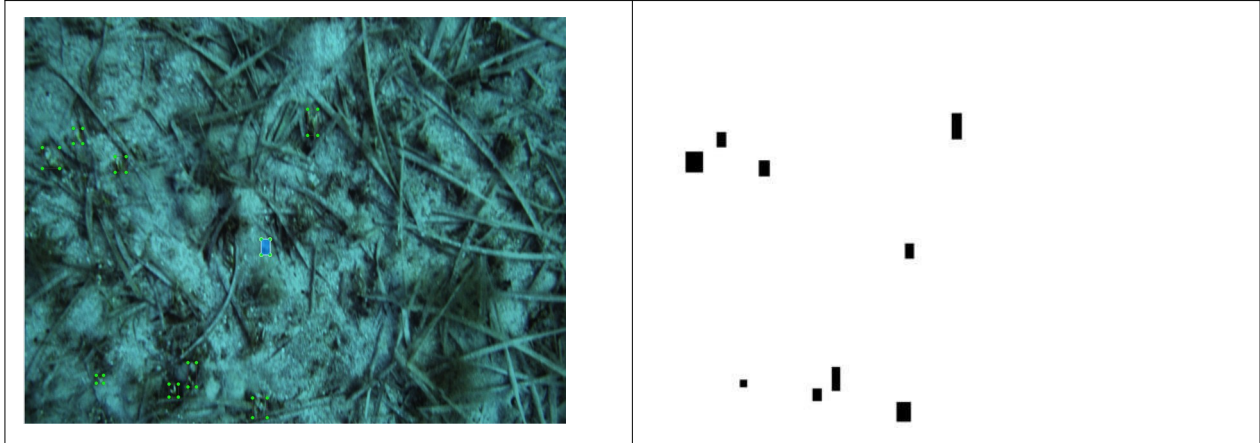


Figure 1

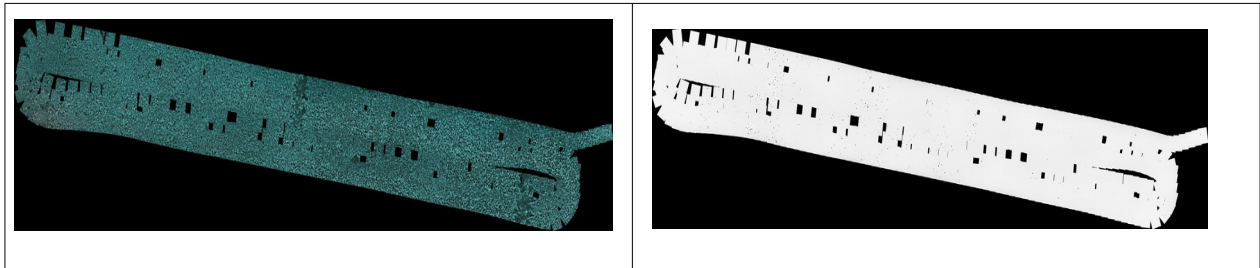


Figure 2

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KEY WORDS (MAX 4) : H. INCRASATTA, AUTONOMOUS UNDERWATER VEHICLE, INVASIVE ALGAE, PHOTO-MOSAICS.



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FORM FOR ABSTRACTS PRESENTATION

TITLE: FROM SPECIES ECOLOGY TO ECOSYSTEM RESTORATION – A MODELLING APPROACH TO SUCCESSFULLY RESTORE *POSIDONIA OCEANICA* MEADOWS

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Posidonia oceanica (L.) Delile is a widespread slow-growing endemic seagrass of the Mediterranean Sea, colonizing the coastal environments from the surface down to 40-50 meters in depth. The meadows formed by *P. oceanica* constitute one of the most important Mediterranean marine ecosystems in terms of productivity and biodiversity, with associated communities representing climax assemblages on soft and shallow substrata (González-Correa et al., 2007). The meadows act as nurseries and refugia for several species, sustain diverse trophic webs, host endangered species, and are able to alter water circulation and sedimentation rate, preventing coastal erosion and shaping the seascape (Ruiz et al., 2001).

Unfortunately, this habitat is dramatically shrinking across large sections of the Mediterranean coasts, due to anthropogenic pressures such as the mechanical damage by anchoring and trawling, as well as the coastal development (Boudouresque et al., 2009). The slow growth of *P. oceanica* means that countering meadow regression implies not only the local protection of this habitat, but also the restoration, whenever possible, of the already lost meadows. The latter is crucial in recovering the functioning and ecological integrity of coastal ecosystems, and the practice is gaining momentum with the development of increasingly efficient approaches. However, in spite of the widespread engagement in restoration programs, the success and outcomes of these actions, in terms of meadow evolution over time, are still hard to predict.

In this context, ecological modeling can provide crucial support in evaluating the potential evolution of the meadows, especially through approaches focusing on describing the growth and the interactions with the environment of the planted propagules. The accuracy of these models, however, critically depends on the understanding of the biology and ecology of *P. oceanica*. To this end, the present research focuses on summarizing through an extensive meta-analysis the wealth of data and findings published on *P. oceanica* during the last 5 decades, using the derived information to parameterize individual based models of meadow evolution in time and space.

Specifically, a spatial energy dynamic budget model (sDEB) was developed, including resource gathering and allocation processes, competitive interactions among shoots for light and space, as well as the effects of environmental factors such as light, nutrients, temperature and substrate type on species physiology.

On the one hand, the model allows evaluating the potential evolution of planted meadows in time and space, on the other hand, meta-analysis results, provided in the form of a georeferenced database, highlight the current knowledge gaps toward which future researches should be oriented to improve our understanding of the ecology of this species and, thus, optimize the management of the unique ecosystem it forms.



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KEY WORDS (MAX 4): SEAGRASS MEADOWS; ECOLOGICAL MODELING; META-ANALYSIS; MEDITERRANEAN SEA



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Monitoring and assessment of the ecological status of coralligenous cliffs by a standardized protocol

SESSION:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coralligenous reefs represent the most important subtidal bioconstruction in the Mediterranean Sea for extent, biodiversity, and carbon dynamics (Bianchi, 2001). They are an iconic underwater seascape providing multifarious ecosystem services, but they are also a very sensitive habitat vulnerable to both global and local disturbances; thus, coralligenous reefs are included in the European Red List of Habitat and their monitoring and quality assessment are required under European Directives and international treaties. The heterogeneity of the coralligenous habitat makes it difficult to identify univocal threats, study methods and ecological indicators, so the development of habitat-specific plans for monitoring and assessment based on standardized methods are strongly required, in order to allow data comparability over a wide space and time scale.

Among different reef morphologies, the coralligenous cliff is the most widespread in the first 40 m depth, and the most exposed to the effects of climate change and anthropogenic pressures affecting coastal waters. It is hence considered a sensitive bioindicator, as well as a habitat under high risk of degradation, for which many ecological indices were developed in the last decade to evaluate its health status. However, most of these indices are based on different approaches and metrics which, in the absence of an integration/intercalibration process, prevent the comparison of results obtained with different methods.

This contribution summarizes the results of multi-year studies carried out through underwater surveys on a large spatial scale, aiming to compare and integrate methods used at the Mediterranean level in a standardized single protocol for sampling and data collection.

The relevant literature on coralligenous reefs was searched, selecting 52 papers reporting detailed methodological information on shallow coralligenous habitats. Methods applied by different authors were compared to identify the best sampling strategy and select the ecological descriptors common to most indices and most sensitive to human pressures. The information collected was synthesized in a STAndaRdized coralligenous evaluation procedure (STAR) (Piazzi et al., 2019) performed by scuba diver scientific operators following a non-destructive protocol, which allows to obtain information about most of the descriptors used by different indices through a single sampling effort and data analysis. To date, the new procedure was tested in the Western Mediterranean subregion in about 100 sites of coralligenous cliffs subject to different human pressures, highlighting significant differences among conditions for the ecological descriptors selected.

The results confirmed the validity of the descriptors chosen and the effectiveness of the STAR methodology in assessing ecological quality of coralligenous cliffs. The information obtained integrating photographic and visual sampling techniques was more complete than that provided by individual approaches, and allowed to build a common database for the application of several indices.

The use of multiple descriptors and the integration of information from multiple ecological levels is the proper approach to identify change in ecosystem quality (Borja et al., 2009); moreover, the simultaneous use of different descriptors allows the detection of community responses to specific pressures, for better addressing intervention measures and conservation plans under the European legislation. In this context, STAR represents the first methodological guideline proposed in the Mediterranean as a tool for environmental policies concerning protection of coralligenous habitats (Gennaro et al., 2020) and may constitute a milestone for the development of increasingly accurate and effective tools shared on a broader Mediterranean scale.

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KEY WORDS (MAX 4) coralligenous cliff, ecological status, monitoring, guidelines



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FORM FOR ABSTRACTS PRESENTATION

TITLE: MONITORING OF PROTECTED MARINE INVERTEBRATES IN COLUMBRETES ISLANDS MARINE RESERVE, USING RANDOM PATH TRANSECTS

SESSION:

FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO

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ABSTRACT:

To this day, several national and international programs for biodiversity conservation do exist, such as OSPAR, Berna and Barcelona Conventions, European Union Habitat Directive (92/43/CEE, HD), National and Regional lists of threatened species, that require active management actions to better their demographic pattern. Most of these species are granted special management measures, because of their excessive exploitation (be it legal and /or illegal), their natural low occurrence, the poor knowledge available for the species and/or a combination between two or more of these factors (Barea-Azcón et al., 2008). However, in order to address proper management actions, knowledge about the geographical and vertical distribution, habitat, status and density patterns of each species is necessary. For this reason, ad-hoc monitoring needs to be performed. While this can be easily done for those protected species with sufficient knowledge and frequency of occurrence, the monitoring of those rarer and poorly known species requires more effort. It is recommended to apply adaptive sampling to maximize the frequency of encounters of those rare species (Jeliazkov et al., 2022) and one possible way to achieve this sampling is through the random path transects (Harmelin-Vivien et al., 1985).

In this work, we present preliminary results of the adaptation of this methodology to monitoring of protected invertebrates living in rocky habitat (Habitat 1170, HD). We obtained the data during an oceanographic campaign during autumn 2023, on board of the R/V SOCIB inside and outside the Marine Reserve of Columbretes Islands (Spain), within the framework of Marine Strategies. The sampling was carried out in three locations inside the Marine Reserve (MR) and one outside the MR. In each location between 12 - 28 transects of 50 m² each were performed by swimming randomly in photophilic, pre-coralligenous and coralligenous habitats (since many of the protected invertebrate species can be found in these habitats. In each transect, each pair of divers swam 5 minutes searching for protected species in the appropriate habitat (Muñoz et al., 2021).

Results indicate that 3.75 ± 0.48 protected species are encountered on average in each site, for a total of 7 protected species identified: the sponges Axinella cannabina, Axinella polypoides and Geodia cydonium, the mollusks Luria lurida and Pinna rudis, the hexacoral Cladocora caespitosa and the starfish Ophidiaster ophidianus. Axinella Cannabina, A. polypoides and L. lurida were found deeper than 23 m depth, while the other species were more common a shallower depth. As expected, C. caespitosa and O. ophidianus were the most frequent species in the MR of Columbretes Islands, with average densities of 3.24 ± 2.73 ind. 100 m⁻² and 0.53 ± 0.08 ind. 100 m⁻² respectively. In addition, according to this methodology, in the Foradada site, mortality was observed for G. cydonium (one of two individuals) and C. caespitosa (18.53 % of the colonies).

In conclusion, we suggest that this methodology, is more adequate for monitoring of protected species, compared with the more common strip transect, since it allows to monitor a larger and deeper areas given its easier logistics, therefore conducting monitoring of these species both above and below the seasonal thermocline, which is advisable in order to detect effects of marine heatwaves on marine communities.



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KEY WORDS (MAX 4) MONITORING, VISUAL CENSUS, PROTECTED SPECIES, COASTAL ECOSYSTEM



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Genetic Sleuths of the Sea: eDNA Metabarcoding Unleashes a New Era for Mediterranean Marine Protected Areas Monitoring

SESSION:

Flora and fauna of coastal ecosystems: protection, management, monitoring

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

The Mediterranean Sea is facing escalating human-induced pressures, leading to the depletion of fish stocks and habitat degradation. Policymakers are prioritizing the establishment of Marine Protected Areas (MPAs), guided by the European Union's marine policy anchored in the 2008 Marine Strategy Framework Directive (MSFD) [1]. This directive emphasizes the critical role of MPAs in preserving marine environments and achieving Good Environmental Status (GES), that Member States are required to attain and maintain according to numerous qualitative descriptors and corresponding monitoring criteria [1, 2], with additional monitoring guidance from The Joint Research Centre [3]. Effective monitoring at both EU and regional levels is essential for MPA success, as outlined in the Commission Report on the MSFD Implementation, which underscores challenges, particularly in monitoring, due to insufficient data and low regional coherence [4]. To address these monitoring gaps, environmental DNA (eDNA) could offer a cost-effective, time-efficient, non-invasive, and sensitive alternative to conventional methods like underwater visual census and trawling surveys for investigating marine biota.

Objectives

This study aims to explore the potential applications of environmental DNA (eDNA) for monitoring MPAs, comparing eDNA metabarcoding with conventional methods. The primary focus is on the Mediterranean, identified in the Commission's report as lacking regional coherence in monitoring [4]. The study seeks to assess the opportunities and challenges of integrating eDNA metabarcoding into Mediterranean MPA monitoring, considering current management practices, potential hurdles, and the perspectives of MPA managers.

Our investigation includes a comprehensive systemic literature review to explore the opportunities and challenges of eDNA applications for monitoring MPAs. Considering the monitoring requirements of the MSFD, we compare the efficacy of eDNA metabarcoding across diverse marine environments and ecosystems with that of traditional methods such as visual census and trawling. Additionally, we conduct a survey among MedPAN MPA managers to gauge the current usage of eDNA in monitoring programs and identify obstacles in the existing monitoring framework. This approach allows us to integrate insights from both scientific literature and on-the-ground practitioners.

Main findings, results, and indications of the proposed work

The literature review reveals widespread use of eDNA metabarcoding across various marine environments and ecosystems, including protected areas. Notably, eDNA methods exhibit efficacy in detecting a broad range of organisms, from bacteria to megafauna, in both water and sediment samples. Therefore, our findings suggest that eDNA metabarcoding can contribute significantly to monitoring MSFD criteria for GES (Figure 1). The analysis also indicates that eDNA methods may address limitations reported by MPA managers regarding current monitoring strategies, such as the challenge of insufficient data availability and comparability.

Overall, while addressing challenges identified in the MSFD implementation report and leveraging MPA managers' experiences, our findings emphasize the role of eDNA in enhancing the management of these crucial marine ecosystems. However, acknowledging eDNA limitations hampering its accuracy and sufficiency (Table 1), successful integration requires enhanced stakeholder coordination and tailored recommendations for MPA managers to optimize network functioning and support marine environment protection.



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Figure 1. Suitability of eDNA metabarcoding to monitor MSFD descriptors [1].

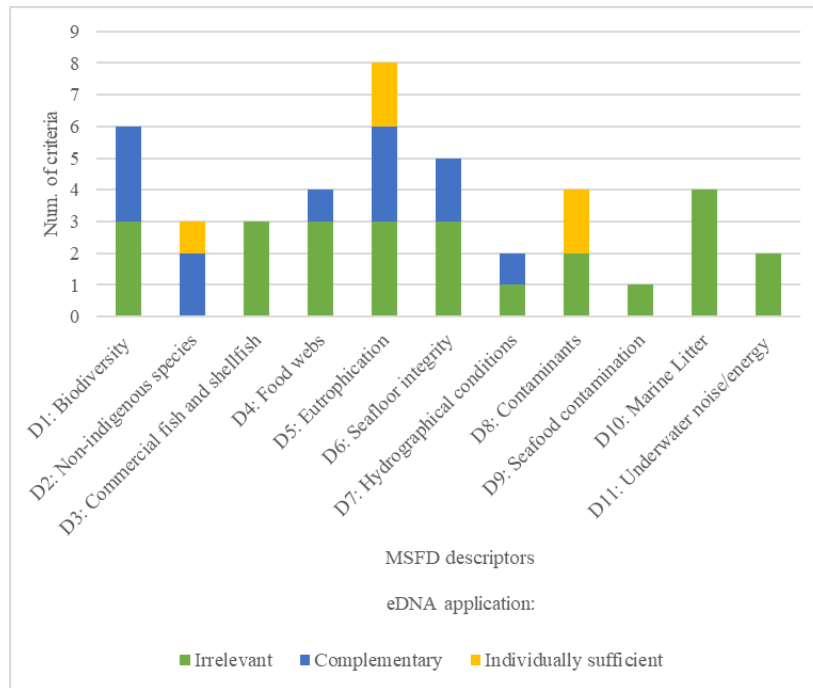


Table 1. SWOT analysis through literature review of eDNA studies in marine environments (n=70) as described by authors.

<p>STRENGTHS:</p> <ul style="list-style-type: none"> • Taxonomic, temporal and spatial resolution • Species detection (invasive, unexpected, rare/elusive/cryptic, indicator) • Diversity assessment (alpha, functional, phylogenetic, multi-trophic) • Community assemblage assessment • Time-Cost efficiency • Little/no required expertise • Non-invasive 	<p>WEAKNESSES:</p> <ul style="list-style-type: none"> • eDNA dispersion • False positive and/or negatives • Abundance assessment • Demographic parameters estimation
<p>OPPORTUNITIES:</p> <ul style="list-style-type: none"> • Standardization/automatization • Retrospective analysis of data • Complementary/simultaneous analysis • Inaccessible/less accessible regions 	<p>THREATS:</p> <ul style="list-style-type: none"> • (A)biotic factors influence on eDNA availability • Procedural biases/errors • Study design biases/errors • Incomplete/erroneous reference databases



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KEY WORDS (MAX 4):

Environmental DNA (eDNA) metabarcoding
Marine Strategy Framework Directive
Mediterranean Marine Protected Areas
Marine biodiversity monitoring

POSTER PRESENTATIONS



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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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FORM FOR ABSTRACTS PRESENTATION

Title: CHECKLIST OF AMPHIPODS OF ITALIAN SEAS: BASELINE FOR MONITORING BIODIVERSITY AND BIOINDICATORS
SESSION: FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO.
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The climate changes of recent decades and the constant increase in anthropic pressure have negatively influenced the characteristics of coastal habitats and the biodiversity associated. This study presents a revised checklist of the amphipod crustaceans of the Italian seas as a contribution to providing a systematic and comprehensive analysis of species presence, which is essential for assessing biodiversity and monitoring progress. Amphipods represent an abundant and ecologically important component of the marine communities. They play a pivotal role in the ecology of marine habitats. The group has been recognized as particularly sensitive to environmental changes of both, chemical and physical nature, and includes species belonging to different trophic and ethological categories. Furthermore, amphipods can be used as bioindicators for monitoring the marine environment as they appear to respond relatively quickly to natural and anthropogenic stresses. In this context, updating the checklists of animal species can be considered a tool of fundamental importance to better understand the spatio-temporal evolution of the negative alterations that biodiversity can undergo. The latest Italian checklist was produced by Sandro Ruffo in 2010 and counted 458 species; however, according to the current systematics, more than 50 names were revised, and some synonymized. According to present results, 493 species have been counted. The list reports 38 new presences, of which seven are non-indigenous (NIS) for the Mediterranean Sea, bringing the number of NIS in Italy to 11. Most of the species are confirmed in the sectors where they were present, while 321 are reported in sectors for which they were absent. Benthic amphipods show more records than planktonic and semi-terrestrial ones. Furthermore, we observed that the new presences mostly come from the regions of Lazio and Tuscany, Campania and western Sicily and Veneto, while the NIS are mostly from the sectors corresponding to Veneto, Lazio and Tuscany and from the south-eastern coast of Sicily. Indeed, the Venice Lagoon, in the northern Adriatic Sea, is the location with the highest number of NIS, probably due to its crowded ports and the thriving mariculture activity. The database, built by determining the presence (1) or absence (0) of species in the various sectors, represented the basis for a hierarchical cluster analysis (HCA) developed by the Sørensen similarity index. The resulting dendrogram shows a clear separation of the sectors corresponding to the Strait of Messina and the southern Adriatic from all other sectors, since these share a smaller number of species compared to all the others. In these two sectors, we have been able to observe that the shared species are mostly planktonic amphipods for which we have no new records. In contrast, all the other sectors have a greater number of species in common and therefore are more similar to each other. There are still many areas or regions with little to no new data (Molise, Marche, Strait of Messina, Calabria, Sardinia, Liguria, Emilia-Romagna, Abruzzo). The largest amount of data was collected in the Veneto, Lazio and Tuscany regions. The institutions that provided the highest number of reports are ISPRA and ARPA, due to the activities carried out within the Marine Strategy. Furthermore, some case studies of these animals in specific locations will be taken into consideration for which ecological information will be available, in order to evaluate the potential of this group in the role of bioindicators. However, further sampling efforts and further monitoring activities are advisable, in particular for planktonic species for which there are very few new records, for parasitic amphipod species and for species that live in sea caves, for which there is almost no information and are considered neglected species.

REFERENCES: (MAX 4)

KEY WORDS (MAX 4): AMPHIPODS; CHECKLIST; BIODIVERSITY; BIOINDICATORS.



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FORM FOR ABSTRACTS PRESENTATION

TITLE: MAPPING OF BENTHIC HABITATS OF ALGERIAN COAST (SOUTH-WESTERN MEDITERRANEAN)

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Objectives

Main findings, results, and indications of the proposed work

Coastal areas are at the interface between land and water, with significant gradients in environmental conditions. These environmental gradients continually force all species to remain within their tolerance limits. In Algeria, there is no classification of marine habitats, and knowledge of the marine and coastal environment is still very poor.

In response to the lack of mapping information and knowledge of coastal marine habitats in Algeria, 2D digital habitat mapping was carried out along 450 km of coastline. The mapping method chosen in this study is the CAT-LIT method developed by Mariani et al (2014). It provides information on the distribution of substrates and habitats, as well as insights into the relationships between rocky shore habitats based on the collection of field data and input into GIS.

Several investigations were carried out. In situ identification of benthic marine species (mainly macrophytes) was carried out in the field during sampling trips (independently of sampling by scraping). Information on substrate type, dominant species, accompanying species, bathymetric level, substrate mode and topography was recorded on site, as well as photographs taken to confirm identification in the laboratory using identification keys.

In this study, we are establishing the first reference database of the coastal marine habitats of the Algerian coast, named "List of ALGERIAN MARin HABitats". This work is the first large-scale mapping of benthic rock substrate habitats on the Algerian coast using the CAT-LIT method. The typology of the area studied revealed the dominance of the natural rocky coast. The coastline studied is highly diverse in terms of species and habitats. 78 benthic habitats were identified. Supralittoral benthic communities are dominated by the crustaceans *Chthamalus spp.* and *Euraphia depressa*, the lichen *Verrucaria amphibia* and the red alga *Rissoella verruculosa*. Mediolittoral benthic communities are mainly occupied by the red alga *Ellisolandia elongata*, photophilous algae and the wrack *Cystoseira amentacea/ tamariscifolia*. The study area is populated by numerous species described as bioindicators of clean, renewed water without a high sediment load. These species are fairly abundant at the site, including the algae *Lithophyllum byssoides* and the anthozoans *Astroides calycularis* and *Actinia equina*. This indicates that the study area has a good quality environment. Seagrass beds in a good state of conservation were identified, along with areas with scattered mattes and others with dead mattes. Rockweed belts were reported in the western zone of the coast studied, with *Cystoseira amentacea/ tamariscifolia* dominating in areas with strong or moderate hydrodynamics, and *Cystoseira barbata* in calm areas. The abundance of Ulvales in Algiers Bay indicates pollution in this area. The analysis of interactions between habitats showed that *Ellisolandia elongata* is a crossroads linking habitats.

This mapping can be used for coastal management and conservation. In addition, the mapping can be used to study changes in habitat distribution and relate them to anthropogenic pressures.



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KEY WORDS (MAX 4)

CARTOGRAPHY, MARINE HABITATS, COASTAL ECOSYSTEMS.



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FORM FOR ABSTRACTS PRESENTATION

TITLE: THE EX-SITU ADAPTATIVE POWER OF THE BLUE CRAB *CALLINECTES SAPIDUS* RATHBUN, 1896.

SESSION:
FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT,
MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Crab is a crustacean animal, mostly edible, which made it a good biological model, several studies have focused on its specimens. Crabs are not only edible, much appreciated on menus and even identified as a festive meal. They play a major role in economic fields where they contribute to the revival of the local economy. It also contributes to maintain the stability of the marine environment. The shell of the crab contains chitin; and chitin is both used in cosmetics and burns treatment. In surgery, it is used for the manufacture of surgical threads because of its resistance and flexibility. It is also used to filter wastewater: it forms ionizable chains that allow organic elements to be fixed in suspension. It even managed to integrate the food industry (juice making). *Callinectes sapidus* is a species of crab native of the western Atlantic Ocean, introduced into the eastern Atlantic; and worldwide. The species has been able to colonize new lands and adapt to other conditions thousands of kilometres away.

In Algeria the blue crab was officially reported on 26 August 2018 in Jijel. and observed at El-Kala commune, wilaya of El-Taref, for the first time according to the local fishermen on 19 November 2019 in Mafragh. and at Mellah Lake; which is a brackish lagoon. Mellah was inscribed on the Ramsar list on December 12, 2004. His lake was a scholar of fish farming in the early of 1920s during the colonial era. At independence this private exploitation gave way to a public



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management: “the Algerian Fisheries Office”. then “the Algerian National Office of Fisheries” (1982- the late 1990s); in 2005 the right to harvest were transferred by the Crown to a private contractor.

Objectives

The blue crab locally nicknamed «Dhaech» in allusion to its devastating character, that eats everything on its way, it ravages, disrupts the environmental ecology and even impoverished it. This crab invaded the Mellah Lake «Ramsar site», which threatens the whole environment balance, and in order to propose a solution to this invasion, while taking advantage of the arrival of this new wealth, our reflection starts from the finding in the first hand of the approval size generated by the blue crab and its contribution in social-economic development, what led us to this issue of breeding the Mellah crab *ex-situ* to exploit it commercially.

Main findings, results, and indications of the proposed work

The crab has successfully integrated into its new biogeographic area, which is Lake Mellah. An area stabilized with the physicochemical and biological conditions of Mellah. The measurements of Mellah crabs remain comparable with their counterparts sampled elsewhere. After three years of installation, the species has become well acclimatized.

Keeping the specimens alive *ex-situ* in land-based tanks supplied with seawater went well. Seawater transportation, electricity for filters and pumps, and food were the only costs involved in the process. During winter the blue crab decreases its activities and its consumption; this is also valid in the tanks where the crab moves only in extreme need. In *ex-situ* consumption is also very low. It should also be noted that each male limits a territory and covers with his body his females to protect them; Each male gets four to five females and protects them from any danger. A blue crab male occupies in our case 0.4 m² of area. *Callinectes sapidus* of the tank expresses its excitement with more mobility and more aggressiveness. This excitement is initiated by either a lack of vital space (≥ 0.4 m²), competition for food or other form of danger. The parasitic study revealed no form of parasitism and our host does not seem to have hosted any parasite.

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KEY WORDS (MAX 4): BLUE CRAB, MELLAH LAKE, EX-SITU, ADAPTATION



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FORM FOR ABSTRACTS PRESENTATION

TITLE: STUDY OF MARINE SPECIES THAT INHABIT THE COASTAL STRIP OF OUR SEAS

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEM: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The study of the sessile, sedentary and vagile species of each coastal marine area, as well as the presence of algal species, studied and recorded by us in the last 30 years along the coasts of Tuscany have shown changes, sometimes conspicuous, in the usual areas investigated.

The study and documentation of all species sampled and taxonomically determined, in the four seasons of the year, allow us a safe comparison between the annual results.

The studies carried out on the changes in *Posidonia oceanica* meadows were very important.

The most harmful change was the continuous retreat of the *Posidonia oceanica* meadows relative to the line of sandy shores with a decrease in their width until, sometimes, the disappearance of species living in the sandy substrate, at the same time the retreat of the *Posidonia*, was highlighted in correlation with the polluting substances found in collaboration with the CNR ICCOM of Pisa.

The *Posidonia* meadows are a defense of the coasts along the shore as the strong waves during storm surges must pass through millions of plants with leaves up to 90cm long, to reach the shore, collected in a cylindrical sleeve every 7/8.

The study of the animal and plant species of coastal ecosystems is based on: sampling in the prairies immersed with a plankton-net operating by a biologist, scratching of rock walls and capture of the species present, including algae, sampling of sandy sediment with a box corer operated at hand, photographing and filming underwater all the vagile and sessile species in the study area.

All the species sampled with the rock scraping, with the plankton net or with the box corer will be photographed under a stereomicroscope for taxonomy determination. To understand any changes between the species we have sampled over time it is also very important to carry out samplings with chemical analysis to verify any presence of toxic substances. For our Institute these analyses are carried out by the CNR I.C.C.O.M. of Pisa.

The decrease in the presence of many species living on *Posidonia* leaves, both invertebrates and small fish, demonstrates that the important nursery function of the prairies is in danger, creating very significant environmental damage.

In recent years of our research on the current situation of biodiversity of animal and algal species in the Mediterranean coastal strip we have recorded, in all marine areas, far from each other, the



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continuous arrival of alien animal and algal species. In the coastal strip of the protect island of Pianosa, which for many years hosted a maximum-security prison, and therefore inaccessible, the participant in one of our researches prof. Gianfranco Sartoni, an algologist of the University of Florence, discovered the presence of the tropical alga *Lophocladia Lallemandii* (Montagne) F. Schmitz, 1833, native to the Red Sea and the Indian Ocean (fig. 1).

Prof. Roberto Bedini, director of the Institute of Marine Biology and Ecology of Piombino, found many crabs of the *Percnon Gibbesi* (H. Milne Edwards, 1853) species on the Island of Elba coming from the Red Sea (fig. 2), the wandering anellid *Neanthes agulhana* (Day, 1963) native to Africa, and other alien species of fishes, molluscs and crabs.

The importance of the studies and controls carried out over the years with various specific skulls allows us to establish damage compensation actions necessary to protect the coastal strip and its inhabitants.

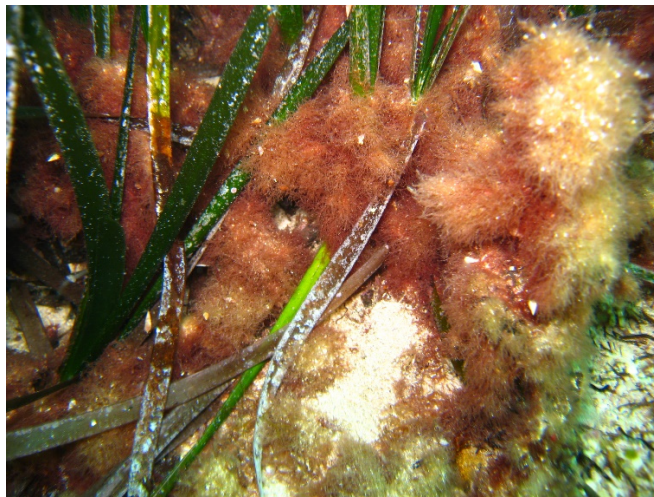


Fig. 1: *Lophocladia Lallemandii* (Montagne) F Schmitz, 1833.



Fig. 2: *Percnon Gibbesi* (H. Milne Edwards, 1853)



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KEY WORDS (MAX 4) **COASTAL ECOSYSTEMS, SAMPLINGS, ANALYSES**



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: Monitoring and assessment of the environmental quality of transitional waters in Sicily (Italy)
SESSION: Flora and Fauna of coastal ecosystems: protection, management, monitoring
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): Transitional water systems (TWS), such as lagoons, estuaries and coastal lakes, are very complex ecosystems located at the interface between land and sea, characterized by confined circulation and weak hydrodynamism, shallow depth, strong variations in temperature and light regimes, high productivity, high potential biodiversity, high vulnerability to anthropic pressure. In the context of the European Water Framework Directive (WFD, 2000/60/EC), five typologies of TWS are reported: delta, estuaries, lagoons, brackish lakes and coastal ponds. The Sicilian TWS include coastal ponds and lakes, mires and swamps but only a few areas fall within the WFD typologies. Almost all of these ecosystems are affected by several protection regimes because of their high naturalistic value, although current knowledge as well as the assessment of their environmental quality are limited and fragmented (Caruso et al. 2010). According to WFD, the ecological status (ES) of the Italian TW has to be quantified through indices, i.e. MPI (Multiparametric Phytoplankton Index), MAQI (Macrophyte Quality Index), M-AMBI (Multivariate-Azti Marine Biotic Index) and HFBI (Habitat Fish Bioindicator) based on appropriate biological quality elements (BQEs) as indicators (phytoplankton, macrophytes, macroinvertebrates and fish). Moreover, physico-chemical and hydromorphological quality elements as well as the analysis of the priority chemical substances in two matrices (water and sediment) (Table 1/A and Table 2/A – Legislative Decree 172/2015) are required. TWS are classified into five quality classes (high, good, moderate, poor and bad) for each water body (WB), in order to assess their ES. Parallel, the chemical status (CS) is represented by 2 quality classes (Good, Not Good) based on compliance with the Environmental Quality Standards, in terms of Average Annual Concentration and Maximum Allowable Concentration of priority substances. The overall ES and CS classification for a WB is determined according to the 'one out, all out' principle: the quality element with the worst status determines the overall status. From June 2020 to December 2022, 2-year cycle of monitoring in 13 WBs within five Sicilian TWS (Cape Peloro, Oliveri-Tindari, Marsala, Vendicari and Longarini-Cuba) was performed to characterize their environmental quality (Fig. 1). According to their geomorphological characteristics, Cape Peloro basins (which includes two water bodies, Ganzirri and Faro) can be classified as brackish lakes, while Oliveri-Tindari (which consists of four WBs, Marinello, Mergolo, Porto Vecchio and Verde) can be classified as coastal ponds. Stagnone di Marsala is a semi-enclosed area under hydrodynamic exchange with the adjacent open



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sea. The Vendicari area (which includes three shallow WBs, Roveto, Grande and Piccolo) and the Longarini-Cuba wetland-complex (which consists of three WBs, Pantano Cuba, Pantano Longarini 1 and Pantano Longarini 2) can be classified as mires and swamps (Mazzola et al., 2010; Bellissimo and Orestano, 2014, Guglielmo et al., 2013).

The overall status of the WBs was found to be very heterogeneous and variable both among and within sites, ranging from good (e.g. the Stagnone di Marsala) to poor/bad ecological quality status (e.g. some ponds of Oliveri-Tindari and Longarini-Cuba) (Table 1). However, it is important to take into account the intrinsic features of each WB when considering these results.

In fact, most of monitored WBs monitored in this study were considered to be of poor/bad ecological value and not good chemical status because of their very low depth, extreme fluctuations in environmental variables, and a drying up in summer that prevents the formation of a rich benthic community. However, these environments are home to a very rich avifauna and are considered some of the most important wet areas in Sicily.

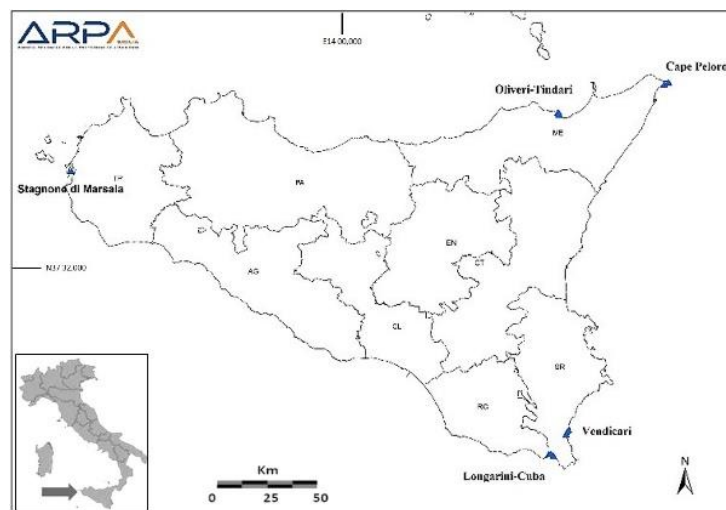


Figure 1. Sicilian transitional waters systems monitored in this study

Table 1. Ecological and chemical status of Sicilian transitional water bodies

Water Body	EQB/Index			Ecological status	Chemical status
	Macroinvertebrates (M-AMBI)	Phytoplankton/ (MPI)	Macrophyte/ (R-MaQI)		
Faro	Good	Moderate	Moderate	Moderate	Good
Ganzirri	Moderate	Moderate	Good	Moderate	Not Good
Marinello	Bad	Moderate	Moderate	Bad	Good
Porto Vecchio	Bad	Good	Good	Bad	Not Good
Mergolo della Tonnara	Moderate	Good	Moderate	Moderate	Not Good
Verde	Poor	Poor	Moderate	Poor	Good
Stagnone di Marsala	Good	no data	High	Good	Not Good
Cuba	Bad	Poor**	High	Bad	Not Good
Longarini1	Poor	Moderate**	High	Poor	Not Good
Longarini2	Bad	Poor**	Moderate	Poor	Not Good
Grande	*	Poor	Moderate	Poor	Not Good
Piccolo	*	Moderate***	Moderate	Moderate	Good
Roveto	Bad	Poor	Good	Bad	Good

*The number of species found is not suitable for the application of M-AMBI index

**The MPI index was calculated only 3 times during the year and not 4 because the swamps were dry

***The MPI index was calculated but is not applicable because the swamp is hyperhaline



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KEY WORDS

Transitional waters, Environmental quality, WFD, Sicily



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

The use of stable isotopes in the study of the avifauna of the Galite archipelago in Tunisia

SESSION:

- FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT,
MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The Mediterranean basin is considered a biodiversity hotspot, characterized by a diverse range of landscapes, marine areas, and organisms. Among its islands is the Tunisian archipelago of "La Galite." Still difficult to access, this archipelago showcases incredible richness and biodiversity, serving as a major migratory route and nesting site for numerous seabirds. Many of these bird species are endemic to the Mediterranean, such as the Eleonora's falcon (*Falco eleonora*), a completely migratory species that nests on Mediterranean islands.

It is estimated that all colonies of Eleonore falcons take approximately two million birds (0.02 to 0.04% of the migration flow) in a single breeding season; therefore, this raptor is considered a keystone species to highlight several aspects concerning the migratory flow of passerines. Through the study of the diet of *Falco eleonora*, we were also able to focus on the avifauna present within the archipelago during this period and on the diet adopted by passerines migrants within their areas of origin through the use of isotopic signatures of stable isotopes of carbon, nitrogen and sulfur. Similarly, attempts have been made to predict their geographical areas of origin using the stable isotope of hydrogen.

A total of 19 feathers of *F. eleonora* were collected, among which 10 belonged to juveniles (30-35 days old) and 9 to mature individuals (>2 years). Concerning the adults, the feathers taken were the primary remnants (P8 or P9); for the juveniles, the sampling was random since all their feathers



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molted at Galite. Clustered undigested prey passerine feathers found in the *F. eleonora* nests were sampled. Seven passerine prey were identified after the morphological characters of the feathers described in the literature and knowledge of migratory bird species flying above the breeding grounds of *F. eleonora*: common nightingale *Luscinia megarhynchos* (*Lu.m*), European greenfinch *Chloris chloris* (*Ch.ch*), spotted flycatcher *Muscicapa striata* (*Mu.s*), common quail *Coturnix coturnix* (*Co.c*), hoopoe *Upupa epops* (*Up.u*), common whitethroat *Sylvia communis* (*Sy.c*) and European storm petrel *Hydrobates pelagicus* (*Hy.p*).

We also collected fragments of beetles and unidentified insects. All biological material was conditioned at 4°C until laboratory analysis. In addition, we collected rejection pellets of *F. eleonore*. The remains of insects from the pellets of rejection are too small to be identified. We grouped all the fragments in a group called insects (*Insect*).

The contribution of passerines to the diet of falcons was significantly higher than that of insects. This contribution was very high compared to those found in other breeding colonies. The diet of all the falcons was dominated by the whitethroat, the nightingale philomele and the hoopoe. For the assignment of adult *Falco eleonora* to their wintering grounds, we found results far from those described in the literature, which perhaps testifies to the limits recorded in the method of assignment, which is based on the signatures of the deuterium isotope. On the other hand, for the allocation of falcon prey, this method is very effective and has revealed results that are very close to those known in the literature.

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KEY WORDS (MAX 4)

Falco-I-Ecology-Isotope-Tunisia



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FORM FOR ABSTRACTS PRESENTATION

Title: Shoreline dynamics and breeding coastal birds in the Marano and Grado barrier islands
SESSION: FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <i>General frameworks</i> Covering almost 12% of the world's coasts (Pilkey & Fraser, 2003), barrier islands are ideal habitat for many species of coastal birds, both sedentary and migratory. The functionality and benefits related to these coastal environments have recently been threatened by the reduction in sedimentary input, by the sea level rise and by human activities (Mc Bride et al. 2013). The Marano and Grado Lagoon (NE Italy) is part of the Natura 2000 network (Special Area of Conservation and Special Protection Area). The lagoon is protected towards the sea by a peculiar system of sandy barrier islands and sand banks, which preserves a high level of naturalness. Here, the Oystercatcher (<i>Haematopus ostralegus</i>), the Little tern (<i>Sternula albifrons</i>), and the Kentish plover (<i>Charadrius alexandrinus</i>) are the most distinctive bird nesting species of conservation concern. Globally, the cause of these species' decline (BirdLife International, 2023; van de Poll et al., 2014) may be due to a variety of threats that vary in space and time, including an increase in the frequency of flooding events, which pose a threat to all coastal breeding birds that nest directly on the ground. <i>Objectives</i> In this study, we examine the monitoring of target species during the nesting phase over a ten-year period (2013 to 2023) and look into the possible effect and/or constraint exerted by the morphodynamic setting of the nesting habitat. The analysis is conducted within the broader context of the multidecadal shoreline evolution from 1891 to 2023, based on historical cartography, aerial photos, and topo-bathymetric surveys. The identification of short-term morphodynamics, responsible for the observed modifications along the barrier islands, has been made possible by a comprehensive analysis of qualitative and quantitative methods. In particular we focused on key morphological indicators, such as coastline advance or retreat, as well as variations in the island extent. <i>Main findings, results, and indications of the proposed work</i> The overall findings indicate a significant shoreline dynamic impacting the majority of the barrier islands, as well as a trend towards the maintenance of barrier extent over time, despite a general rollover process. Overall, the insular system of Grado is self-sustaining through a compensatory longshore process which



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benefits form a significant sediment input, coming from the up-drift areas. The short -term morphological responses and relationships seen across the considered variables can be attributed to the processes of washover (transversal dynamics) and spit progradation (longshore dynamics).

In this morphodynamic context, the nesting population of oystercatchers has grown over the years, while greater difficulties have been registered for the Little tern and the Kentish plover, whose breeding success has been more limited and more exposed to the dynamism and the characteristics of the barrier islands habitat. This underline how, despite sharing the same nesting habitat, the response to different pressures could vary from species to species.

Furthermore, our results allowed to provide a first set of management indications for their protection, based on the principles of adaptive management and maintenance of morphodynamic processes.

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KEY WORDS (MAX 4)

BARRIER ISLAND,
COASTAL BIRDS,
MARANO AND GRADO LAGOON,
MORPHODYNAMICS



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FORM FOR ABSTRACTS PRESENTATION

TITLE: Extraction and purification of macromolecular protein R-Phycoerythrin,R-Phycocyanin and Allophycocyanin from Red algae
SESSION: 11-12 JUNE
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <i>Phycobiliproteins; pigment-protein complexes found in cyanobacteria, red algae, and cryptomonads, are crucial for light harvesting (Sun et al., 2009), the transfer of light energy to the photosynthetic reaction centers is carried out by these proteins. PBPs are made up of a complex made of proteins and phycobilins, which are chromophores that are covalently bonded (Glazer, 1985). PBPs are classified by their spectral characteristics. The most frequently detected PBPs are phycoerythrin (PE), phycocyanin (PC), and allophycocyanin (APC) (Sonani, 2016; Hsieh-Lo et al., 2019) and have potential applications in pharmaceutical and dietary supplement production (M.P. et al., 2015; Senthilkumar et al., 2013; Kovaleski et al., 2022). According to a report (Sukwong et al., 2019), the demand for PBPs is increasing at a rate of 5% annually in the global market. PBPs are a feasible option for use as biocolorants in the cosmetics industry and as additives in the food business due to their colorful nature. This biotechnology is becoming relevant now, as the food industry is focusing on utilizing natural and healthy ingredients (Shetty et al., 2017). In this communication we will discuss a comparison study of the two red algae and the distinction will be centered on the quality of the purified phycobiliproteins. We find R-PE and R-PC in red algae, exhibit distinct colors in aqueous solutions: reddish and blueish respectively. Additionally, APC displays a blue-greenish (Sepúlveda-Ugarte et al., 2011). Red algae can be used to produce high-value proteins and bioactive compounds (Álvarez-Viñas et al., 2019), he has been the subject of a novel extraction technic. This method combines three approaches (maceration, freezing-thawing, and ultrasound) and results in an R-PE extraction yield 7 mg/g in the brute extract. Later on, a semi-purification using two precipitations with ammonium sulfate and dialysis (Brain-Isasi et al., 2022) and the R-PE was quantified. Following dialysis, R-PE was isolated and refined using DEAE (Diethylaminoethyl) cellulose separation in column chromatography. Phosphate buffer was employed as the mobile phase, and phosphate buffer and sodium chloride were used to elute the samples. Finally, R-phycoerythrine (R-PE) exhibited absorption at $\lambda = 566$ nm, R-phycocyanine (R-PC) at 620 nm, and proteins at 280 nm (M.P. et al., 2015; Senthilkumar et al., 2013).</i>
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KEY WORDS (MAX 4): PC, PE, APC, MACROALGAE, MACROMOLECULAR PROTEIN



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

**TITLE: INVESTIGATING HOLM OAK FOREST DIEBACK BY MULTILEVEL
APPROACHES: PHYSIOLOGICAL MEASUREMENTS, DENDROCHRONOLOGY AND
REMOTE SENSING**

SESSION:

FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Over the past two decades, the occurrence of extreme climatic events in Mediterranean region has increased and such climatic pressures contribute to the spread of vegetation dieback over several Mediterranean forest communities. Dieback affects even tree species considered well adapted to the Mediterranean environmental conditions, such as the evergreen *Quercus ilex* L. (holm oak) (Alderotti and Verdiani, 2023; Pasquini et al., 2023). Since this decline has worsened over the last 15 years in many Mediterranean stands, particularly after severe droughts occurred in 2012 and 2017 (Pollastrini et al., 2019), it is crucial to develop effective tools for studying this phenomenon by multi-level approaches combining different scales of measurement. Our study was conducted over three years (2019-2021) in declining (D) and non-declining (ND) *Q. ilex* stands in Maremma Regional Reserve (southern Tuscany, Italy), assessing both physiological (gas exchange and water relations) and biochemical traits (carbohydrate analysis in the wood and xylem sap isotopic signal ($\delta^{18}\text{O}$)). Secondly, dendrochronological, tree-ring $\delta^{13}\text{C}$ analyses and SSR genotyping were combined to investigate the effects of previous droughts on tree growth and testing the hypothesis that different damage levels observed in the two *Q. ilex* stands were connected to different population features. Lastly, the relationships between physiological indicators and satellite-derived Normalized Difference Vegetation and Water Indices (NDVI and NDWI) were analyzed.

The results of physiological analyses showed that seasonality had a strong effect on these traits, with the main stress occurring during the summer of 2020, as evidenced by the lowest gas exchange values. Furthermore, plants in the ND stand exhibited significantly higher photosynthetic performances than those in the D stand across multiple seasons, with the highest values of photosynthesis recorded in January 2021 and 2022. According to the results of $\delta^{18}\text{O}$ analyses, holm oaks in ND and D stands mainly took up water from deep soil sources (bottom soil or ground water) thanks to their deep-root system, thus explaining why *Q. ilex* showed only slight different ring-width patterns between the two stands, with a low responsiveness to seasonal climatic variations for trees at both stands. By contrast, the $\delta^{13}\text{C}$ value of trees at ND stand significantly exceeded that observed at D site over the last 20 years, revealing a more conservative water use of this population. This study allowed highlighting that the higher resilience to drought of *Q. ilex* at ND stand was probably due to a safer water strategy of this population underlying the potential of combining $\delta^{13}\text{C}$ analysis with SSR genotyping as a powerful tool for identifying trees putatively tolerant to water deficit. Such a method may also be used in the selection of genotypes for seed-bearing plants to preserve Mediterranean holm oak ecosystem types. Furthermore, while the high spatial resolution of Sentinel 2 helped identify the overall *Q. ilex* decline, these indices were inadequate for analyzing forest stands characterized by a 'salt-and-pepper' dieback phenomenon. Our study emphasizes the significance of a multiscale approach that combines in situ physiological measures and satellite data to monitor *Q. ilex* decline in Mediterranean region.



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KEY WORDS (MAX 4)

HOLM OAK, FOREST DIEBACK, TREE-RING $\Delta^{13}\text{C}$, PHOTOSYNTHESIS



Tenth International Symposium

**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: MONITORING GELATINOUS ZOOPLANKTON AND ITS DYNAMICS IN THE EAST ADRIATIC (2018-2023)

**SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT,
MONITORING _ MARINE ECOSYSTEMS**

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

In warmer months associated with seaside tourist season along the eastern Adriatic, many media reports mentioned the unusual appearance of numerous transparent creatures in the sea. These are encounters with typical but unfairly overlooked groups of marine organisms called: gelatinous zooplankton (GZ). In fact, GZ is a ubiquitous part of the pelagic community, which includes a diverse group of organisms of various sizes visible to the naked eye. Most species fit into the following three taxonomical categories: Cnidarian, Ctenophora, and Tunicata.^[1] A common feature they share is a fragile skeleton-free gelatinous body with >95% water in their tissue, which poses a challenge when studying them and explains a reliance on the visual census data. That in part explains why GZ is less reported on than other pelagic organisms (e.g., fish and crustaceans) and pinpoints a discrepancy in the status of their population. However, given that they compete with fish for zooplankton availability and their proliferation is rarely top-down controlled, a shift in their dynamics can alter marine food webs.^[1] Indeed, they are often considered a trophic dead-end and their increased importance in an ecosystem is an undesirable outcome in the direction of general ecosystem degradation. Massive GZ blooms also negatively affect marine fisheries, aquaculture, and tourism, pose a threat to human health, and malfunction in thermopower plants.^[1,2] Nonetheless, an increase in GZ appearances is often linked to some anthropogenic stressors.^[1,2] In the Adriatic, the increase in gelatinous proliferation was most evident in the north – one of the biologically viable areas of the Mediterranean,^[3,4] underlining the importance of studying GZ phenomena.

Objectives

Our goal was to demonstrate a successful monitoring practice of the abundance of common GZ species in the Adriatic. We have done so by daily monitoring along the western coast of Istria and integrated it into the database of offshore cruises during the periods of maximum GZ proliferation or linked to an expected appearance of a particularly dangerous species. To put these findings in the context of the rest of the Adriatic, we have compared our findings to a week-long monitoring cruise in the southern part (Split to Dubrovnik, project M.A.R.E. June 2023). In this way, we have aimed to create a systematic 6-year data set of GZ dynamics in the northeastern Adriatic and contrast these findings from the southern part.

Main findings, results, and indications of the proposed work

The invasive Ctenophora *M. leidyi* was the most abundant and frequently occurring GZ along the western Istrian coast, reaching locally ~400 GZ/m². It was demonstrated that those massive blooms influence the displacement of anchovies (2nd major stock of bluefish in the Adriatic),^[4] but damage fishing equipment, and impact tourist activities. In 2023, they appeared in drastically smaller numbers, possibly due to the extreme drought affecting the River Po that could influence nutrient load circulation patterns in the north-Adriatic. Among the Cnidaria, *Aurelia* spp., *Rhyzostoma Pulmo* and *Cothyloriza tuberculata* were the most common and numerous, while among the stinging jellyfish, *Chrysaora hysoscella* was the most frequent in the warmer season. Among those stinging, a few decades ago, *Pelagia noctiluca* was the dominating species,^[3] and it reappeared again in 2023. Firstly, in late spring in the southern Adriatic, proliferating to greater numbers in the early summer, and expanding northwards, finally reaching the southern coast of Istria in the 2nd half of summer. It is possible that further spread was restricted due to the presence of a resource competitor – *M. leidyi*. In the south, we observed the occurrence of cnidarians *P. noctiluca* and *Aurelia aurita*, Ctenophora (*Leucothea multicornis* and *Bolinopsis vitrea*) and some Tunicata. Namely *Salpa maxima* and a bloom of *Thalia democratica*. Literature mentions occasional *M. leidyi* presence in the harbour of Ploče,^[4] and here we report on public concern about their spread to close by pristine areas around Mljet island. However, we did not encounter *M. leidyi* and assume that common and morphologically similar *B. vitrea* could have caused confusion. Moreover, Tunicates in the north were represented only by short episodes of chain forming *Salpa* spp. in the spring months. In conclusion, due to the different impacts GZ can have, there is a real need for continuous local monitoring of their populations, especially in commercially and ecologically important areas.



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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KEYWORDS (MAX 4) GELATINOUS ORGANISMS, EAST ADRIATIC, ISTRIAN COAST, MONITORING



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**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: MONITORING THE MONK SEAL *MONACHUS MONACHUS* IN THE CENTRAL MEDITERRANEAN

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The Mediterranean monk seal *Monachus monachus* was once a common inhabitant of the Mediterranean Sea. Over time, its distribution has experienced a sharp and concerning reduction, primarily attributed to various factors stemming from human activities [1].

Known reproductive sub-populations of the species are nowadays concentrated along the coasts of Greece and Turkey. However, occasional but recurrent sightings or movements of individuals are being recorded along most of the coasts in the species' former distribution range within the Mediterranean Sea [1].

The Marine Strategy Framework Directive 2008/56/EC and subsequent actualizations require the establishment of monitoring programmes to obtain indicators for the Good Environmental Status of European waters. Here, we present the monitoring programmes we carried out on the Endangered Mediterranean monk seal in the central Mediterranean Sea aligned with three descriptors within the Marine Strategy Framework Directive.

Studies based on biogeography, habitat availability and the use of terrestrial habitats by the Mediterranean monk seal provide information for potential indicators on the abundance and the distribution of the species (Descriptor 1 of the Marine Strategy Framework Directive):

A. Seal sightings were recorded in the Ionian Sea in Greece (from 1985 to 2023), in Southern Apulia in Italy (from 2011 to 2023), in Albania (from 2018 to 2022), in Montenegro (from 2013 to 2023) and, to a minor extent, in Croatia (from 2011 to 2013) [1, 2].

B. Habitat surveys for the species were conducted in the Ionian Sea since 1985 (on-going up to the present) and, for shorter periods of time, in Southern Apulia (from 2011 to 2015), in Southern Albania (in 2019), in Montenegro (from 2013 to 2015) and, to a minor extent, in Northern Croatia (from 2011 to 2013). Habitat use by seals was confirmed for the entire Ionian Sea, Southern Albania and Northern Croatia [2].

C. Photo-identification was carried out using camera traps in Greece and in Albania; in the central Ionian Sea (from 2018 to 2023), 25 sub-adult and adult animals were identified and the use of one cave in North West Corfu by 2 seals was documented. In Albania (2022), two individuals were documented [2, 3]. Population parameters are in due course for the central Ionian Sea main population.

Our more recent monitoring work is aligned with the Descriptor 4 and Descriptor 10 of the Marine Strategy Framework Directive. Samples of faeces collected from marine caves in Greece (1992 and 2011-2023), in Italy (2012 and 2013), in Albania (2019) and Croatia (2011 and 2013) were analysed to study the trophic ecology of the seals across the area. The results provide valuable information for various criteria for the Descriptor 4.

Parallel studies on microplastics in samples from these countries [4], provide information for the Descriptor 10, Criterion 3.

The output of the work carried out in the central Mediterranean Sea for such a long period of time indicates the relevance of continuous monitoring systems for the monk seal as a top predator in the area. The species may be useful as a key species within the [Marine Strategy Framework Directive](#) for these three descriptors above.

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KEY WORDS (MAX 4) MARINE ECOSYSTEMS, BIODIVERSITY. THREATENED SPECIES, MONITORING OF COASTAL ECOSYSTEMS



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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: ECOLOGICAL ZONATION AND ABIOTIC VARIABILITY IN AN ENCLOSED NATURE PARK: THE CASE OF THE SALINI SALTWORKS IN MALTA

SESSION:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The Salini saltern complex, the largest saltworks facility in Malta, is a former natural wetland that now functions as a nature park. The entire salina is oriented along a NE to SW axis measuring 740m by 140 m, with a surface area of 90000 m². It comprises two large reservoirs at the seaward extremity (each 12000 m² in area) and 33 smaller enclosures ('pans') in the inland portion, with surface areas ranging from 900 m² to 2000 m² (Fig.1). Although the salina has been the subject of recent studies, these have either focused on a taxon, usually avifauna, or have assessed the nature park in isolation with little regard for its external context.

This study aimed to address a knowledge gap by recording trends in abiotic and ecological conditions across the primary axis of the salina and relating them to the external marine conditions. The salina was visited monthly between 25 July 2022 and 5 July 2023. During each visit, the temperature, pH, electrical conductivity, nitrate concentration and phosphate concentration of water was measured in the open sea, in the two large reservoirs, and in 15 of the 33 smaller pans. The diversity of macroalgae, spermatophytes, and non-planktonic fauna (excluding interstitial fauna) was evaluated through direct observation, collection of specimens and automated photographic monitoring.

The data indicated water quality changes in both spatial and temporal dimensions within the salina. The principal trend was a sharp gradient of abiotic conditions along the primary axis of the salina from the seaward side to the landward side, suggesting clear changes in the characteristics of water during its movement from the open sea into the reservoirs and the pans. The mean electrical conductivity (EC) varied from 52.3 mS cm⁻¹ in the marine environment to 58.5 mS cm⁻¹ in the reservoirs and rising to 109.4 mS cm⁻¹ in the inner pans, reaching 200 ms cm⁻¹ in individual pans. This trend was statistically significant ($r = 0.723$, $p = 0.001$). Variations in the pH, nitrate content and phosphate content of the water showed no discernible spatial pattern. These gradients were more pronounced during the dry season, with EC, nitrate, and phosphate levels highest in July and August before declining during the wet season. Temporal variations in pH were unremarkable and reflected predictable patterns driven by photosynthetic activity. Conditions in the innermost pans, those furthest from the sea, were extreme during the dry season with hyperhaline water, deposition of evaporites, and water temperatures sometimes in excess of 50°C.

The abiotic conditions generated an ecological gradient. If the diversity of macroscopic species in the marine environment was taken as a comparative baseline, the species richness increased considerably in the two reservoirs and decreased to much lower levels in the inner pans. The elevated species richness in the two reservoirs is attributable to the greater stability of this portion of the habitat relative to the marine environment (in terms of mechanical energy) and the inner pans (in terms of physico-chemical extremes). These reservoirs were colonised by four spermatophytes (*Posidonia oceanica*, *Cymodocea nodosa*, *Ruppia* sp., *Halophila stipulacea*), at least 26 taxa of macroalgae, and approximately 30 species of macroscopic fauna. The inner pans were progressively depauperate with increasing distance from the sea. The outermost of these were colonised by killifish (*Aphanius fasciatus*) whilst the innermost only supported *Dunaliella salina* (Chlorophyta).



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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In conclusion, the findings underscore the importance of considering both internal conditions and the external marine influence to inform effective habitat management strategies. These should focus on maintaining the conditions that support the assemblage of species, in the more stable reservoirs that serve as biodiversity hotspots within the complex.



Fig. 1: Aerial view of the Salini complex. A scale bar and North arrow are shown. The sampled inner pans (P-*) and reservoirs (R-*) are shown. Water enters the salterns from R-1.

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4)

Salinas
Ecological zonation
Abiotic variability
Malta



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: USING MULTISPECTRAL UAV IMAGERY AND GROUND TRUTHING TO ASSESS THE SUCCESS OF VEGETATION REINFORCEMENT IN A COASTAL AREA – THE CASE OF INWADAR NATIONAL PARK, MALTA

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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Abstract (min 3000 max 4000 characters):

The success of vegetation reinforcement programmes can only be assessed in relation to a known baseline accumulated through several years of field observation. This traditional process, although accurate, is labour-intensive and therefore slow and expensive. However, recent technological developments have made UAVs (Unoccupied Aerial Vehicles) accessible to consumer budgets, facilitating their utilisation in both pre-restoration and post-restoration monitoring.

This study made use of remote sensing multispectral imagery to aid in the assessment of an ongoing vegetation reinforcement programme in a coastal area in Malta, Inwadar National Park (INP). These processes were carried out in a designated 'intervention site' (area: 13486 m²).

The intervention site and its immediate environs were aerially mapped using a DJI Phantom 4 Multispectral UAV capable of capturing imagery in visible, Near Infrared (NIR) and Red Edge (RE) wavelengths. The imagery was processed to produce a false-colour image expressing a modified-NDVI (Normalised Difference Vegetation Index), with a resolution of approximately 1 cm/pixel. Figure 1A illustrates the resulting image in which the vegetation cover and relative intensities of chlorophyll (assumed to be a proxy of photosynthetic activity) are evident. Whilst much of the coastal fringe was characterised by bare rock, plants typical of the coastal community in INP occurred in isolated pockets of soil. The confluence of vegetation cover and rates of photosynthetic activity increased further away from the shoreline.

Ultimately, a succession of false-colour images generated over time will permit the observation of seasonal fluctuation in plant productivity within the 'intervention' sites to be characterised (Fig 1A and B). This provides a baseline against which the success of the reinforcement programme could be measured.

The NDVI data would be cross-calibrated in the field using a chlorophyll meter, allowing the various NDVI categories to be associated with a quantitative measure. This process is currently under study, however,



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a preliminary vegetation reinforcement study has shown the beneficial use of this equipment as a reliable indicator of general plant 'health'.

In this study, approximately 60 plantlets that were cultured *in vitro*, were translocated into five 2 m x 2 m plots within the intervention site, in January 2023. The state of 'health' of the translocated plantlets was assessed empirically through the measurement of chlorophyll concentration in the leaves, and compared with values from 150 leaves of the same species *in situ*. The results (Figure 2) indicated that in most cases, the variability in chlorophyll content of the leaves in the comparison sample was higher than that recorded from the experimental plots. While this may be attributable to the difference in sample size, it could also be a result of stress that plants within the experimental plots may have been subjected to.

In this case, given the small area of the plots in relation to the whole area of the intervention site, it would have been futile to assess the vegetation success of such a small sample with UAV imagery. Despite this, broader vegetation reinforcement programmes can make use of both monitoring methods simultaneously, allowing UAV imagery to be associated with this respective quantitative measure. This implies that once the initial ground-truthing and cross-calibration has taken place, the UAV imagery can be used to accurately and cost-effectively monitor large areas of vegetation in much shorter times than those required for ground-based surveys.

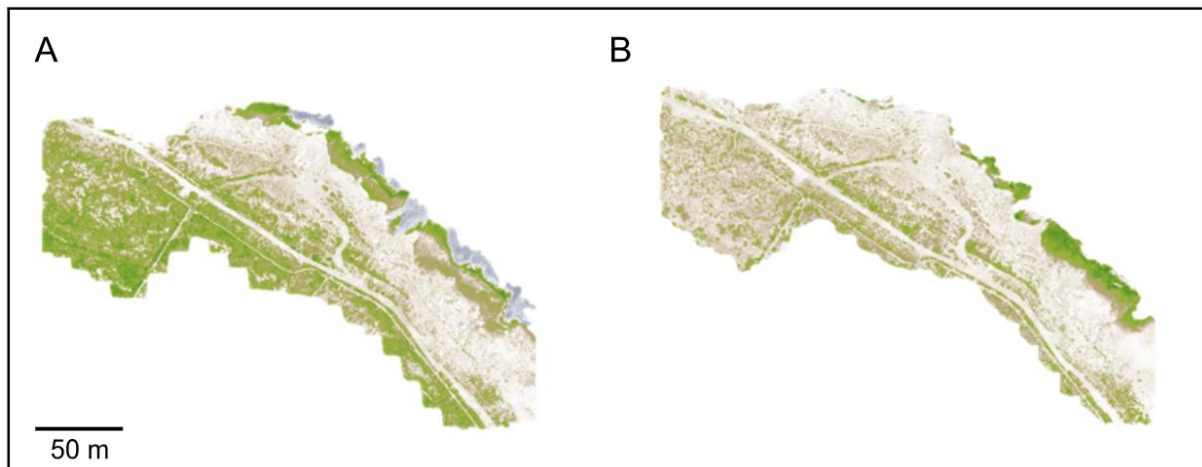


Figure 1: NDVI images of the intervention site. Darker shades of green indicate higher rates of photosynthetic activity, shades of brown indicate lower rates and white indicates no photosynthesis. Blue indicates absorption of light.



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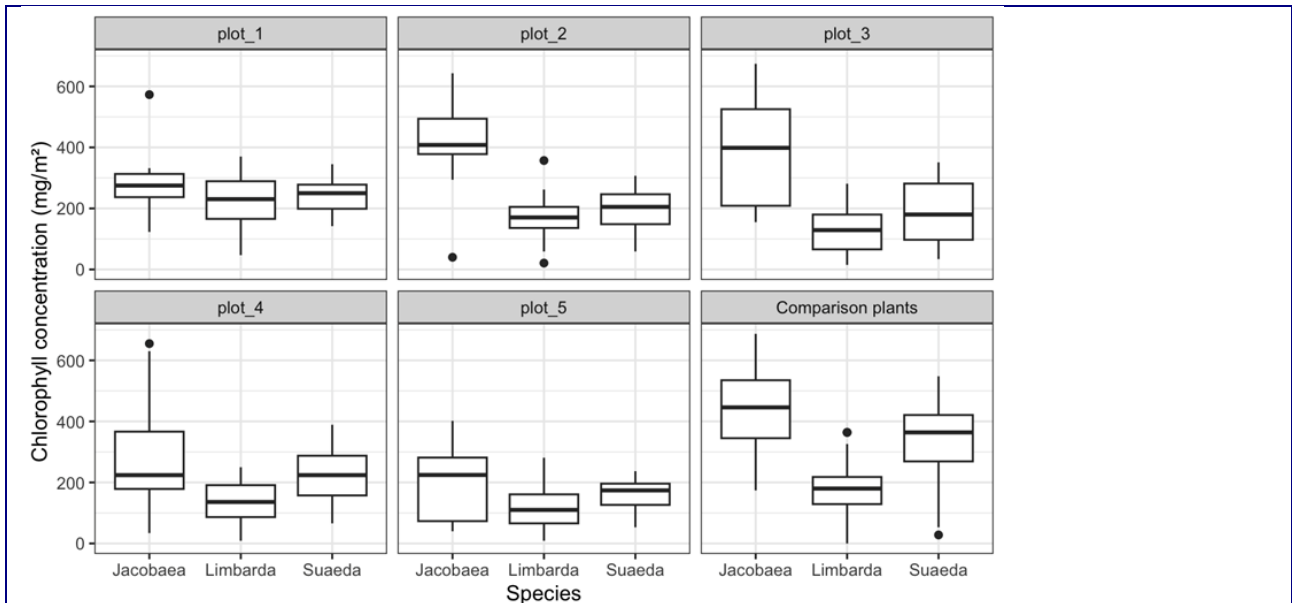


Figure 2: Chlorophyll concentration (mg/m²) in the leaves of the target species in each experimental plot after 4 weeks from planting, and “comparison plants”.

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4)

Monitoring
Vegetation reinforcement
NDVI
Chlorophyll concentration



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

ENVIRONMENTAL ISSUES AFFECTING LOGGERHEAD TURTLES *CARETTA CARETTA*: A STUDY ON THE PRESENCE OF INORGANIC POLLUTANTS IN ORGANS, TISSUES AND EGGS

SESSION:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

In the context of the One Health approach, which integrates health and environment, there is an increasing interest in the issue of contaminants in marine ecosystems and their impact on both human and animal health.

Certain animals have long been recognized as valuable indicators for assessing the health implications of different environmental exposures. Among these so-called "sentinel" species, sea turtles play a crucial role in research aimed at monitoring environmental pollution and its effects on animal and human health. These animals have been extensively employed to evaluate exposure to various chemical contaminants.

The loggerhead turtle *Caretta caretta* (Linnaeus, 1758) is the most abundant sea turtle species in the Mediterranean Sea. It is categorized as "vulnerable" among the endangered species listed on the International Union for Conservation of Nature's Red List of Threatened Species (<https://www.iucnredlist.org>). The main threats to this species are attributed to high level of anthropic activities in coastal areas, maritime traffic, macroscopic (plastic and other waste) and chemical pollution of the sea, fishing practices, as well as the ingestion of hooks and lines.

Concerning chemical pollution, various human and industrial activities, including the use of fertilizers and pesticides, the production of plastic, oil and gas, result in the discharge of large quantities of toxic metals, including arsenic, cadmium, mercury, and lead, as well as non-essential and potentially toxic metals, along with various organic contaminants such as polychlorinated biphenyls (PCBs), pesticides, PAHs and PFAS, into marine environments.

Sea turtles can accumulate these harmful substances over extended periods and across vast geographical scales, due to their extensive migrations. Organs including the liver, kidney and adipose tissue serve as storage sites for these pollutants. Upon attaining sexual maturity, these contaminants may be transferred to subsequent generations through the eggs, thereby exposing developing embryos to potentially high doses of pollutants [1].

Inorganic contaminants (such as heavy metals and potentially toxic trace elements), and persistent pollutants (like dioxins, PCBs, PFAS) that accumulate in the tissues of sea turtles, can interfere with normal biological functions and weaken their immune system [2]. Furthermore, recent studies have provided basic data about the potential role of sea turtles as sentinel species for zoonotic and terrestrial pathogens in the marine environment including protozoan parasites, pathogenic bacteria such as *Salmonella* or *Chlamydia* spp., and viruses like *Chelonid herpesvirus* [3].



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Another crucial factor to consider is the impact of climate changes which have been significantly altering the nesting areas for turtles, leading to an expansion in the Western Mediterranean regions in recent years [4]. Notably, the coasts of the Campania and Calabria regions in southern Italy represent an important nesting site for loggerhead turtles. At the same time, along these coasts, there is an intense recovery activity of stranded turtles whose carcasses are subjected to necropsy at the laboratories of the Istituto Zooprofilattico Sperimentale del Mezzogiorno.

The study aimed to quantify specific chemical contaminants and characterize pathogenic microorganisms in organs, tissues, and eggs of *C. caretta*. It seeks to investigate potential correlations between the health and biometric parameters of turtles and the environmental and climatic risk factors that could influence the emergence and spread of diseases, along with their potential vectors. The ultimate goal is to improve health management and conservation efforts for these endangered species. Additionally, the results of chemical, microbiological, and environmental analyses offer valuable insights into the overall health of the marine environment and its implications for both human and animal populations.

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KEY WORDS (MAX 4) THREATENED SPECIES, MARINE ECOSYSTEMS, SEA TURTLE, CARETTA CARETTA



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

ABSTRACT

TITLE: MONITORING PHENOLOGICAL TRAITS OF A COASTAL MEDITERRANEAN MAQUIS AREA THROUGH AUTOMATED SYSTEMS

SESSION:
FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT,
MONITORING

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Understanding the dynamics of ecosystems, in an era of global change and declining biodiversity, requires monitoring biotic components, such as individual behaviors and traits. Low-resolution and short-term monitoring of a limited number of biological and ecological parameters does not lead to a complete understanding of ecosystem dynamics (Besson et al, 2022). Conversely, high-resolution monitoring might turn out to be expensive and time-consuming, and characterized by frequently invasive investigation techniques which limit the temporal and spatial range of historical observations (White & Hastings, 2020). However, to track vegetation changes over long periods, the development of more reasonably priced near-surface remote sensing systems, and the application of easier-to-use and open code software tools for large-scale datasets analysis, offer potential solutions to these issues (Liu et al, 2019).

Integrate systems, based on acquisition of high frequency digital image, represent innovative frameworks for tracking vegetation with automated processes, as well as recording standardized data on morphological and phenological traits across ecosystems at high level of detail (Richardson, 2019).

In this study, a description of prototypal near-surface monitoring systems for detecting changes in phenological traits of Mediterranean maquis species is reported. Outcomes from experimental campaigns performed over coastal ecosystems are also presented.

The monitoring prototype were developed at the CNR Laboratories, using high resolution cameras, connected to automated robots, and equipped with power supply devices. The systems perform the following major functions: (1) image acquisition of the study area visual coverage; (2) raw image storage in a local hardware device; (3) transfer and storage of images on a remote server and post-processing.

A protective case has been added to protect the hardware systems against the negative effects of marine aerosol, and to prevent atmospheric water vapor from condensing on the surfaces. The case is equipped with actuators which enable daily opening while acquisition images.

The monitoring systems were tested over Mediterranean maquis ecosystems, located along coastal areas in North-West Sardinia, Italy. The systems were positioned on 3 meters height pylones. The optimal viewing angle was determined by studying series of images framed from different viewpoints. Optimization of the cameras parameters values were obtained using a specifically developed custom software.

The collected high-resolution digital images were analyzed to obtain data on phenological characteristics of the plants and the state in relation to environmental conditions. Digital numbers (DN), representing RGB color channel



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information in the visible spectrum, are transformed into chromatic coordinates through the application of a specific software routine, and vegetation indices (GRVI, ExG, REI) were calculated at daily scale.

Patterns of vegetation indices during the growing seasons were examined to highlight the changes in vegetation status through the variation in the green/red signals where inflection points of the curves indicate the time of significant changes.

The results of this study can significantly advance our knowledge of how plants respond to environmental changes, especially those relate to phenological behavior in response to climate change in Mediterranean coastal ecosystems. Integrated systems can provide a valuable support for ecological and environmental studies.

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KEY WORDS (MAX 4) NEAR SURFACE MONITORING SYSTEM, PHENOLOGICAL TRAITS, HIGH-RESOLUTION DIGITAL IMAGES, VEGETATION INDICES.



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

TITLE:

**ESTIMATION OF GROSS AND NET CARBON FLUXES IN A COASTAL AREA
UNDERGONE TO CLEARCUTS**

SESSION:

**FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE,
MONITORAGGIO**

AUTHORS:

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ABSTRACT:

Forest ecosystems have a fundamental role in the carbon (C) cycle both at global and local scales; this role is even more crucial in view of the ongoing climatic changes (Pan et al., 2011). Different techniques have therefore been put forward and often utilized to investigate on this topic; among them, remote sensing and biogeochemical models are complementary tools for studying and monitoring the main processes of forest ecosystems, with special reference to gross and net C fluxes (Su et al., 2022). An example of this approach is given by the integrated strategy developed and experimented by our research group in several European forest areas (Maselli et al., 2009; Sánchez-Ruiz et al., 2020). This strategy is based on the combination of the outputs derived from a radiation use efficiency (RUE) model, Modified C-Fix, with those from a model of ecosystem processes, BIOME-BGC. The former model requires remotely sensed NDVI images as a fundamental input, while the latter is entirely driven by ancillary data descriptive of forest conditions. The outcomes of the two models are then combined taking into account the effects of forest disturbances through the use of the ecosystem disequilibrium theory. Owing to this configuration, the modelling strategy can be applied to analyse the response of forest ecosystems to climatic changes but is also suitable to investigate on the impact of human activities (forest thinning, clearcuts, etc.).

More specifically, the current study presents the application of this consolidated model combination strategy to the analysis of medium-term, gross and net C fluxes in a Mediterranean, coastal pine wood ecosystem. This forest is located within the San Rossore Regional Park (Tuscany, Central Italy) and was originally dominated by the presence of *Pinus pinaster* Ait.; this species however was highly attacked by an insect, *Matsococcus feytaudi*, since 2004 and was therefore undergone to clearcuts around 2012. The modelling strategy is applied to reconstruct the evolution of the secondary succession for the years 2013-2022 using data obtained from different sources: a daily meteorological dataset, a set of 16-day MODIS NDVI images at 250 m spatial resolution, a LiDAR image derived from a flight over the Park in 2015 and a digital orthophoto over the same area referred to 2021. In particular, the two latter



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images are utilized to retrieve the structural data, i.e., vegetation height and fractional cover, of the ecosystem.

The study shows how the modelling strategy, based on all available information, can be successfully applied to i) investigate on the influence of clearcuts on this forest ecosystem and ii) to reconstruct the evolution of the secondary succession occurring after the disturbance in terms of gross and net C fluxes. Such assessment is relevant for providing the information required for sustainable forest management, concerning in particular the ecosystem services linked to the C cycle. The potential of the strategy, however, has to be confirmed by further investigations to be carried out using ground and remote sensing observations of both C fluxes and stocks taken in the same and other forest areas.

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KEY WORDS: SECONDARY SUCCESSION, MATSOCOCCUS FEYTAUDI, GPP, NEP



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

TITLE:

Carbon and nitrogen stable isotope analyses of emergent plants in a Mediterranean Coastal Lagoon (Cabras Lagoon, Italy)

SESSION:

Flora e Fauna degli ecosistemi costieri: tutela, gestione, monitoraggio

AUTHORS:

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ABSTRACT:

Understanding the spatial-temporal variation of carbon and nitrogen stable isotope compositions ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) of plant leaf provides important information regarding the physiology of plants species as well as their responses to changing environmental conditions in the ecosystem (Snyder et al. 2022). Yet, little is known about the spatial variations in the isotopic values of emergent plants in Mediterranean coastal lagoons.

We studied the spatial-temporal variations in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of emergent plants within a selected area of the Cabras lagoon (Sardinia, Italy). Leaf samples were collected at two-four stations (50-100 m apart) selected randomly at two sites (1.5-2 km apart) in March, May and August 2006 as part of a larger study on the food web of Cabras Lagoon (Como et al. 2012; Como et al. 2018).

The analyses did not detect spatial-temporal differences in $\delta^{13}\text{C}$ for any investigated species. *Sporobolus* sp. (ex *Spartina* sp.) was found to be $\approx 13\%$ enriched in ^{13}C in comparison to the other emergent plants (-13.06 ± 0.04 vs. -26.43 ± 0.22). Contrary to the $\delta^{13}\text{C}$ values, variability among dates or sites were found in $\delta^{15}\text{N}$ values of *Salicornia europea* aggr., *Phragmites australis*, *Sporobolus* sp. and *Limonium narbonense*, whereas no differences in the $\delta^{15}\text{N}$ were detected for *Juncus* sp. and *Halimione portulacoides*. *S. europea* was more ^{15}N -enriched in March than in August and in May, whereas *P. australis* and *L. narbonense* were more ^{15}N -enriched in August and in May than in March. *Sporobolus* sp. showed a significant difference in the $\delta^{15}\text{N}$ between sites. Above all, the most ^{15}N enriched values were found in *P. australis* and *S. europea*.

Our results highlighted distinct $\delta^{13}\text{C}$ values of *Sporobolus* sp. compared to those of other emerged plants, in accordance with its different photosynthetic pathway (C4). Due to the adaptation to



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warmer, drier environments, C4 plants metabolize almost all the ^{13}C from the CO_2 they take up and, therefore they retain more of the heavy isotope of carbon, ^{13}C , in their tissues than C3 plants (Snyder, 2022). Furthermore, we found different patterns of variation in $\delta^{15}\text{N}$ in plants living at different heights on the shores. While no differences in the $\delta^{15}\text{N}$ were detected in plants living on the upper shore levels, such as *Juncus* sp. and *H. portulacoides*, variability in $\delta^{15}\text{N}$ values were found in plants living at intermediate moisture conditions (*L. narbonense*) as well as lower on the shore, in the wettest part in direct contact with water (*S. europea*, *P. australis*, and *Sporobolus* sp.). The variability of N isotopes in *S. europea*, *P. australis*, *Sporobolus* sp. and *L. narbonense* found in our study indicates the resource-use plasticity of these plants in using different N sources, suggesting a mechanism whereby diversity increases niche complementarity leading to more efficient N acquisition and therefore promoting ecosystem functioning. Although these species uptake soil N through the roots, they can also exploit alternative available N sources (more ^{15}N enriched) including those in the water column. Our results indicated that stable isotope analysis is a valuable tool for studying the physiology and ecology of emergent plants that should be taken into account for monitoring these species and for implementing the conservation programs of coastal lagoons.

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KEY WORDS:

$\delta^{13}\text{C}$, $\delta^{15}\text{N}$, emergent plants, coastal lagoons



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: THE ASSESSMENT OF NON INDIGENOUS SPECIES WITHIN THE MARINE PROTECTED AREA OF “SECHE DELLA MELORIA”: FIVE YEARS OF MONITORING USING THE ALEX INDEX.
SESSION: FLORA E FAUNA
AUTHORS: DE BIASI A.M. ¹ , PIAZZI L. ² , PACCIARDI L. ¹ , PERTUSATI M. ¹ , PORCHERA A. ³ , PRETTI C. ¹
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <i>General frameworks</i> The Marine Strategy Framework Directive (MSFD) highlights the importance of Non-Indigenous Species (NIS) management, promoting appropriate actions to monitor the abundance and distribution of invasive species and their impact on native assemblages, in order to maintain the Good Environmental Status of coastal ecosystems. In this context, the ALien Biotic IndEX (ALEX, [1]), was proposed for the assessment of macroalgal assemblages. <i>Objectives</i> This paper aims at presenting results concerning the NIS monitoring of the Marine Protected Area of “Secche della Meloria” (Tuscany, north-western Mediterranean Sea) conducted using the ALEX index. Meloria Shoals are a 90 km ² wide rocky platform located about five km off the Tuscany coast. Coralligenous reefs characterize the bottom below 10 m depth interspersed with <i>Posidonia oceanica</i> beds. <i>Main findings, results, and indications of the proposed work</i> The monitoring program started in 2018 for coralligenous reefs and in 2022 for <i>P. oceanica</i> meadows. Macroalgal assemblages were sampled in three sites located inside the protected zones A, B and C of the MPA. In each site three samples (400 cm ²) of coralligenous were collected as well as five orthotropic rhizomes were taken in the <i>P. oceanica</i> meadow. The abundance of macroalgae was expressed as percentage cover of the sampling surface. The identified macroalgal species were grouped in four categories according to the literature and to their invasiveness traits observed in the considered geographic area: Group I (Native species), Group



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II (Casual alien species), Group III (Established alien species), Group IV (Invasive alien species). The $ALEX_{EQR}$ was calculated as $ALEX_{EQR} = (5 - ALEX) / 5$ where $ALEX = [(0GI)+(3(GII+GIII))+5GIV]/100$. GI, GII, GIII, and GIV are the quantitative dominance of each macroalgal group expressed as cover of the group/the cover of the total assemblage $\times 100$. Five intervals of $ALEX_{EQR}$ values corresponding to the five ecological status of macroalgal assemblages are considered: 0-0.30 bad, 0.31-0.50 poor, 0.51-0.70 moderate, 0.71-0.85 good, and 0.86-1 high.

A total of 73 macroalgal taxa were identified, 9 Ochrophyta, 8 Chlorophyta and 56 Rhodophyta. Four introduced species were found, the Chlorophyta *Caulerpa cylindracea*, the Rhodophyta *Acrothamnion preissii*, *Womersleyella setacea* and *Falkenbergia* spp. (sporophyte of *Asparagopsis*). The ALEX index indicated a general high ecological status. Values of ALEX ranged between 0.69 and 0.90 and did not significantly change between habitats and years. Coralligenous reefs exhibited a higher abundance of NIS, confirming the sensitivity of this habitat to the spread of both *C. cylindracea* and filamentous species. *P. oceanica* meadows were mostly affected by filamentous NIS. In fact, seagrass beds are considered highly resistant to the spread of *C. cylindracea*, while filamentous taxa, such as *W. setacea* and *A. preissii*, may easily colonize the rhizomes. The application of ALEX for different years in coralligenous reefs showed small variations in time. These results suggest that the invasion of macroalgal NIS reached a balanced stage in the studied area. In fact, NIS invasions are characterized by different steps such as arrival, settlement, expansion, persistence and optionally regression. The shift from expansion to persistence phase depends on the balance between the native assemblages and NIS, that may occur, as it seems to happen in the studied area. The proposed approach may represent a useful standardized method for the assessment of macroalgal NIS and their effect on native communities. This sampling design considers different habitats and different spatial scales together with a technique that allows to detect cryptic and rare NIS. At the same time, it allows to assess the ecological quality of the studied area, therefore it represents a versatile tool both in monitoring programs and in impact evaluation studies [2, 3, 4].

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KEY WORDS (MAX 4)

BIOLOGICAL INVASIONS, CORALLIGENOUS REEFS, ECOLOGICAL QUALITY, SEAGRASS MEADOWS



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: Comparing the genetic structure of two *Posidonia oceanica* meadows located in protected or unprotected areas of the Italian Southern Adriatic Sea

SESSION: flora e fauna del sistema litorale dinamiche e protezione

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ABSTRACT

Posidonia oceanica (L.) Delile, 1813 is a phanerogam endemic in the Mediterranean Sea, which represents coastal habitats of relevant conservation importance.

These meadows are also good biological indicators of the health status of marine ecosystems and of the anthropogenic and natural impacts on coastal environment that are causing alarming disappearance of this marine flowering plant throughout the Mediterranean basin. The European Union's Habitat directive (92/43/CEE) considers *P. oceanica* beds as priority habitats that have become one of the main targets for environmental protection and management in the Mediterranean Sea (Montefalcone et al., 2019).

In this study, we investigated the population genetic structure of two meadows located in the Italian Southern Adriatic Sea along the coast of Apulia region: the San Vito-Barletta and the Tremiti Islands meadows. In the southern part of the Apulia region, the multiple spots of the large San Vito-Barletta meadow constitute a Site of Community Importance (SCI), while a little further north the Tremiti Islands Marine Protected Area (MPA) is home to a meadow divided into three main patches (Figure 1). Both meadows are currently under a regression phase due to a large panel of anthropogenic stressors (Costantino et al., 2010).

The San Vito-Barletta meadow is permanently subject to the impact of more or less important urban centres such as port enlargements, sewage discharge, commercial fishing practices and industrial activities.

The *P. oceanica* meadow located in the Tremiti Islands MPA is included in a "partially protected" zone and is mainly affected by seasonal pollution and touristic activities (Tursi et al., 2022).

The Tremiti Islands meadow has been surveyed and monitored periodically in the past twenty years highlighting a general deterioration of the main indicators of its conservation status. However, the application of mitigation actions produced positive results in a relative short term since the meadow showed encouraging sign of improvement when main anthropogenic factors were removed (Tursi et al., 2022).

Population genetic studies on seagrasses increase the general knowledge on these marine flowering plants and support coastal management and/or restoration programmes. The majority of currently available data show that genetic analysis allow the quantitative tracking of populations in both spatial and temporal frame, the prediction of evolutionary potential and the resistance and resilience capacity under the pressure of various environmental stresses .

Herein, we have explored the genetic structure of these two *P. oceanica* meadows. Since only two patches of the San Vito-Barletta SCI have been previously studied (de Virgilio et al., 2020), we wanted to deepen our knowledge on this meadow and compare its genetic structure with that of a *P. oceanica* meadow situated in the Tremiti Islands MPA away from large cities and their anthropomorphic factors and



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therefore in less contaminated waters. We report different genetic structures between these meadows. The latter exhibits a monoclonal structure with low genetic/genotypic diversity. In contrast, the former possesses a subpopulation structure and higher genetic/genotypic diversity (Figure 2). Thus, the San Vito-Barletta and Tremiti Islands meadows are genetically distinct requiring different conservation and/or restoration strategies.

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KEY WORDS (MAX 4) Population genetics, Anthropic impacts, Seagrass, Italian Southern Adriatic Sea.

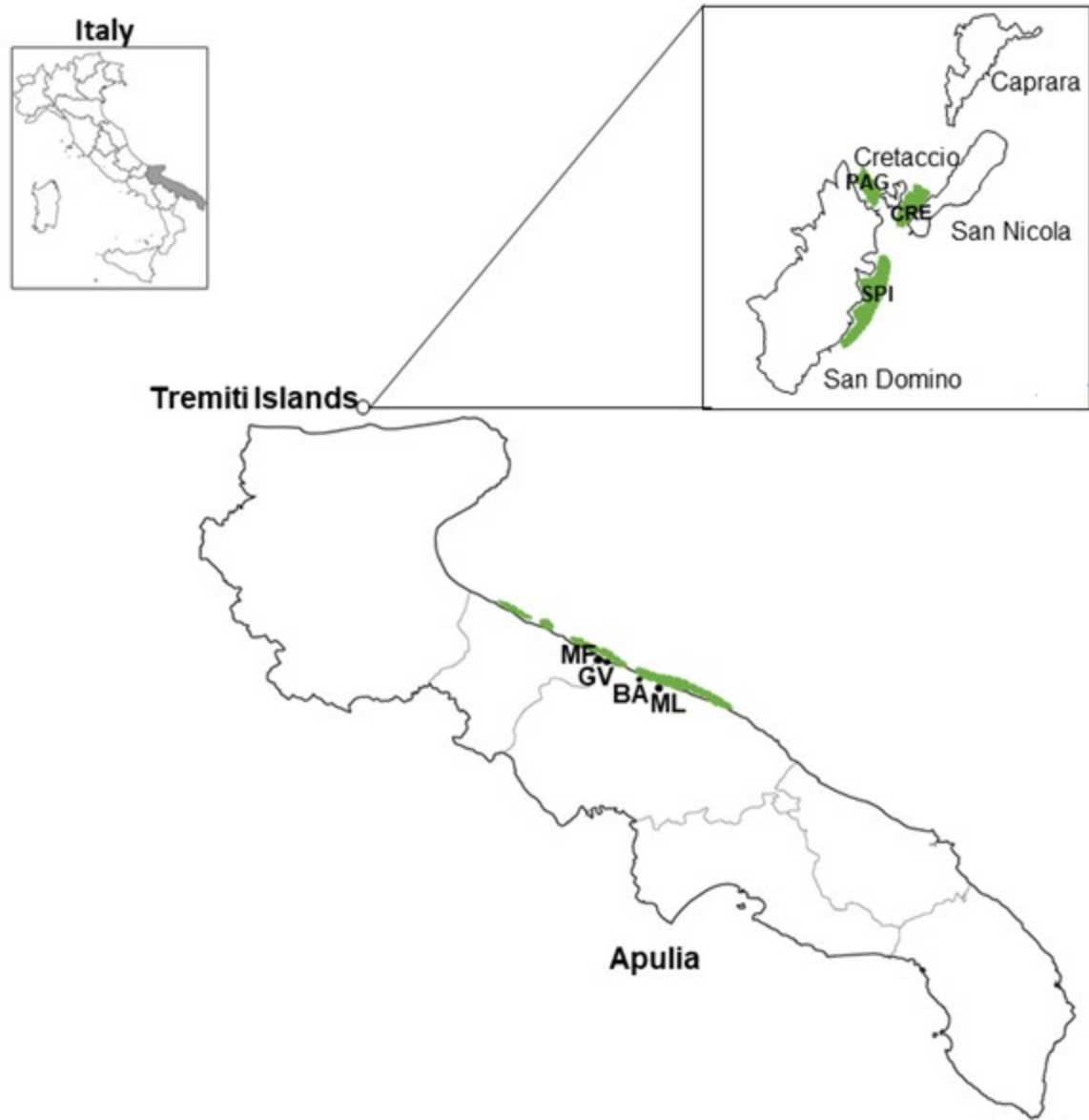


Figure 1. Location of the study stations along Tremiti Islands MPA and San Vito-Barletta SCI. Tremiti Islands MPA sampling stations: PAG (meadow at Pagliai beach), CRE (meadow located between San Nicola and Cretaccio Islands), SPI (meadow located at Spido cove). San Vito Barletta sampling stations: Molfetta (MF), Giovinazzo (GV), Bari (BA), Mola di Bari (ML).

Figure 2

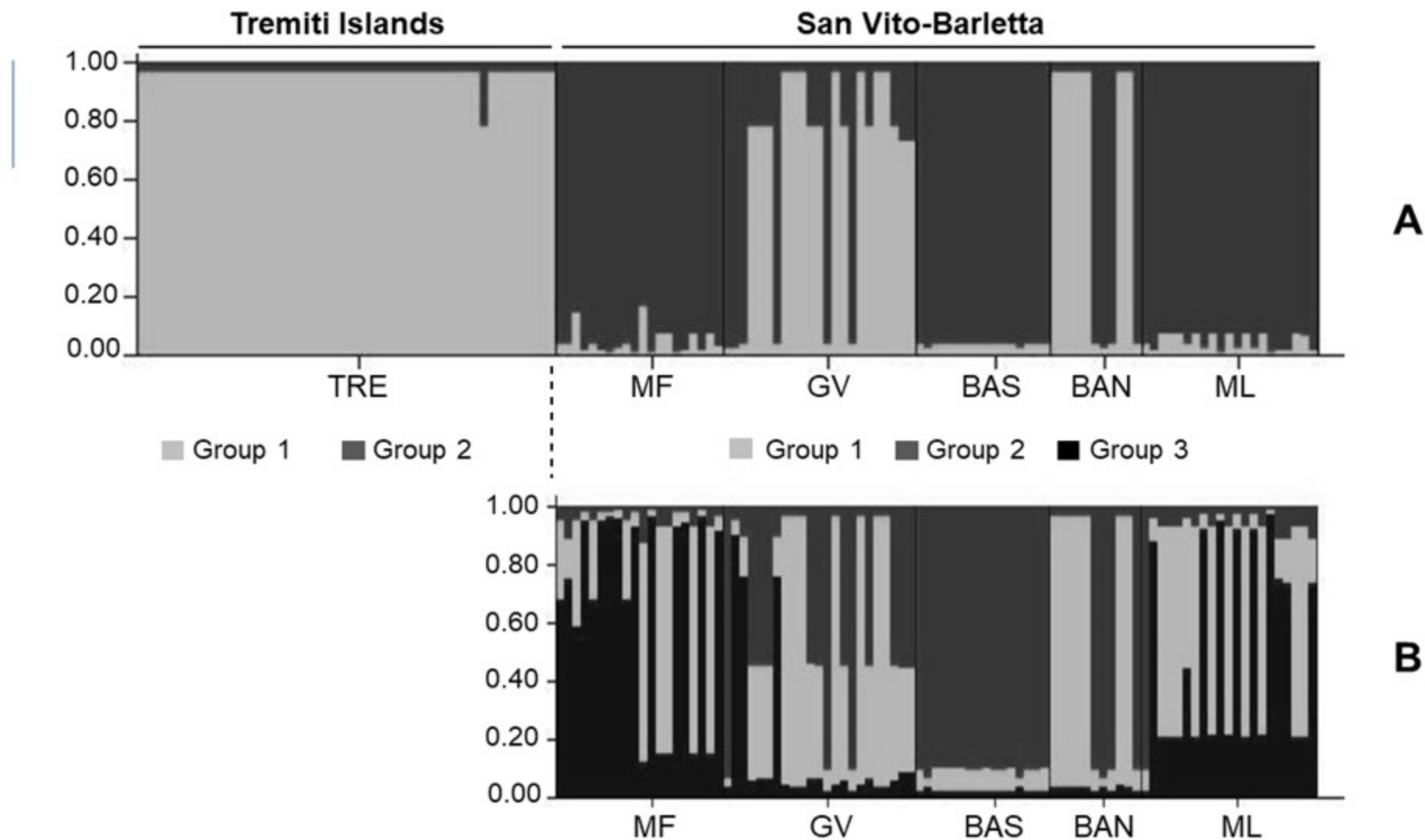


Figure 2. Bar plot resulting from Bayesian analysis performed with the software Structure. Each MLG is represented as vertical bar of different grey intensity in proportion to estimated membership coefficient (Q) to the k clusters. A) Tremiti Islands MPA and San Vito-Barletta SCI. TRE (Tremiti Islands meadow. B) San Vito-Barletta SCI. MF (Molfetta), GV (Giovinazzo), BAN (North of the harbour of Bari), BAS (South of the Harbour of Bari), ML (Mola di Bari).



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FORM FOR ABSTRACTS PRESENTATION

TITLE: ANALYSIS OF THE AMPHIPOD SYNTAXON ON HARD BOTTOMS ANTI-TRAWLING STRUCTURES.

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

THIS WORK IS PART OF A ENVIRONMENTAL MONITORING PROJECT CONDUCTED BY ISPRA. FOLLOWING THE DEPLOYMENT OF ANTI-TRAWL TRIPODS, A NEW ISPRA MONITORING PLAN WAS ESTABLISHED TO ASSESS THE INTEGRITY OF THE MARINE ENVIRONMENT. THE ANTI-TRAWL TRIPODS HAVE BEEN PERIODICALLY ANALYSED TO EXAMINE VARIOUS ASPECTS OF THE MARINE AREA WHERE THEY HAVE BEEN INSTALLED, INCLUDING ANY CHANGES IN FAUNAL AND ALGAL BIODIVERSITY RESULTING FROM THE INTRODUCTION OF ARTIFICIAL STRUCTURES. THIS STUDY INVOLVES OBSERVING RECRUITMENT ON THE ANTI-TRAWL BARRIERS TO ASSESS THE COLONIZATION OF ARTIFICIAL SUBSTRATES INTRODUCED INTO THE MARINE ENVIRONMENT. IN GENERAL, THE COMPLETE BENTHIC COMMUNITY STRUCTURE WAS INVESTIGATED, IN ORDER TO HAVE A BIOLOGICAL LECTURE OF THE MARINE ECOSYSTEM. THESE ASSEMBLAGES WERE STUDIED SINCE 2018, AND THEN UP TO OCTOBER 2022. IN PARTICULAR, HERE WE PRESENT THE AMPHIPOD SPECIES SAMPLED IN EIGHT STATIONS. UNIVARIATE AND MULTIVARIATE ANALYSES WERE CONDUCTED IN ORDER TO ASSESS BOTH THE QUALITATIVE AND QUANTITATIVE STRUCTURE OF THE SYNTAXON AMPHIPODA ASSEMBLAGES. THE WORK HAS FOCUSED ON AMPHIPOD SYNTAXON AS A PARTIAL DESCRIPTOR OF THE COMMUNITY AND, THEREFORE, A TOOL FOR ASSESSING THE CURRENT STATE OF THE ECOSYSTEM. IT WAS VERY INTERESTING FROM AN ECOLOGICAL POINT OF VIEW TO OBSERVE THAT FROM THE VERY BEGINNING (2018) TO 2022 THERE HAD BEEN AN EVOLUTION OF COMMUNITY, IN TERM BOTH OF NUMBER AND SPECIES RICHNESS, ALSO LOOKING AT THE DIFFERENTIATION OF NICHES AND ECOLOGY OF



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SAMPLED SPECIES. MANY SPECIES SHOWED AN ECOLOGY BOTH LINKED TO HARD BOTTOM AND TO SANDY SOFT-BOTTOM. SOME SPECIESMEN ARE MORE LINKED TO BOTTOM MORE EXPOSED TO THE LIGHT, WHILE OTHERS TO THE DARK SIDE OF TRIPODS. FURTHERMORE, ELABORATING AMPHIPODA STRUCTURE WITH MULTIVARIATE STATISTICS, WE CAN SEE THAT A PARTIAL DIFFERENTIATION BEGAN TO EXIST AMONG UPPER STATIONS AND DOWN STATIONS, INDICATING THEN THE PREFERENCE OF DIFFERENT SPECIES AND THEN TO DIFFERENT SPECIESMEN JUST DESCRIBED ABOVE, IN RELATION TO THE LIGHT ALONG THE WATER COLUMN.

THE PRINCIPAL STRUCTURAL INDEXES, H' (SHANNON INDEX) AND N (ABUNDANCE INDEX) SHOWED A SIMILAR BEHAVIOR OF THESE TWO, BOTH IN THE UP AND IN THE DOWN STATIONS.

THE MOST ABUNDANT SPECIES WAS *ARGISSA STEBBINGY*. THEN, ALSO SPECIES BELONGING TO AORIDAE AND TO HAUSTORIDAE FAMILIES WERE PRESENT IN A RELATIVE ABUNDANT NUMBERS. IT WAS VERY INTERESTING TO SEE THAT THE MORPHOLOGICAL DIMENSIONS OF ALL INDIVIDUALS WERE NOT HUGE, COMPARING THEM TO DIMENSIONS OF SIMILAR SPECIES, FOUND BY ISPRA IN THE DIFFERENT MONITORING PROJECTS, ON SOFT-BOTTOM. IN THIS CONTEXT, THE EXAMINATION OF BENTHIC COMMUNITIES BECOMES NOTABLY IMPORTANT. BENTHIC POPULATIONS DISPLAY DYNAMICS THAT ENABLE THE ANALYSIS OF SPATIAL AND TEMPORAL CHANGES IN THE "PHYSICAL ENVIRONMENT," EFFECTIVELY SERVING AS THE "BIOLOGICAL RECORD" OF THE ECOSYSTEM. IT HAS BEEN FREQUENTLY EMPHASIZED THAT AN "ECOSYSTEM'S BIOLOGICAL INTERPRETATION" HOLDS PRECEDENCE, AS IT OPERATES ON THE PREMISE THAT BIOLOGICAL CHARACTERISTICS PRESERVE A "RECOLLECTION" OF PREVIOUS EVENTS WITHIN THE SYSTEM. CONSEQUENTLY, THIS BIOLOGICAL ASPECT IS INSTRUMENTAL IN COMPREHENDING ITS PRESENT BEHAVIOR AND FACILITATING PREDICTIONS.

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KEY WORDS: HARD-BOTTOMS; AMPHIPODS; BENTHIC COMMUNITIES; ANTI-TRAWLING STRUCTURES



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Monitoring *Toumeyella parvicornis* (Cockerell) (Hemiptera: Coccidae) infestation on coastal and urban *Pinus pinea* L. stands through integration of remote sensing and *in situ* data

SESSION:

Flora e fauna degli ecosistemi costieri: tutela, gestione, monitoraggio

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

At the end of 2014, the tortoise pine scale *Toumeyella parvicornis* (Cockerell) was recorded in Italy (Napoli) for the first time (Garonna et al., 2018). The insect rapidly spread attacking stone pine trees *Pinus pinea* L., a species representative of the Mediterranean landscape. In 2018, *T. parvicornis* was reported also in Rome and led to the decay and death of many plants around central and south Italy (D'Amico, G. et al., 2023). The origins of this scale species are from North America and then it expanded to Southern USA and Canada.

The alien pest produces sticky honeydew related to feeding activity, this causes the development of sooty molds that cover branches and needles (Garonna et al., 2018). To contain infestation, endotherapeutic treatments can be carried out.

The study aims to define the infestation rate and verify the treatment's effects through integrated analysis of *in situ* surveys and remote sensing data.

The municipality of Rome is the area where the study is being conducted. It has a public space incidence of 3.7%, approximately 4,800 hectares (SNPA, 2022), allocated among equipped green areas, historical



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archaeological parks, and large urban parks. In larger urban parks and historical villas (i.e., Villa Pamphilj, Villa Borghese, Pineta Sacchetti), more uniform coverage of the same arboreal species can be found. To control infestations, during the periods of November 2020 to December 2021, January to June 2022 and Spring 2023, several abamectin endotherapeutic treatment cycles are carried out in Rome.

This work was developed in two phases: *in situ* surveys and satellite analysis. Surveys are conducted by filling out a five variables evaluation form, and then collected data are used to define regions of interest for satellite image analysis (PlanetScope) and validate results.

The sites for analysis are selected inside the area delimited by Ring Road A90, more densely populated and urbanized. The choice of plots is affected by various factors: accessibility of the plant's location, the density of crown coverage, homogeneity of species, and the resolution of satellite images available for the following phase.

Variables assessed during surveys are two associated with sooty mold (presence and quantity), two associated with tree crown (desiccation and density), and the last one associated with the overall vitality of the plant. The visual assessment can be executed from the ground without professional equipment or expertise in the assessment. Both the peculiarity of pest attacks and usability by non-specialists of this method have been parameters of the selection of variables.

In the following phase, satellite images of 12 months (august 2021/2022) are analysed (PlanetScope), evaluating vegetational indexes. Four indexes were selected (NDVI, RDVI, SAVI, SIPI) (Shi et al., 2018) and elaborated on 3 sample areas: one treated on October 2021 (BO), one treated on December 2020 (SA), and one with a biological pest control (GL).



Figure 1 - NDVI trend of plants classified as 20% and 80% of crown desiccation

Our results show that areas with a higher level of infestation have values of photosynthetic activity slightly lower. These differences are minimal because all trees we analyzed are infested, even if at different stages. To confirm these preliminary outcomes, we are focusing on acquiring data over healthy pinus, so that PlanetScope time series can be used for comparison purposes.

The capability of monitoring forest health status through automatic analysis of remote sensing images is crucial to promptly react when forest damages occur or insect infestation starts, and our research is a first step toward new advances in this field.

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<https://doi.org/10.3390/s18061901>

**KEY WORDS (MAX 4) - COASTAL ECOSYSTEM, INVASIVE SPECIES, SPREAD
MONITORING, FIELD SURVEY**



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FORM FOR ABSTRACTS PRESENTATION

TITLE: STABILITY OF EPIBIOTIC COMMUNITIES ON THE METAL SURFACES OF SHALLOW-WATER WRECKS IN THE MALTESE ISLANDS

SESSION:
FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General framework

In the marine realm, artificial metal structures, including sunken vessels, give rise to new underwater habitats on the ocean floor. Recently, intentional scuttling of defunct vessels has transformed these structures into popular diving sites, thereby boosting coastal tourism.

Artificial reefs are submerged structures composed of natural or synthetic materials which serve to protect, enhance, or restore components of marine ecosystems (Seaman & Lindberg, 2009). Sunken vessels in the photic zone are commonly categorized as artificial reefs by the general public, due to their tendency to attract a higher density of fish compared to the surrounding habitat. However, the overall numerical increase in fish populations is not significant. Fishes apart, the ecology of sunken vessels remains understudied. In particular, research concerning the colonization of wrecks by sessile organisms, and the subsequent ecological succession occurring on their surfaces, is notably lacking on a global scale.

Objectives

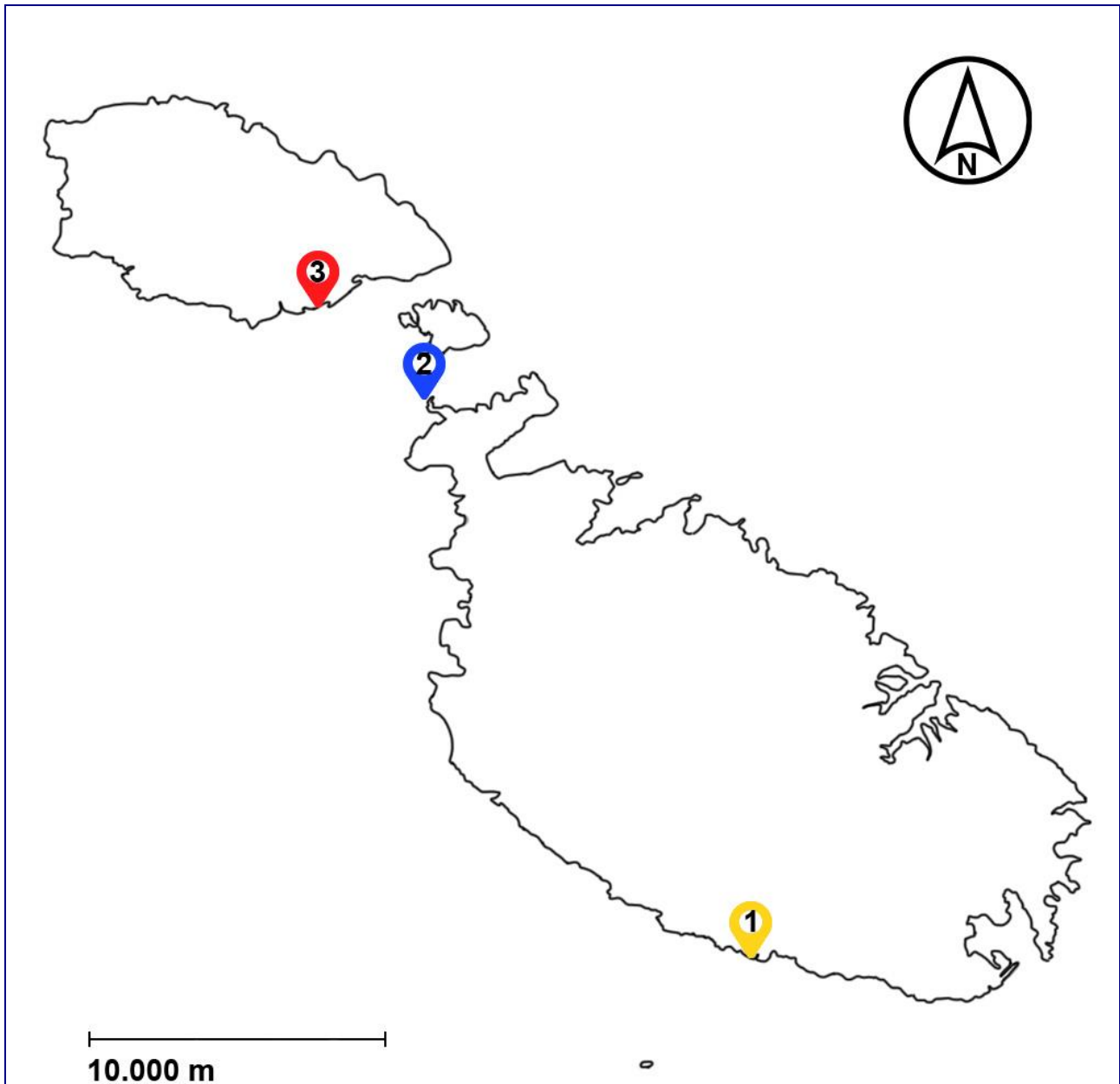
The epibiotic communities on the metal hulls of three wrecks around the Maltese islands were studied to determine whether wrecks submerged for extended periods exhibit consistent epibiotic assemblages among themselves and if these are similar to those of nearby natural hard substrata. The wrecks investigated were the oil tanker MV Um el Faroud, the patrol boat P29, and the ferry MV Karwela, which were deliberately sunk off the coasts of Malta and Gozo, to serve as diving attractions (Figure 1).

The epibiota on the hull of each wreck, and on nearby natural hard substrata, was studied by taking photoquadrats, and quantifying taxon richness and cover of the colonizing organisms, which were categorised into five functional groups based on structure: Encrusting, Turf, Filamentous, Short arborescent and Tall arborescent.



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1. MV Um el Faroud: Depth 36m, scuttled in 1998 off Wied iz-Zurrieq
2. P29: Depth 34m, scuttled in 2007 off Cirkewwa
3. MV Karwela: Depth 45m, scuttled in 2006 off ix-Xatt l-Ahmar

Figure 1: Outline map of the Maltese Islands showing the location of the three wrecks investigated, the approximate depth, and the date when they were scuttled.

Main findings, results, and indications of the proposed work

The composition and structure of the epibiotic assemblages on the hulls support the hypothesis that ecological succession on these surfaces reaches a specific stage but does not progress further due to flaking off of the substratum as the metal corrodes. This would account for the observed mosaic of disclimax communities characterized by patches of biota at various stages of succession interspersed with areas of bare/painted metal on the hulls, and suggests frequent interruptions and restarts of the ecological succession (Dethier, 1984). The hull



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assemblages had a higher taxon richness than those on nearby natural rocky surfaces in all cases, in concordance with the notion of a disclimax state with many competing species on the wrecks and an equilibrium 'climatic' climax state with fewer but ecologically dominant species on the natural rock (Dean & Connell, 1987a, b). Functional group analysis showed the natural hard substrata to have a high proportion of tall arborescent forms, as is expected for a 'climatic' climax community in the Mediterranean rocky infralittoral, while wrecks had a higher cover area of less complex epibionts, especially filamentous epibiota. NMDS ordination of taxon and functional group cover showed the wrecks to be distinct, with a higher taxonomic dissimilarity than a functional group dissimilarity. This suggests a truncated ecological succession on wreck surfaces, with each wreck exhibiting unique characteristics and developmental patterns. Further investigation into the factors underlying these patterns is needed. These results contribute to our understanding of the ecological impacts of wrecks on marine ecosystems, thereby informing environmental impact assessments as well as the management of scuttled vessels as habitats for marine life.

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KEY WORDS (MAX 4):

DISCLIMAX, SUCCESSION, INFRA-LITTORAL ROCK, COLONISATION



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

TurtleTosca: drone monitoring of the *Caretta caretta* nests in the Migliarino San Rossore Massaciuccoli Park

SESSION:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The loggerhead turtle (*Caretta caretta*) is the most abundant sea turtle species in the Mediterranean Sea. The Annexes II and IV of the EU Habitats Directive included it in the priority species. Its conservation requires protection of the turtle's entire natural range, both within and outside Natura 2000 sites, including nesting beaches. Italy hosts regular nesting events along the Ionic coasts of the southern Calabria and in the Pelagian Islands (Linosa and Lampedusa; Mingozzi et al., 2008), as well as along the southern Tyrrhenian Sea (Campania). In 2023, 454 nests were identified along Italian beaches, these results represent the absolute Italian nesting record. It was also an exceptional year (2023) for Tuscany, in the central of Italy, where 24 nests were found. In this region, the first nest identified dates back to 2013. Until 2018, only seven nests of the *Caretta caretta* species were documented in Tuscany. However, this area of central Italy seems to no longer be an exceptional site, so it is necessary to organize monitoring activities in order to cover most of the Tuscan beaches where *Caretta caretta* could nest.

Between the mouths of two rivers, the Serchio and the Arno, lies a natural park, managed by the Tuscany Region, called the Migliarino San Rossore Massaciuccoli Natural Park (MSRM Park), a protected area with 34 km of protected coastline.

With the aim of identifying, protecting and managing *Caretta caretta* turtle nests in this area, a monitoring program has been initiated using UAVs (Unmanned Aerial Vehicles), or drones, inside MSRM Park, within the coastal stretch of protected area with access allowed, by the managing body, for research purposes only. The work protocol applied envisaged the use of a Phantom 4 PRO v2 quadcopter-type UAV, which had already been used previously, in the same area, for environmental surveys of several types (Merlino et al., 2020, 2021; Luppichini et al. 2020). The temporal frequency of the survey was twice a week, with the involvement of only two operators acting from two different access points. In the first working season, which ran from June to August 2023, one carcass and some possible *Caretta caretta* tracks were identified, but no nest at the moment. The activities were carried out, and disseminated, thanks to a citizen science project with the Legambiente association, which involved around 40 volunteers.

One of the possible reasons for the absence of nesting within the protected area of the park could be the



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presence of considerable quantities of material, much of it anthropogenic, accumulated on these beaches, due to the presence of the nearby river outlet of the Arno and the lack of frequent beach cleaning operations. This considerable amount of material could act as a deterrent for spawning, although further investigation will be necessary to confirm this hypothesis. In any case, the protocol developed, based on the aerial survey, has proven to be extremely efficient, allowing for frequent surveys even in areas with difficult direct access to the sites to be examined, limiting anthropogenic impact in protected and fragile environments, and greatly reducing the number of personnel required for this type of investigation.

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KEY WORDS (MAX 4)

LOGGERHEAD TURTLE
UNMANNED AERIAL VEHICLE
SCIENTIFIC MONITORING
CITIZEN SCIENCE



Tenth International Symposium

MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: EFFECTS OF ARTIFICIAL SWEETENERS ON BIOLOGICAL PROCESSES OF *AURELIA COERULEA* POLYPS

SESSION: FLORA E FAUNA DEGLI ECOSISTEMI COSTIERI: TUTELA, GESTIONE, MONITORAGGIO

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Artificial sweeteners (ASs) are emerging contaminants increasingly used in hypocaloric diets, animal feeds, pharmaceuticals, and care products, reaching revenues of approximately 21.3 billion USD in 2021 [1]. Although their effects are currently debated, some ASs negatively affect humans and animal models, altering several metabolic pathways and leading to dysfunction of multiple biological systems (e.g., [2]). Since ASs are poorly degradable in aquatic ecosystems, they can disperse in the marine environment through inadequate industrial sewage treatments [3], possibly affecting coastal benthic fauna. However, the effects of ASs on marine organisms have so far been neglected.

We tested two ASs, aspartame and saccharine, on the model organism *Aurelia coerulea* in its polyp stage, following the REACH Legislation for xenobiotics (Regulation (EC) No 1907, 2006). In addition to providing insights into the effects of ASs on marine organisms, polyp populations play a key role in controlling seasonal jellyfish blooms. Their alteration potentially reflects on the benthic-pelagic trophic web and on the impacts of jellyfish outbreaks on the human activities [4].

Aurelia coerulea polyps were exposed to 1) aspartame in Filtered Sea Water, FSW (100µg/l), ASP; and 2) saccharine in FSW (100µg/l), SAC; the control was constituted by FSW. The exposure was carried out for 60 days, 6 replicates per treatment constituted by 1 polyp. Response variables were measured twice per week: 1) Mouth Disc Diameter (MDD) as proxy for the growth; 2) Number of newborns to indicate asexual reproduction; 3) Health status, by assigning to each polyp the scores 1 (optimal), 0.5 (intermediate) and 0 (bad); 4) Mortality rate; for a total of 18 sample points. Feeding and solution renewal were standardized and carried out twice per week.

Polyps of the two treatments and control presented differences in their growth rate and asexual reproduction, showing overall effects of time, treatment, and time × treatment for MDD, and time and time × treatment for reproduction. Post-hoc planned comparisons highlighted differences between FSW vs SAC and between FSW vs ASP for growth and between FSW vs ASP for reproduction. The MDD of polyps exposed to ASP and SAC showed a decline after ca. 10 days after the beginning of the exposure. This size reduction lasted 2 weeks for SAC and 4 weeks for ASP polyps. Surprisingly, after the low peak, the MDD



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started to re-increase, reaching pre-exposure conditions by the end of the trial. Size reduction of ASP polyps was reflected by their health status that declined from average score 1 to average score 0.17 ± 0.11 , indicating a degeneration process. As for the MDD, the health improved after the low peak, and healed to score 1 by the end of the trial. Conversely, SAC did not worsen the health of exposed polyps. Mortality was not registered in any of the experimental replicates.

Aurelia coerulea has been widely used as model organism for ecotoxicology trials, being a relatively simple organism, reproducing asexually and allowing to obtain clonal populations in short time. Aspartame showed to have stronger effects on polyps in comparison to saccharine, by severely impairing their growth, asexual reproduction, and health, even though not leading to their irreversible degeneration and death but rather to a full recovery. Low concentrations of xenobiotics (e.g., heavy metals) could induce acclimatisation in exposed *Aurelia* polyps, but it has been demonstrated that higher concentration could lead to irreversible degeneration and mortality [4]. Analogously, the threshold concentration of aspartame sweetener of 100 µg/l was enough to alter the physiological processes of *A. coerulea* polyps, and our results suggested that slightly higher concentration may lead to prolonged degeneration and consequent mortality.

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KEY WORDS (MAX 4)

ENVIRONMENTAL POLLUTION; ECOTOXICITY; MODEL ORGANISM; SCYPHOZOA.



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

**TITLE: DIET COMPOSITION AND PARASITE NEMATODES
RELATIONSHIP IN *TRACHURUS TRACHURUS* OF THE GULF OF BEJAIA**

**SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION,
MANAGEMENT, MONITORING**

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ABSTRACT

Trachurus trachurus (L.) is one of the most economically important species, especially in Algeria. Therefore, it must be managed appropriately. Although extensive knowledge of its biology exists, significant gaps remain. The diet of horse mackerel *Trachurus trachurus* from the Gulf of Bejaia was studied according to size classes and months. The stomach contents of 240 specimens of this species were analyzed. The vacuity coefficient is 20%. In total, 12 prey species belonging to six main groups (Euphausiidae, Decapods, Copepods, Amphipods, Molluscs and Teleosts) were identified. Euphausiids and Teleosts were the most ingested prey and were found in all size classes. Copepods and Amphipods are the most dominant foods. *Meganyctiphanes norvegica* (Cn=23.72%) and *Engraulis encrasicolus* (Cn=6.22%) were the most frequent prey. The parasitological indices of nematodes observed in horse mackerel are very high when Euphausiidae exist in abundance in the stomach contents of *Trachurus trachurus*, in fact, the prevalence of *Anisakis simplex* is significant with the dominance of *Meganyctiphanes norvegica* in the foods of the horse mackerel.

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Key words (MAX 4): *Trachurus trachurus*, Diet, Nematodes, Golf of Bejaia.



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: Interactions between Cetaceans and fisheries in the Algerian coast, challenges and outlook.

Session: Flora and Fauna of coastal ecosystems: protection, management, monitoring

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Algeria is a North African country with a coastline on the Mediterranean Sea, which extends over 1622.8 km. The Algerian basin water dynamics are characterized by the interaction between light waters of recent Atlantic origin and the resident denser waters.

Algerian waters are one of the regions of the Mediterranean or the presence of cetaceans is more frequent while in terms of the frequency of individuals than the species diversity.

Data from strandings and sightings indicate the presence of eleven cetacean species in Algerian waters during the past 40 years (Boutiba, 1992; Larbi Doukara, et al., 2014).

Eight species (*Tursiops truncatus*; *Delphinus delphis*; *Stenella coeruleoalba*; *Grampus griseus*; *Globicephala melas*; *Physeter macrocephalus*; *Ziphius cavirostris*; *Balaenoptera physalus*) occur regularly, whereas *Balaenoptera acutorostrata* has been observed rarely, and *Kogia breviceps* is considered accidental. A single floating humpback whale carcass (*Megaptera novaeangliae*) has recorded once.

Marine mammals stranding's represent a major source of biological information that is useful to provide valuable information on sources of mortality for cetaceans populations.

A comprehensive investigation of the possible cause of stranding was made via necropsies on the carcasses of the animals in order to detect signs of human interaction, as well as by comparing various criteria reported in the literature.



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Human activities are affecting the marine environment, and changing the physico-chemical balance of the water. Moreover, competition between marine mammals and fisheries for food resources is also a source of concern.

The contributions of this study address the stranding and necropsies of the bodies of these species found stranded, in order to examine the proportion of human and non-human induced mortality affecting this population, necropsies were conducted.

The big majority of the cases refer to animals killed by the man, voluntarily or accidentally, and that been recovered adrift or brought instead of the stranding by the currents, an interaction with some type of fishing gear had occurred.

Between 2008 and 2012, out of the 52 cetacean stranding records along the Algerian west coast, common dolphins (*Delphinus delphis*) were recorded in 14 cases. All recorded strandings were of individual cases with no mass strandings registered during the reported period.

To examine the proportion of human and non-human induced mortality affecting this population, necropsies were conducted. In 10 cases, an interaction with some type of fishing gear had occurred; in three, there was no link with human activity; and in one case, it was not possible to determine the cause of death due to the condition of the carcass (severely decomposed).

Common dolphins are probably still one of the most abundant cetacean species on the Algerian west coast; sighting and stranding data indicate a regular presence of common dolphins in this area. The common dolphin has recently reported to be rare in the middle latitudes of the Western Mediterranean.

Although dolphins enjoy a significant protected status at the national level, many species threatened due to accidental capture in fishing gear and the number of incidental catches of common dolphin needs to be acknowledged. It is thus important to establish the necessary measures to minimize incidental mortality of dolphins in Algerian coastal waters (Larbi Doukara, 2021).

The short-beaked common dolphin (*Delphinus delphis*, Linnaeus, 1758) listed as least concern by the International Union for Conservation of Nature (IUCN) Red List (Hammond et al., 2008)

However, at a regional level, the IUCN status for the Mediterranean subpopulation was been listed as Endangered since 2003 due to its decline since the 1960s.

This investigation work completed the gaps concerning the knowledge of marine mammals frequent the Algerian littoral.

The results obtained confirm the presence of very diverse marine mammals in Algerian waters.



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However, these fragile, sensitive and beautiful marine creatures are subject daily to heavy anthropogenic pressure in their natural habitat.

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KEY WORDS (MAX 4) : CETACEANS, STRANDINGS, NECROPSY, FISHING GEAR



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Cryptic diversity of the complex widespread scorched mussel *Brachidontes pharaonis-variabilis*

SESSION:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Brachidontes pharaonis is a Lessepsian mussel that has successfully colonised the Mediterranean Sea following an immigration pathway through the Suez Canal from the Red Sea. The species represents a good model for studying the prerequisite conditions upon successful colonisation. Previous analysis had shown the co-existence of two mitochondrial haplogroups (M-type and L-type) detected within some sites of the Mediterranean Sea and Red Sea. Further, the species was demonstrated genetically splitted in three lineages of which two belonging to putative different *Brachidontes* species inhabiting respectively Indian and Pacific Oceans.

The morphological variation within *Brachidontes pharaonis* is so high that the range boundaries are not still defined and the species is misidentified in regions outside the putative distribution area. The current study aimed to assess the genetic variation of *B. pharaonis* in the Mediterranean Sea and adjacent zone (western Indian Ocean). Samples of *B. pharaonis* from ten Mediterranean localities are compared with samples collected in the westernmost area of Indian Ocean. Current genetic studies demonstrated the existence of *pharaonis* genotypes in all Mediterranean localities and revealed that the *B. pharaonis* distribution is limited to the Mediterranean Sea and the northern Red Sea region. However, some studies identified samples as *B. pharaonis* collected in Thailand, Indonesia and Malaysia. Such misidentifications corroborate the difficulties in the taxonomic diagnosis. *Brachidontes pharaonis* was listed as present in Southeast Asia and categorised as a non-indigenous that originated from the western Indian Ocean and the Red Sea by shipping activities. The genus *Brachidontes* often occurs as one of the most common bivalve taxa in enclosed coastal marine habitats, such as marine lakes, hence, records of *B. pharaonis* from other regions should be treated with caution. At the same time, the *B. variabilis* data from the Indian and Pacific Oceans raised a flag of potential cryptic species. This study highlighted the importance of taxonomic approach to solving various issues pertaining to the species group complex, morphological variations and cosmopolitan claims of species.

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4)

INVASIVE ALIEN SPECIES (IAS), CRYPTIC VARIATION, COASTAL FAUNA



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

THE AMPHIPODA AND CUMACEA ASSEMBLAGE RESPONSE TO LNG TERMINAL INSTALLATION IN ADRIATIC SEA (MEDITERRANEAN SEA)

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The increase of energy demand, due to industrial and human activities, have led to find new solutions to ensure the constant availability of energy sources, as Italy is not a large producer of fuels, the decision was made to resort to the storage of energy reserves.

Therefore, the Italian government have installed the first offshore liquefied natural gas (LNG) terminal that stores and re-gasifies liquefied natural gas. The terminal was built in the offshore sea and linked to the onshore by a submerged pipeline.

The LGN terminal was positioned in the North Adriatic Sea in the offshore area in front of Chioggia and the Institute for Environmental Protection and Research (ISPRA), who had monitored the installation and exercise activities about 10 years, the monitoring program was executed in three phases: ante operam (before terminal installation), during terminal installation and during terminal exercise.

The terminal installation activities have generated a sediment movement that has influenced all the benthic habitat. The monitoring process concerned different matrices: water, sediments, and biota; in this study, the results carried out by the macrozoobenthic community analysis, are shown. These communities are recognized as an important tool to evaluate the environmental conditions, because the animals that make up these communities live in close contact with the seabed, have a long-life cycle and can indicate a seabed perturbation, moreover these animals play an important role in the marine food chain, as they constitute the food for a large number of benthic fish.

Our study was about two groups of crustacea belonging to macrozoobenthic community: Amphipoda and Cumacea. The sampling surveys were carried out for 10 years from 2005 to 2015, at each station, samples were collected with two replies, fixed with conservative solution, successively the samples were sorted, and the animals collected were identified to the lowest possible level.

Quantitative and qualitative analysis were carried out to observe changes on Amphipoda and Cumacea communities following the LGN Terminal installation and exercise, also data on ecology or preferred kind of sediment were collected if available in scientific literature, changes both in the space and time were analyzed. The results have shown a minimum change of community during the Terminal installation and the exercise activities both for Cumacean and Amphipods taxon for the 10 years of investigation.

This study provided information about the effect due to the first LGN terminal in our Sea on two benthic taxa and allowed to collect information about temporal change of the Amphipoda and Cumacea communities.

In the last years other LNG terminals were installed in the Italian Sea, the results of this study will be used to improve the planning sampling survey to understand the building effect on benthic communities.



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Furthermore, the Cumacean taxon is a macrozoobenthic minor group so little scientific literatures is available, the data collected during this study add information to insiders, and it will be an opportunity to increase the research on this taxon.

REFERENCES: (MAX 4)

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3. Marusso et al. 2013
- 4.

**KEY WORDS: PERACARIDA COMMUNITIES; AMPHIPODS; CUMACEANS;
ENVIRONMENTAL MONITORING**



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

**TITLE: PROTECTED COASTAL AREAS BOOST SURVIVAL AND CONSERVATION OF
ENDANGERED MEDITERRANEAN OSPREYS**

**SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION,
MANAGEMENT, MONITORING**

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Objectives

Main findings, results, and indications of the proposed work

Reintroductions represent an opportunity to restore local biodiversity. However, they need monitoring plans before and during their implementation to ensure concrete and lasting results (Sutherland *et al.*, 2010). During the last century, the osprey *Pandion haliaetus*, a medium-large sized bird of prey specialized in catching fish and strictly dependent on coastal habitats, suffered a dramatic demographic decline becoming extinct as a breeder in several countries of the Mediterranean area, including Italy (in 1968). Thanks to conservation efforts and reintroduction programs, the species gradually recovered though it is still evaluated as endangered at regional scale and critically endangered in Italy, thus representing a priority from a conservation point of view (Monti *et al.*, 2023). In this context, protected areas represent one of the most important tools for limiting the current loss of species and habitats, while evaluating and quantifying their effectiveness is of fundamental importance to better understand their long-term effects on the conservation of target species and biological communities. In this work, we evaluated the role and effectiveness of coastal protected areas as an essential tool for the survival of the species in the Mediterranean (Europe and Africa). As part of a long-term monitoring program (2012-2024), >50 individuals from three different populations of the central Mediterranean (Corsica, the Balearics and central Italy) were captured and equipped with GPS-GSM devices to track their movements and space use behaviour. We estimated the size of their home ranges, daily distance covered and modelled the spatio-temporal variability in the use of coastal protected areas on an intercontinental scale, in Europe and Africa, during the non-reproductive period. Ospreys made a greater use of protected areas in Europe than in Africa. The overlap between home ranges and protected areas was 3 times greater for adults ($62.7 \pm 24.8\%$) than for juveniles ($20.9 \pm 21.2\%$), especially in Europe. Mean distance from PAs was 16.3 times larger for juveniles compared to adults, especially when in Africa. Time spent outside PAs was twice higher for juveniles than adults. The survival probability of the osprey increases proportionally as a function of the time/space spent in the protected areas and this effect was particularly pronounced in juveniles. However, juvenile ospreys due to their inexperience, spent less time than adults in PAs and went further and for more days away from them, thus increasing the risk of mortality. While in Europe, the network of protected areas is dense and continuous, in Africa the opposite occurs, with more isolated protected areas and



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often in low numbers (Müller *et al.*, 2020). However, we recorded a greater number of cases of mortality in Europe and outside protected areas. The causes of mortality were almost entirely associated with both direct and indirect human activities, such as illegal shooting, electrocution, collision with power lines, showing that outside protected areas the habitat-matrix is more dangerous in Europe than in Africa (as per the *Human Footprint Index*; Venter *et al.*, 2016). In conclusion, the more the network of protected areas is large and well-managed with stringent binding measures in place, the more the osprey will benefit from the protection of habitats, which are fundamental not only for short-term survival, but also on the long-term. A widespread and effective network of protected areas across countries along with coordinated cross-border conservation strategies also beyond PAs is key to ensure the future survival of the osprey and for securing many other migratory species at the flyway scale.

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KEY WORDS (MAX 4)

- Conservation
- Osprey
- Protected areas
- Survival analysis



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: **Highly diverse molluscan assemblages of *Posidonia oceanica* meadows in the Gulf of Gabes (Central Mediterranean): Seasonal dynamics and environmental drivers**

SESSION: **Flora and Fauna of coastal ecosystems: protection, management, monitoring**

AUTHORS: **Nawfel Mosbahi^{1*} ; Randa Mejri¹ ; Jean-Claude Dauvin²**

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Seagrass beds are distributed in intertidal and subtidal shores from tropical and temperate areas (Polte et al., 2005). Seagrass bed communities are usually characterized by a larger number of species and higher abundances than adjacent unvegetated sediments (Fredriksen et al., 2010; Barnes and Barnes, 2012). Molluscs are important components of the benthic macrofauna associated with seagrass beds in terms of number of species and abundance (Williams and Heck, 2001) and considered the dominant organisms in the food webs of the seagrass bed system (Hemminga and Duarte, 2000). The seasonal dynamics of the molluscan fauna associated with *Posidonia oceanica*, has been studied throughout an annual cycle in the southern coasts of Tunisia. Samples were collected seasonally (five replicated per season) using a non-destructive sampling technique on quadrats of 50×50 cm at two sites located in the Gulf of Gabes. Several environmental variables from the water column (temperature, chlorophyll a), the sediment (percentage of organic matter) and the seagrass meadows (shoot density, leaf height and width, number of leaves per shoot) were also measured in order to elucidate their relationships with the dynamics of the molluscan assemblages. In these meadows, a total of 17,416 individuals of molluscs were collected, belonging to 71 families and 114 species, being Rissoidae, Calliostomidae and Trochidae the best-represented families, and Mytilidae, Nassaridae,



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Tellinidae and the dominant ones in terms of abundance. The assemblages were dominated by micro-algal grazers, and filter feeders. The species richness and the abundance displayed significant maximum values in summer, whereas evenness and diversity displayed maximum values in spring, being significant for the evenness. Both abundance and species richness values were positively correlated to seawater temperature and percentage organic matter, only for the latter, and negatively to leaf width. Significant seasonal groupings were obtained with multivariate analyses (MDS, Cluster, ANOSIM) using qualitative and quantitative data that could be mainly related to biological aspects (i.e. recruitment) of single species. The southern molluscan assemblages showed spatial and temporal variation correlated by seasonal dynamics and environmental drivers. The patchiness of the meadows, intercalated in other habitats like photophilous algae, and the strong hydrodynamism resulting from the unusually shallow setting, may promote the movement of species between these habitats and the seagrass and therefore enhance the species richness. This large faunistic list for the molluscan fauna associated with *P. oceanica* is therefore different than those observed in other Mediterranean *P. oceanica* meadows, and highlights the conservation value of these fragmented meadows located in their southern distributional limit.

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KEY WORDS (MAX 4)

Posidonia oceanica seagrass, Mollusc diversity, Gulf of Gabes, environmental drivers



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: **Contamination and Ecological Quality Status of the Southern Tunisian coasts**

SESSION: **Flora and Fauna of coastal ecosystems: protection, management, monitoring**

AUTHORS: **Nawfel Mosbahi^{1*} ; Randa Mejri¹ ; Jean-Claude Dauvin²**

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coastal ecosystems are complex environments known for their importance in terms of biodiversity. But they are also extremely sensitive, because they are exposed to several anthropogenic pressures (Rees *et al.*, 2006; Johansen *et al.*, 2018). The Gulf of Gabès, located in central Mediterranean Sea, is now undergoing a high stress caused by intensive anthropogenic pressures due to trawling practices, while pollution (e.g phosphogypsum inputs, industrial waste) and shipping activity are causing more serious environmental problems. These anthropogenic activities impacting marine systems, causing a deterioration of seagrass beds, notably the *Posidonia oceanica* meadows, a decline in fisheries, and changing the structure functioning of benthic communities (Khedhri *et al.*, 2016). To assess the impact of the increasing pollution, several methods and indices have been established. Macrobenthic communities are largely used as an environmental bioindicators, especially in the polluted environment where their sensitivity to pollutants may be expressed by a modification in the benthic assemblages (Dauvin *et al.*, 2017). The present study reports the response of benthic macrofauna sampled during ten years' survey) to multiple anthropogenic pressures and to improve our knowledge of the impact of metallic contamination on structure of macrobenthic communities, as well as the Ecological Quality Status in Southern Tunisian coasts. Based on the quantitative and qualitative analysis of



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320 surface sediment samples collected in Southern Tunisian coasts by specific sampling methodologies depending on the sediment type and depth for each studied zone. The sampling was carried out from January 2013 to April 2023. 402 macrobenthic taxa were identified. Among them, polychaetes (34%) and crustaceans (32%) are the most dominant groups. Three macrobenthic assemblages were identified according to their environmental characteristics such as sediment type, organic matter content and heavy metal contamination. The benthic and biotic indices (AMBI, BENTIX and BO2A) are applied to assess the ecological status of Southern Tunisian coasts, which varies from poor to good status. The Ecological Quality Status (EcoQS) of the southern Tunisian coasts was significantly influenced by the environmental conditions for each studied site (e.g. organic matter, heavy metals contamination level). The present study could be considered as providing important baseline data for the implementation of environmental policies and management plans in the future.

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KEY WORDS (MAX 4)

Macrobenthic fauna; heavily metal; southern Tunisian coasts; benthic assemblages.



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PROBLEMS AND MEASUREMENT TECHNIQUES**

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FORM FOR ABSTRACTS PRESENTATION

<p>TITLE: UTILIZE OF BIOINDICATOR ORGANISMS FOR THE DETECTION OF MICROPLASTICS IN MARINE COASTAL AREAS</p>
<p>SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING</p>
<p>AUTHORS: MELISSA ORSINI</p> <p>CONTACT PERSON AND E-MAIL ADDRESS: MELISSA ORSINI, M.ORSINI@PM.UNIVPM.IT</p>
<p>AFFILIATION: UNIVERSITÀ POLITECNICA DELLE MARCHE E-MAIL ADDRESS: NOT PROVIDED</p>
<p>General frameworks Microplastics (MPs, <5 mm) are increasingly proving to be ubiquitous in all marine ecosystems and coastal areas. To assess their distribution and bioavailability, abiotic matrices are analysed along with bioindicator organisms. Bivalves are ideal biological indicator for monitoring anthropogenic pollution in coastal waters due to their special characteristics. They also play an active role in the dynamics of MPs transport incorporating them into biodeposits and influencing their bioavailability in the water column (Piarulli and Airoidi). Macrophytes are widely used as indicators of water quality and have been recently proposed as possible bioindicators for monitoring MPs. The presence of aquatic plants and macroalgal forests can contribute to the alteration of the local MPs fluxes through mechanisms of physical retention. Recently also insects have been proven as suitable indicators to assess MP pollution in terrestrial environment. Their scavenging habits facilitate the ingestion of MPs during their feeding.</p> <p>Objectives The present study aims to monitor MPs pollution in the Conero Riviera (Central Adriatic Sea), an area of high naturalistic, tourist and economic value, applying a strategy based on the use of indicator species integrated with the analysis of abiotic compartments. Mussels (<i>Mytilus galloprovincialis</i>) were chosen to provide valuable information on MPs up-take from the surrounding environment and on possible exposure to humans through consumption of these seafood products. Local macroalgal species (<i>Ulva lactuca</i>, <i>Cystoseira compressa</i>, <i>Gongolaria barbata</i>) were sampled to verify the possible adherence and entanglements of MPs on their fronds. In addition, experiments under controlled laboratory conditions were conducted to better understand the role of these species in affecting MPs distribution in the water column, focussing on how algal surface</p>



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complexity might influence surface adhesiveness.

For the first time, *Oniscidea* spp. were used to conduct a land-based survey of MPs pollution in adjacent coastal environments: these omnivorous scavengers, represent a large group of terrestrial isopods living the rocky shore of the Conero coast; It was suggested that these organisms could ingest MPs, acting as important bioindicator of plastic pollution.

Results obtained from quantification and characterization of MPs in biotic samples were elaborated and integrated with background levels of MPs found in abiotic matrices.

Main findings, results, and indications of the proposed work

Samples were properly processed for MPs extraction following validated methods for each matrix (Pittura et al., 2022): potential MPs were sorted out, chemically analyzed through micro FTIR-spectroscopy and characterized by shape and size-class.

The analysis of MPs on whole soft tissues of mussels made it possible to highlight the presence of MPs in 30% of analysed mussels with an average ingestion of 1.31 ± 0.6 items/individual. Almost all extracted MPs were fibres made of polyester. Likewise, algae collected in the field trapped almost exclusively fibres made of polyester. This evidence could be attributed to the prevalent use of synthetic garments and specific point sources in coastal areas, e.g., domestic wastewater and textile industries (Salvador Cesa et al., 2017).

Exposure of macroalgae to MPs in laboratory experiments highlight different trapping capacities between species with different surface complexity, assuming that macroalgae with greater surface area to volume ratio (*Ulva* in our case study), could trap more MPs than other species of a similar size.

Analysis of insects' guts showed ingestion frequencies of about 75%, with an average concentration of 0.4 MPs/organism, suggesting *Oniscidea* as valid bioindicators of MPs pollution in coastal areas. Future outcomes might evaluate the use of terrestrial Isopods living in correspondence of one of the main Italian rivers (Po' River) as bioindicator to monitor plastic pollution in coastal freshwater systems that flow into the Adriatic Sea.

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TITLE: PAH BIOMONITORING IN MARINE COASTAL ENVIRONMENTS
SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <p>Mediterranean coasts are widely affected by urban (tourism, transport), agricultural and industrial activities, which are responsible for sea contamination by inorganic and organic pollutants. Among them, polycyclic aromatic hydrocarbons (PAHs) are persistent and potentially genotoxic and carcinogenic pollutants, deriving from the incomplete combustion of organic matter (e.g. coal, wood), or from crude oil and petroleum products (e.g. kerosene, gasoline, diesel, lubricating oil). PAHs tend not only to accumulate in sediments and in biological tissues, but also to be magnified along the food chains (Castro-Jiménez et al., 2021). Several studies have highlighted the usefulness of <i>Posidonia oceanica</i>, the dominant endemic seagrass in the Mediterranean Sea, as biomonitor of potentially toxic elements and organic pollutants (Pergent et al., 2011). This species is customarily used as a 'biological quality element' in monitoring programs of the EU Water Framework Directive, providing information about the ecological status of coastal ecosystems. The regression of <i>P. oceanica</i> meadows, however, imposes the need to protect this macrophyte and find alternative marine species as passive and/or active biomonitors.</p> <p>In order to identify new potential marine biomonitors of organic pollutants, we compared the concentrations of 14 PAHs in leaves of <i>P. oceanica</i> with those measured in thalli of the red alga <i>Laurencia microcladia</i>, another native macrophyte widespread along the Mediterranean coasts, and in sediments. Both the species were collected from the eulittoral and upper infralittoral zone of the Cilento coast (southern Italy), in 4 sites differing in anthropogenic pressure (Fig. 1a). On pulverized samples, PAHs were extracted using Matrix Solid Phase Dispersion and sonication from macrophytes and sediments, respectively, and were quantified by GC-MS/MS.</p> <p>The total PAH concentration ranges were comparable between the two species (1.29-1.36 ng/g d.w. for <i>L. microcladia</i>, 1.13-1.35 ng/g d.w. for <i>P. oceanica</i>), but differences could be observed in the accumulation of different PAHs. In particular, benzo[a]pyrene, fluorene, acenaphthene and acenaphthylene were preferentially accumulated in the alga, whereas benzo[b,j,k]fluoranthene, fluoranthene, anthracene, dibenzo[a,h]anthracene in the plant (Fig. 1b). The comparison with PAH concentrations in sediments indicated that not only for the alga, but also for the plant, the absorption from sediments was negligible. Regardless of the species (Figs. 1c and 1d), the site 5, corresponding to the harbour of San Marco di Castellabate, with moderate (300 moorings) ship traffics, showed the highest concentrations of anthracene and benzo[a]pyrene, in respect to the others sites, subjected to different levels of restrictions (from full to partial reserve) within a marine protected area (Santa Maria di Castellabate). Differences in the accumulation patterns of several PAHs among sites in relation to the level of protection were also observed (Figs. 1c and 1d).</p> <p>Overall, the findings suggest the suitability of <i>L. microcladia</i> in PAH biomonitoring studies, especially in relation to anthracene and benzo[a]pyrene, overcoming the limitations associated to the use of <i>P. oceanica</i> and enabling active biomonitoring campaigns in addition to passive biomonitoring studies. Even in association with analyses on <i>P. oceanica</i>, <i>L. microcladia</i> can still prove useful in improving the accuracy and reliability of results, considering the specific accumulation capability of the two species.</p>
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KEY WORDS (MAX 4): POLYCYCLIC AROMATIC HYDROCARBONS, *POSIDONIA OCEANICA*, *LAURENCIA MICROCLADIA*, CILENTO COAST

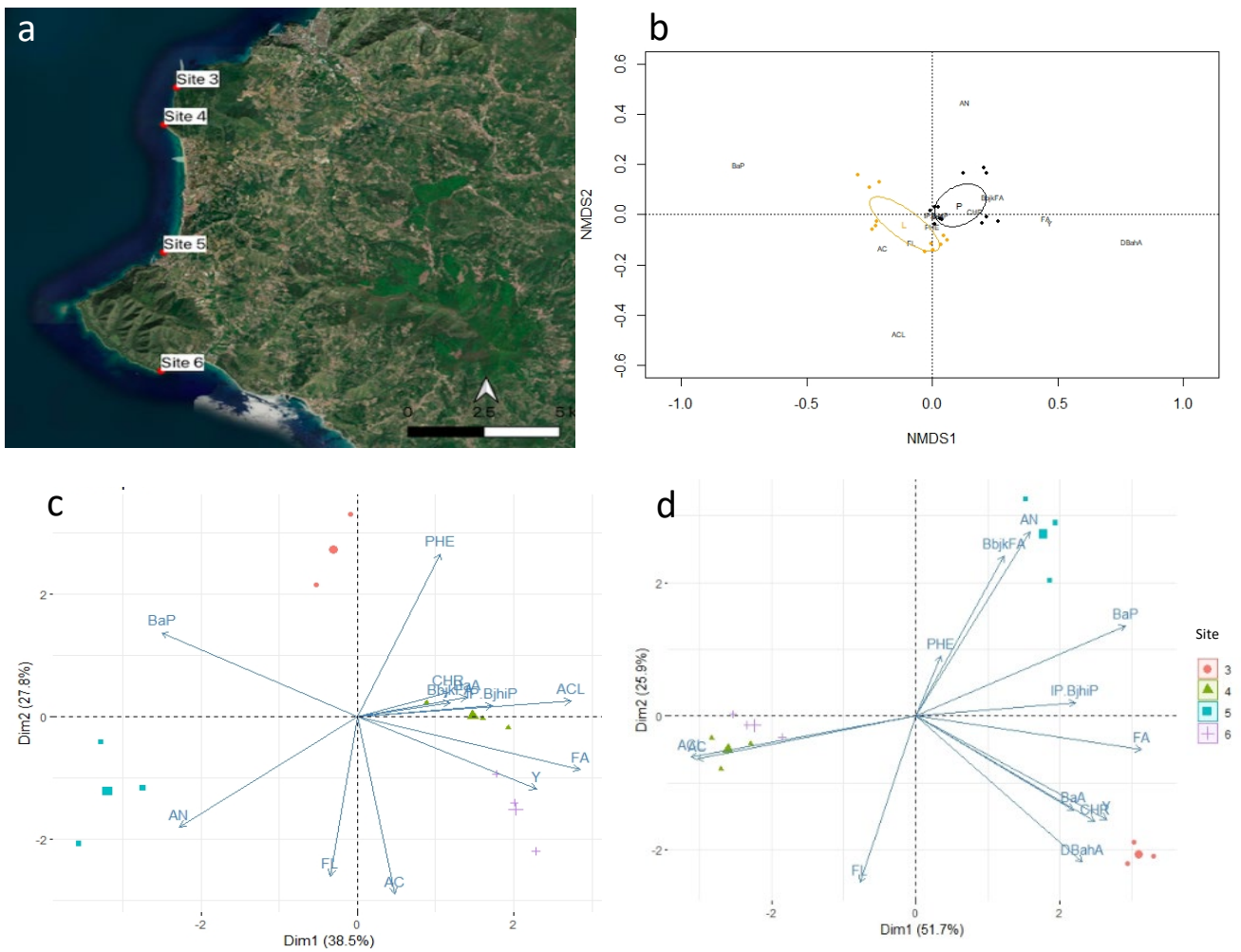


Fig. 1 Map of the study area, with the indication of the sampling sites (a). Non-metric multidimensional scaling biplot based on the measured PAHs with the superimposition of the confidence ellipses ($\alpha = 0.05$) for *L. microcladia* in yellow and *P. oceanica* in black (b). Principal component analyses based on the PAH concentrations in *L. microcladia* (c) and in *P. oceanica* (d).

ACL = acenaphthylene, AC = acenaphthene, FL = fluorene, PHE = phenanthrene, AN = anthracene, FA = fluoranthene, Y = pyrene, BaA = benzo[a]anthracene, CHR = chrysene, BbjkFA = benzo[b,j,k]fluoranthene, BaP = benzo[a]pyrene, IP+BjhiP = indeno[1,2,3-c,d]pyrene+benzo[g,h,i]perylene, DBahA = dibenzo[a,h]anthracene.



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FORM FOR ABSTRACTS PRESENTATION

TITLE: MAPPING SUBMERGED VEGETATION AND WATER QUALITY USING MULTI- AND HYPERSPECTRAL IMAGERY OF ORISTANO GULF (ITALY)

SESSION: Flora and Fauna of coastal ecosystems

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Shallow-water habitats are among the most important and productive ecosystems on the planet. These ecosystems, which include seagrass beds, coral reefs and macrophyte beds, are significant hotspots for biodiversity. In salty and brackish waters, seagrasses often develop along gently sloping, safe beaches. Several types of seagrasses live at depths of 1 to 3 meters (Reynolds et al., 2018) since photosynthesis requires light. Seagrasses have the ability to create thick underwater meadows, some of which have been mapped from remote sensing.

The majority of seagrass conservation efforts concentrate on preserving the species richness of the habitats and the benefits they offer to ecosystems and humans. The spread of seagrass may be targeted by looking at the seabed covering and how it changes over the course of the year. To this purpose satellite-derived products of substrate and vegetation bottom coverage at different spatial-temporal resolution can help water managers and users in better understanding, exploiting and managing seagrass beds in shallow waters (Kutser et al., 2022).

Water quality status has a critical role for biological life, from algae to seagrass to fish communities. Some examples of human-related activities that enhance water turbidity are: i) soil runoff from agriculture fields, building sites; ii) bank erosion in rivers and coastline; iii) runoff that contains fertilizer, as this promotes the growth of algae in the water. Submerged vegetation receives less sunlight when there is a high turbidity level. Because plants produce oxygen, fewer plants grow, which limits the amount of oxygen accessible to aquatic life. Additionally, high turbidity damages fish habitat, and makes water unfit for consumption. For these reasons, the characterization of turbidity, suspended particulate matter (SPM) and Chlorophyll-a (Chl-a) concentration can support water managers and user in understanding the degree of water transparency and the trophic status of the ecosystem and, as for seagrass, remote sensing techniques offer relevant observations.

This study has the main objective of testing and applying algorithms to obtain bottom substrate, canopy cover, bathymetry mapping together with water quality maps (e.g., SPM, Chl-a) from hyperspectral (e.g., PRISMA, ENMAP) and multispectral (e.g., Sentinel-2) satellite data. The study is developed in the framework of the PRISMA



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SCIENZA OVERSEE project, and it is focused in the Gulf of Oristano (Sardinia, Italy) coastal areas. One of the proposed algorithms is the bio-optical model implemented in BOMBER (Giardino et al., 2012) that was used to map substrate type and coverage, bathymetry and concentrations of two water quality parameters (i.e. SPM and Chl-a) in the Gulf of Oristano.

For the Gulf of Oristano the substrate coverage maps changes were followed for the period May-October 2022 investigating the spatial-temporal variability of *P. oceanica*, and it is discussed in combination with water quality parameters concentration and distribution. When compared to in situ measurements, results about bathymetry and substrate and vegetation bottom cover distribution data were accurate. It was feasible to determine which areas exhibit greater variability by analyzing the differences in the satellite-derived products obtained between 2020 and 2023. The results were then shared with the end users to offer information for the proper management of the gulf's coastline area.

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KEY WORDS (MAX 4) SEAGRASS, REMOTE SENSING, PRISMA, WATER QUALITY



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FORM FOR ABSTRACTS PRESENTATION

TITLE: EMPOWERING STUDENT ENGAGEMENT AND ENVIRONMENTAL UNDERSTANDING: THE COASTAL HEALTH MONITORING SCHEME (CHMS).

SESSION:
FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

In higher education, motivating and engaging students in projects with practical social value is a challenge for universities. Nowadays, students can actively participate in research projects initiated by their professors. While this participation is seen as a valuable formative activity, it is important to emphasize that its primary purpose is to contribute to the successful execution of the specific research project, rather than being the core focus of their educational journey.

The CHMS serves as a prime example of this educational approach. This initiative is the result of a collaborative partnership between the Iberostar Foundation and the University of the Balearic Islands, made possible through the Chair of the Sea. The project is distinctive in that it has a dual purpose: first, it provides a significant training platform for students, enabling them to gain practical experience in monitoring marine biodiversity. Second, it plays a crucial role in collecting essential data related to the health of coastal ecosystems. This is achieved through the utilization of bioindicator species and the measurement of specific physicochemical parameters.

The origins of this project can be traced back to 2021 when it was launched as a pilot test on the island of Ibiza, involving the setup of 12 monitoring stations. Nowadays, an impressive network of 50 monitoring stations has been established, with distribution as follows: 20 stations in Mallorca, 15 in Menorca, 10 in Ibiza, and 5 in Formentera. The effective execution of this extensive project is achieved with undergraduate Biology students at the University of the Balearic Islands.

Each monitoring station becomes the focal point for a comprehensive set of surveys conducted during the spring and summer seasons. The data collection process involves the meticulous execution of three transects of 60 m². These transects play a vital role in quantifying the number of individuals, which in turn allows for the calculation of species density for different groups. For enhanced precision, target species are selected for each group, with a particular focus on sea urchins, sponges, sea cucumbers, and anemones. Furthermore, the study extends to population structure analysis, which is facilitated by the measurement of the diameter of sea urchins and the basal diameter of anemones.

Furthermore, variable-length transects are utilized to quantify the abundance and population structure of another group of benthic species, such as sea snails and limpets. Other transects are conducted to assess the diversity and



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abundance of 11 crab species. Additionally, a specific inventory and abundance estimation are carried out for Blennoidea fishes.

The culmination of the fieldwork efforts is the creation of a recorded dataset that effectively serves as a comprehensive biodiversity inventory. To further augment the value of the data collected, submerged sand samples are diligently gathered. These samples are integral in quantifying the organic matter content and granulometric composition of the sand.

The successful implementation of the CHMS is made possible through the support of the Iberostar Fdn., the Baleària Fdn., local councils, and Island Councils. Their contributions extend to essential aspects such as inter-island transportation, logistical support for accommodation, and team mobility on each island.

This collaborative and integrated approach not only contributes to valuable insights into the health of coastal ecosystems but also provides a unique educational opportunity for students pursuing marine biology. By bringing together multiple stakeholders and actively involving dedicated students, the CHMS exemplifies how practical engagement and research can lead to a deeper understanding of our natural environment.

REFERENCES: (MAX 4)

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KEY WORDS: BIODIVERSITY, MONITORING OF COASTAL ECOSYSTEMS, COASTAL HEALTH, STUDENT EMPOWERING



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: OBJECTIVE QUANTITATIVE PARAMETERS TO EVALUATE REPRODUCTIVE ACTIVITY IN *ENGRAULIS ENCRASICOLUS* L.

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Understanding the regulation of major biological functions is important for optimizing the reproductive potential of all species. Reproduction, in particular, plays a vital role in ensuring optimal production in response to various environmental factors. However, to fully comprehend the physiological mechanisms involved in reproductive biology, it is essential to conduct macroscopic qualitative studies of gametogenesis. While these studies provide valuable insights, microscopy remains the primary validated method for investigating reproductive processes at a cellular level. Conventional microscopic procedures, however, have limitations. They are predominantly qualitative and lack objective quantitative indicators.

To overcome these limitations, this paper focuses on highlighting novel histological indicators that have been confirmed and correlated with macroscopic reproductive parameters in both male and female European anchovies (*Engraulis encrasicolus*). The anchovy was chosen as the biological model due to its ecological, economic, and social importance in the Béjaïa region. To conduct this study, weekly sampling was performed from commercial catches in the Gulf of Béjaïa, located in the northeast of Algeria. The experimental design involved measuring microscopic parameters in one microscopic field, including the number (STN) and area (STA) of seminiferous tubules in males, as well as the absolute number of oocytes (ON) and surface area of oocytes (OA) in females. These last measurements were carried out independently of the maturation stage of the oocytes. Additionally, the macroscopic reproductive stages were assessed using a five-degree standard maturity staging system, which included stages such as immature, developing, spawning capable, regressing, and regenerating. The gonadosomatic index (GSI), a commonly used indicator of reproductive activity, was also considered.

The results of this study revealed that OA and ON accurately reflected the different maturity stages in female anchovies. Furthermore, they exhibited analogous and inverse development, respectively, compared to the GSI. This suggests that OA and ON can serve as reliable indicators of reproductive activity in anchovies. Additionally, the simultaneous development of OA and ON with the GSI during the study period allowed for the identification of different reproductive events. In terms of male reproductive activity, the values of STN and STA provided valuable information regarding spermatogenesis. These parameters allowed for the distinction of the five Brown-Petersen stages, which are commonly used to assess the maturation of male gametes. Moreover, STN and STA accurately reflected the different reproductive events observed during the study period.

Based on these findings, ON and OA can be considered as new, accurate, and quantitative parameters for investigating the reproductive activity in female anchovies. Similarly, the standardized measurement of STN and STA provides a precise quantitative assessment of male reproductive activity. By combining histology and image analysis, this approach offers quantitative parameters that reveal different reproductive phases in anchovies.

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KEY WORDS : SPERMATOGENESIS, OOGENESIS, GSI, ENGRAULIS ENCRASICOLUS



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: THE ROLE OF REBREATHING DIVERS IN THE STUDY OF A MARINE DEEP-WATER CAVE ECOSYSTEM.

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General Framework:

This study focuses on the rich marine habitats of Jubilee Shoals, a submerged rocky reef off the coast of Cyprus (eastern Mediterranean). The shoals' habitats comprises *Posidonia oceanica* meadows on the plateau, coralline communities on its vertical walls, and a cave system at its base. The exploration this complex environment was made by means of closed-circuit devices (Rebreathers). The survey demanded the expertise of trained cave divers not only for their safety but also to ensure the quality of the data collected. The strategic use of rebreathers allowed for silent and bubble-less operation and extended dive time.

Objectives:

In this comprehensive study, our primary objective was to provide a quantitative description of the epibenthic communities and biodiversity within the cave system. Employing meticulous analysis, we aimed to unravel the intricate interactions between alien and native species coexisting in this unique ecosystem. Our research went beyond conventional methods, incorporating the creation of a 3D model to enhance visualization and comprehension of the ecological data. Using photo-quadrats, we accurately determined and quantified the percent of cover of epibenthic species, deepening our understanding of their distribution patterns and the delicate ecological balance within the cave environment.

Additionally, we investigated the potential impacts of divers, assessing their activities in the cave ecosystem. Leveraging the state-of-the-art technology, including rebreathers, our research not only facilitated in-depth exploration but also expanded the horizons of scientific understanding. This innovative approach enabled us to conduct meticulous studies in the challenging underwater environment itself and to contribute to the knowledge of cave ecosystems, paving the way for future research and conservation efforts in similar environments.

Main Findings, Results, and Indications of the Proposed Work:

Mel, A comprehensive mapping of the Jubilee Shoals cave system was achieved through extensive exploration, diverse sampling methods, and the advantages offered by closed-circuit rebreathers. Significant variations in the species abundance, cover and ecological interactions were observed throughout the cave system due to the gradients in the penetration of light and other physical parameters. These differences aid



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in understanding the ecosystem's functions and the factors contributing to these phenomena. Our findings emphasize that scientific exploration in cave environments at depths exceeding 30-40 meters should predominantly rely on closed-circuit rebreathers. The rebreathers' approach of our study demonstrates the significant advantages to the scientific exploration of cave and other dark environments at depths exceeding 30-40m: Firstly, rebreathers recirculate breathing gas, minimizing wastage and ensuring efficiency irrespective of the diver's depth. Secondly, the dynamic breathing mixture maintains a consistent oxygen partial pressure, reducing the non-oxygen fraction in the gas. Consequently, this minimizes decompression time for specific dive profiles. Thirdly, the absence of exhaled bubbles in water during normal breathing enables near-silent operation. This silent approach is especially pertinent for undersea biological research, allowing for undisturbed, close observation of marine life and eliminates the impact of bubbles in the cave system and organisms in general

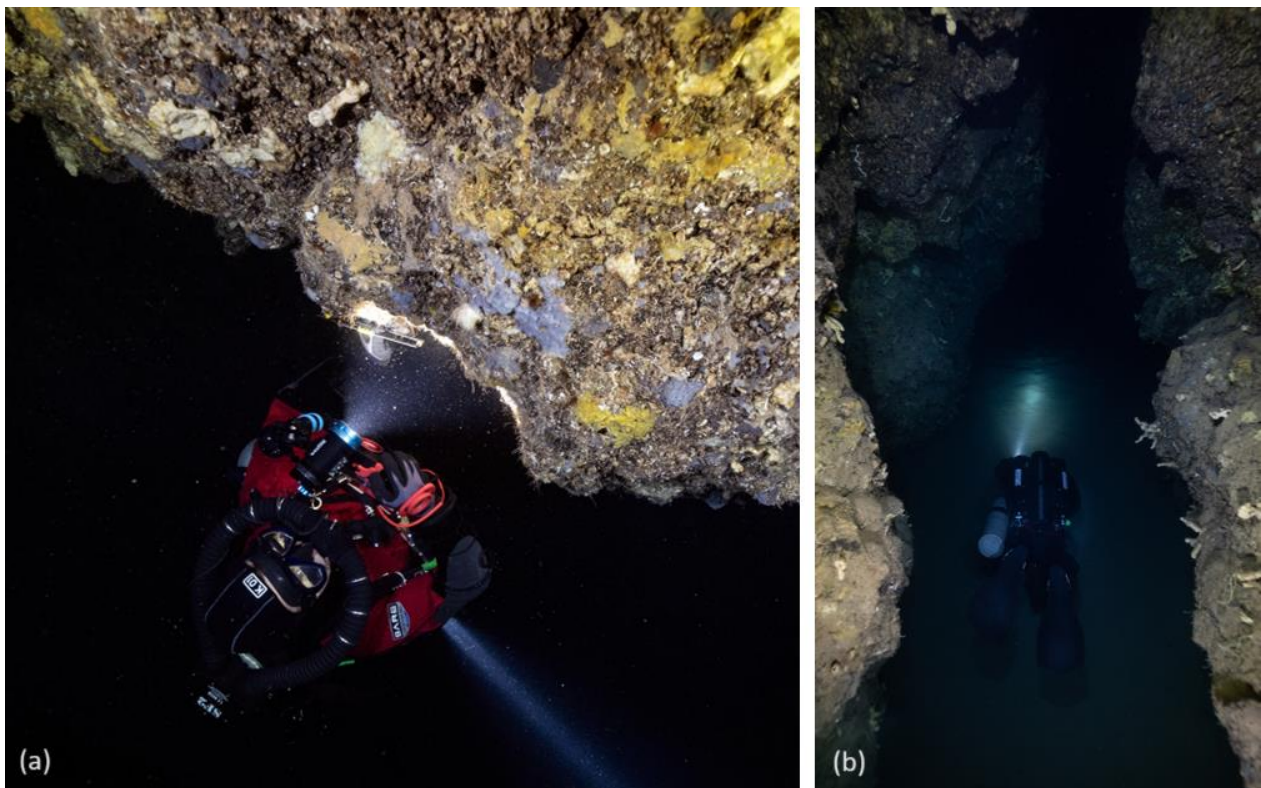


Figure 1: (a) Epibenthic community on the cave's ceiling surveyed with photo-quadrats (b) Silent and bubble-free surveys of mobile species in the cave's galleries.

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KEY WORDS (MAX 4)

SCIENTIFIC DIVING, MARINE CAVES, DARK ENVIRONMENT, EPIBENTHIC COMMUNITIES



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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

TEMPORAL AND SPATIAL VARIABILITY IN THE ISOTOPIC COMPOSITION OF SEA URCHINS ALONG PORTUGUESE COAST

SESSION:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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ABSTRACT:

Paracentrotus lividus is widely distributed throughout Mediterranean basin and Atlantic coast, highly appreciated for its gonads. It is broadly distributed along the Portuguese coast and its exploitation has potential to grow. Sea urchin's gonads store nutrients, being good sources of high-quality protein, long chain polyunsaturated omega-3 and micronutrients¹.

The nutritional richness of the gonads is mainly influenced by feeding habits of the sea urchin. Although the feeding habits and dietary inputs of *P. lividus* are well characterised², fluctuations on nutritional composition and sensory traits and the possible influence of seasonality and habitat on the quality of the gonads are still little understood. Hypothesizing that such fluctuations will be reflected in the elemental and isotopic abundances of C and N of *P. lividus*' organs, this study aims to investigate the temporal and spatial variability in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotopic signatures and elemental content of N and C in two organs of sea urchin (gonads and intestine) from five distinct areas of the Portuguese coast.

Stable isotopes analysis has been recognised as a powerful tool for exploring environmental-ecological-biological processes in aquatic systems. Carbon isotopes are largely used to determine the source of food and N isotopes the organism's trophic position³. Regarding sea urchins, the works found focus mainly on dietary patterns, trophic interactions or effects of anthropogenic disturbances. To the best of our knowledge, this is the first approach exploring the use of isotopic composition analysis for understanding drifts among *P. lividus* populations either in time and space and assess its potential of application as a management tool for identifying the most suitable locations and the periods of the year to collect sea urchins with richer isotopic signatures and high-quality gonads.

Sampling campaigns were carried out between 2019 and 2020 (one campaign per season) in five rocky shores along the Portuguese coast (Fig. 1). Three rock pools were selected in each shore, and five specimens were collected per pool. The gonadosomatic index (GSI, %) was calculated and C and N elemental and isotopic composition were determined in gonads and intestine using isotope ratio mass spectrometry.

Spatial and temporal patterns in stable isotopic C and N levels in sea urchin tissue data, and ecological indices, have been analysed using multivariate and univariate analyses methods available in PRIMER v7 statistical package and PERMANOVA+PRIMER add-on package.

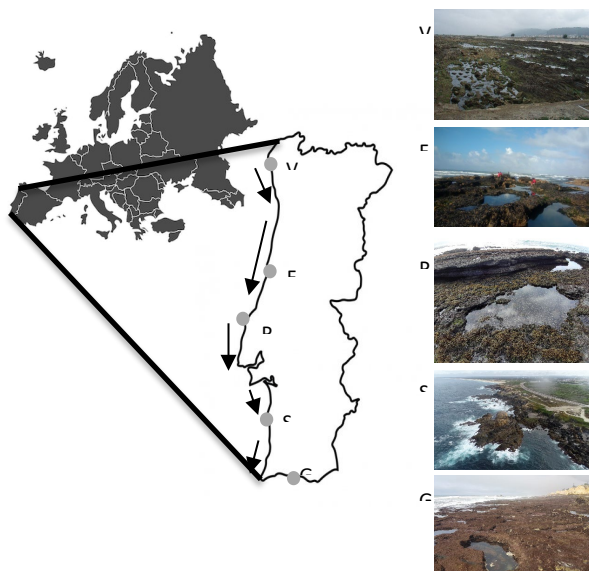


Figure 1. Geographical location of sampling sites surveyed in the present study: five rocky shores beaches, namely, Viana do Castelo (VC), Figueira da Foz (FF), Peniche (P), Sines (S) and Guia (G). Arrows indicate the direction of the average flow of Portugal current.

In this study, the analysis of elemental and isotopic composition of *P. lividus*' gonads and intestines evidenced relevant fluctuations among the sea urchins collected along the Portuguese coast. Data showed a significant variation in space, among five distinct rocky shores (Fig. 2, segregation between VC and FF vs P and S for both gonads and intestines data), and seasonal variability was registered in each shore. The differences found herein highlight ecological fluctuations along the coast but may also reflect the quality of the commercialised sea urchins among different areas of the country.



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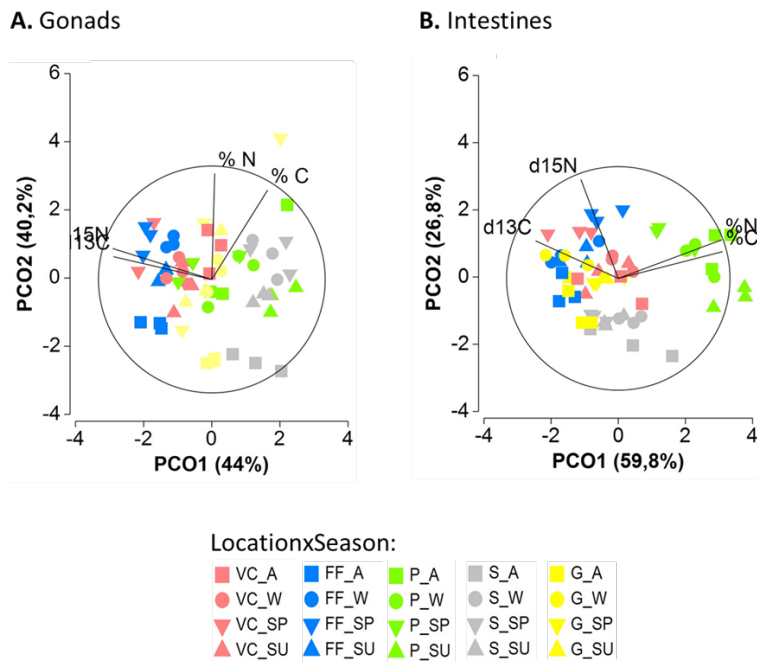


Figure 2. Two-dimensional Principal Coordinates Analysis (PCO) ordinations based on the isotope composition of gonads (A.) and intestines (B.) of the sea urchins from five rocky shores along Portuguese coast, highlighting spatial and temporal factor's interaction 'LocationxSeason'. Locations labels: Viana do Castelo – VC; Figueira da Foz – FF; Peniche – P; Sines – S and Guia – G. Seasons labels: A - autumn, W - winter, SP - spring and SU - summer. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$: carbon and nitrogen isotopic ratios (‰); C and N: elemental carbon and nitrogen (‰).

This information is of utmost importance for recreational and professional harvesters aiming to meet current market requirements. The combined analysis of elemental and isotopic composition and biological parameters, as gonad weight and GSI, permitted to discriminate the best locations and season for harvesting sea urchins: data suggest that sea urchins with richer and heavier gonads may be harvested in northern sites during spring. From an ecological and economic point of view, harvesting *P. lividus* in mid-spring may be advantageous since part of the population may be allowed to spawn and reproduce, ensuring the stock renewal, while harvesters will still manage to collect sea urchins with well-developed gonads.

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KEY WORDS (MAX 4)

PARACENTROTUS LIVIDUS; STABLE ISOTOPES; SEASONALITY; SUSTAINABILITY



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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FORM FOR ABSTRACTS PRESENTATION

TITLE: *POSIDONIA OCEANICA* BIOMARKERS AS A STRATEGY FOR MEDITERRANEAN ENVIRONMENTAL ASSESSMENT

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Seagrass meadows are valuable ecosystems endangered by human activities worldwide. Regions like the Mediterranean basin are suffering from water shortage exacerbated by climate change, and desalination industry have become a relevant source to address the issue. The development and implementation of desalination technologies, especially seawater reverse osmosis (SWRO) plants, seems promising to address water scarcity in these regions of the world. Indeed, the environmental impact that receives more attention is that associated with the discharge of brines resulting from the desalination process into coastal waters. Brines are the residue the SWRO process, and constitute mostly a concentrated seawater that, without pre-dilution, can double natural salinity levels discharge.

Desalination-derived brine may have different effects on benthic communities; in this regard, the endemic seagrass *Posidonia oceanica* have shown physiological vulnerability to brine-extrapolable increased salinities (Blanco-Murillo et al. 2022). Previous investigations under laboratory mesocosm experiments under hypersalinity exposure (43 psu) reached with either artificial sea salts or brines on *P. oceanica* for up to 10 days resulted in a growth biomass decline, lipid peroxidation and a short-term up-regulation of genes related to ion exclusion and oxidative stress (specially *SOS1*, *FeSOD* and *MnSOD*) (Blanco-Murillo et al. 2023). Brine exposed plants differentially demonstrated lower reduced-oxidized ascorbate (ASC/DHA) ratio and greater expression of oxidative stress related *CAT* and *STRK1* compared to the same salinity reached with artificial salts. The latter data demonstrated that although brines can induce biological stress in *P. oceanica*, physiological performance and predictively effects at higher levels of biological organization are principally related to excess salinities contained in desalination discharges (Blanco-Murillo et al. 2023).

As most investigations regarding desalination (and hypersalinity) effects on seagrasses have been conducted under laboratory-controlled initiatives, transplantation experiments were performed with *P. oceanica* following a brine dilution plume in a desalination plant in Alicante (Spain). *P. oceanica* from an unimpacted meadow were placed at 3 locations: Control (~37 psu), intermediate influence (IB, ~39 psu) and high influence (HB, ~42 psu). Reactive oxygen metabolism (H₂O₂, TBARS, ASC/DHA) and molecular (gene regulation) responses were analyzed at 1, 3 and 6 days.

H₂O₂ and TBARS increased with hypersalinity, and ASC decreased in HB, indicating reactive oxygen species (ROS) production, lipid peroxidation and antioxidant consumption. Genes related to osmoregulation and antioxidant metabolism were up-regulated at higher salinities, indicating a salt-sensitive response. Stress responses near the limit



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of tolerance highlight the importance of considering appropriate conservation measures to address *P. oceanica* meadow survival in the context of desalination plants operation. Moreover, the investigation highlights a battery of different biomarkers that can be further used for easy monitoring of desalination brine effects on coastal ecosystems of the Mediterranean Sea.

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2. Blanco-Murillo, F., L. Marín-Guirao, I. Sola, F. Rodríguez-Rojas, J. M. Ruiz, J. L. Sánchez-Lizaso and C. A. Sáez (2023), "Desalination brine effects beyond excess salinity: Unravelling specific stress signaling and tolerance responses in the seagrass *Posidonia oceanica*" *Chemosphere* 341: 140061

KEY WORDS (MAX 4): DESALINATION; OXIDATIVE STRESS; OSMOTIC REGULATION; ENVIRONMENTAL BIOTECHNOLOGY



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FORM FOR ABSTRACTS PRESENTATION

TITLE: METAL POLLUTION MONITORING AND ASSESSMENT IN THE WESTERN MEDITERRANEAN COASTAL ECOSYSTEMS THROUGH AN INTEGRATED STUDY

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Coastal zones are areas that suffer high anthropogenic pressure, both from the population centers that settle there and from the industries that exist around these centers. All this means that the levels of pollutants are high in these areas and pose a risk to ecosystems and to maintain a good environmental status. In addition, the special characteristics of the Mediterranean Sea, which is a confined body of water with limited exchange, as well as its important population and industrial settlements, make it one of the most polluted seas on the planet (1). That is why it is necessary to carry out a monitoring of the pollution of these waters to detect possible highly polluted areas and their evolution over time in order to advise the competent administrations so that they can carry out the necessary actions to improve the environmental status of the different areas.

Objectives

The objective of the present work is to use a systematic monitoring in time and space of the Spanish Mediterranean coast in order to evaluate the environmental state of its ecosystems from the point of view of metal contamination. For this purpose, several environmental matrices such as sediment and biota from the same areas will be integrated and their concentrations will be evaluated by comparing them with the Environmental Quality Standards.

Main findings, results, and indications of the proposed work

Two sentinel organisms, the mussel and the red mullet, as well as coastal marine sediments, were used for this study (1, 2). Mussels integrate the levels of metals present in the water over time and mullets reflect the levels of metals in the sediment as they feed on the fauna present in muddy areas. Mussels were sampled at 31 locations and mullet and sediment at 11 locations along the Spanish Mediterranean coast. In addition to the metals considered as priorities in the European directives (Cd, Hg and Pb), the preferential metals (As, Cu and Zn) and other metals that may indicate the presence of certain anthropogenic activities were analyzed.



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The spatial distribution shows areas of the coast clearly affected by metal contamination and exceeding the values established by European directives for Hg, Pb or Cd. In some cases, they exceed the levels in the three matrices considered (mussel, red mullet and sediment), and in other cases only in one of them. The positive side is that the temporal trends show a decrease over time of the concentrations of these metals, which indicates that highly anthropized ecosystems from the point of view of metals can recover their good environmental status in the future thanks to the measures taken by the administrations to reduce the levels of pollutants, in this case metals.

Conclusions

This work shows the importance of carrying out an integrative study contemplating several environmental matrices to evaluate the environmental status of an ecosystem and also over time to see the evolution of highly anthropized areas and take measures to recover them if necessary.

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KEY WORDS (MAX 4) METALS, COASTAL POLLUTION, MONITORING, INTEGRATED MATRICES



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: AN OPEN-AIR SCHOOL LABORATORY FOR EXPERIENCING PLANT DIVERSITY IN A MEDITERRANEAN COASTAL CITY
Session: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING
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<p>Monitoring plant diversity in Mediterranean coastal landscapes is a priority. Anthropogenic pressures such as urbanization, invasion by alien species and climate change are seriously threatening biodiversity and functioning of Mediterranean coastal ecosystems (1). To face this problem, it is essential that the new generations of citizens be aware of the role that biodiversity plays for people and the environment. On the other hand, the use of native tree and shrub species of the Mediterranean shrublands for the realization of Nature-based Solutions (NbS) and ornamental green areas in urban environment has been proposed as a valuable strategy for their adaptability to abiotic stress (2).</p> <p>With the aim of better raising citizens' awareness of issues related to biodiversity and NbS (3) an Open-Air Laboratory (OAL) has been realized in the urban park of Villa Corridi in the Mediterranean coastal city of Livorno (Tuscany, Italy), taking advantage by the presence of primary and secondary schools within the park and by a spontaneous formation of Mediterranean shrub vegetation. Hence, the OAL was realized as a living-lab for schoolchildren to promote the knowledge on structural and functional biodiversity of Mediterranean coastal ecosystems (3) and for encouraging students to explore these environments and record scientific data on them. While the structural biodiversity is related to the number of species and biomass within an ecosystem, the functional biodiversity refers to the variation in the functional traits and biological processes of all species within a community. Therefore, it represents a crucial component of biodiversity, affecting the ecosystem dynamics, its resilience to climate change and its ability to promote ecosystem services.</p> <p>To promote knowledge on structural biodiversity, schoolchildren with their teachers were involved in a "photographic hunting" to collect georeferenced pictures of Mediterranean shrub and tree</p>



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evergreen species (*Arbutus unedo*, *Cistus creticus* subsp. *eriocephalus*, *Laurus nobilis*, *Myrtus communis*, *Pinus halepensis*, *Pistacia lentiscus*, *Quercus ilex*, *Rhamnus alaternus*, *Viburnum tinus*). Photos were then used to create a geodatabase through a specific project on the *iNaturalist* website, while some samples were collected and used for the creation of an educational herbarium. On the other hand, to promote knowledge on functional biodiversity, schoolchildren participated to experimental field campaigns with scientists to record the leaf functional traits, such as photosynthetic activity and light energy dissipation mechanisms through measurements of chlorophyll fluorescence parameters and leaf pigments. Leaves were collected to determine the leaf mass per area and estimate the water-use efficiency through the analysis of carbon stable isotopes. These functional traits were associated with changes in environmental conditions, relating them to the data recorded by schoolchildren via the meteorological station installed since 2017 on the roof of the school as part of the primary school macro-project "Ecoplanet". Species-specific adaptive responses to seasonal environmental changes were observed among the different analyzed species, depending on their peculiar morpho-physiological characteristics.

This study, carried out within the National Biodiversity Future Center (NBFC, Spoke 5 and 7) of the National Recovery and Resilience Plan, represents a pilot citizen science experience to engage young people in biodiversity monitoring and environmental issues, enabling them to explore the natural environment where they live mixing science with fun. Moreover, it has improved our knowledge on functional biodiversity of the Mediterranean shrub and tree species and on their resilience to environmental constraints in urban environment. The information gathered would be useful for selecting tolerant plants to be used as ornamentals as well as for habitat restoration purposes in similar Mediterranean urban areas.

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KEY WORDS (MAX 4)

CITIZEN SCIENCE

MEDITERRANEAN SHRUBLAND

NATURE-BASED SOLUTIONS

URBAN BIODIVERSITY



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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FORM FOR ABSTRACTS PRESENTATION

Title: Enhancing blue carbon uptake by seagrass restoration in a global hotspot of climate change
Session: Flora and fauna of coastal ecosystems: protection, management, monitoring
Authors: Lior Shalev ¹ , Ori Hepner Ucko ¹ , Shahar Malamud ^{1,2} , Jonathan Belmaker ^{1,2} , Gidon Winters ^{3,4}
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Abstract (min 3000 max 4000 characters): <p>Since CO₂ emissions are a major cause of global climate change, efficient strategies and solutions are being considered for capturing and burying CO₂. The main strategy used so far has been massive tree plantation. Yet, because trees live on soils that are rich in oxygen, the "green" carbon captured by trees, is rapidly converted into CO₂ that is released back to the atmosphere. On the other hand, "blue" carbon, the carbon captured in aquatic ecosystems, gets buried in oxygen-depleted soils which prevents the release of CO₂, storing blue carbon for relatively long periods. These differences between green and blue carbon, have promoted growing interest in planting seagrasses for enhancing blue carbon sequestration.</p> <p>Seagrasses are marine flowering plants (angiosperms), found in shallow coastal waters, where they provide important functions such as ecosystem bioengineering, cycling nutrients and sequestering blue carbon. Worldwide, seagrasses are responsible for at least 15% of all oceans' carbon capturing (blue carbon). <i>Cymodocea nodosa</i> is a Mediterranean seagrass species that grows usually in shallow and sheltered waters. <i>C. nodosa</i> is widespread in both the western and eastern basins of the Mediterranean Sea, but it was never really documented along the Israeli coast (eastern Mediterranean). Recent work has reported on the surprising widespread presence of <i>C. nodosa</i>, growing in relatively warm and deep waters (8- 18 m) along the Israeli Mediterranean open coast, representing the most eastern <i>C. nodosa</i> population known so far. Since the Mediterranean is a hotspot for climate change, going through a rapid tropicalization process (becoming warmer and saltier), with the eastern Mediterranean characterized by the most extreme conditions, these newly found populations may be a "treasure chest" in terms of their potential adaptation</p>



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to extreme conditions, providing future restoration projects with seagrasses that will survive the harsh conditions predicted for the region.

We aim to understand the best conditions for developing *C. nodosa*-based shallow meadows along the Israeli coastline, thereby enhancing the local stocks of blue carbon. To do so, we collected *C. nodosa* seedlings at deeper sites (12 m; July 2022) and replanted them at 4 m depth along the beaches of Tel Aviv, with 3 different treatments: seedlings that were completely covered by net (i.e., protected by grazing), seedlings that were only partially covered by net (i.e., not protected from grazing) and seedlings without any cover. Results thus far found that *C. nodosa* only survived in the net-protected plots. This suggests that grazing, potentially by the invasive fish *Siganus rivuatus*, prevents the establishment of this species in shallow waters in this area.

We are currently performing additional experiments, both in the lab (priming of plants to thermal stress) and the field (e.g., different protection from grazing) to shed light on the optimal conditions for planting *C. nodosa* along the Israeli Mediterranean open coast and quantify the carbon sequestered in the sediments of such planted meadows. Using *C. nodosa* “super plants”, primed to the harsh conditions along the Israeli coast could contribute to improving the survival of seagrass plants in restoration projects near and far in a world of rapid changes.

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Key words: (max 4)

Seagrass restoration, Blue carbon, *Cymadocea nodosa*, Climate change



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

How to protect and conserve the Mediterranean Slipper Lobster

Session:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT:

Lobsters are important target for fisheries in many marine regions. Yet, in recent years populations of valuable species of commercial lobsters have been depleted due to overfishing, coastal development, and habitat destructions. An example of such a problem is the Mediterranean Slipper lobsters, *Scyllarides latus*. They are found in rocky coasts of the Mediterranean and central-east Atlantic but become rare in many regions due to anthropogenic activities. The objectives of the present paper is to review conservation and protection methods for the lobsters and to point out the most effective ones. Field and laboratory studies indicate that *S. latus* shelter in horizontally oriented caves and crevices, with more than one opening, during the day, and forage during the night as an adaptation against diurnal predators such as trigger fish. It is important to protect these hard substrate essential for the survival of the lobsters.



Figure 1. Mediterranean slipper lobsters in an artificial reef in the north Mediterranean coast of Israel (Photographed by Stephen Breitstein, University of Haifa)

If these habitats are deteriorated or destroyed, it is possible to construct environmentally friendly artificial reefs (e.g., Fig. 1) designed according to behavioral-ecological preferences of the lobsters (e.g., Spanier et al., 2010). Protection of lobsters from fisheries is another important tool for conservation especially during the reproductive season in the spring. Early efforts to protect lobsters primarily revolved around regulating fishing seasons and implementing size limits, traps limits, and harvesting quota to ensure sustainable fishing practices. However, the regulations, if



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existed, were not always effective and obeyed. One reason is that the marine areas to be inspected is vast compared to the relatively small numbers of inspectors/rangers. One of the best methods to conserve the lobsters is creating Marine Protected Areas (MPAs). Miller et al. (2023) studied adults *S. latus* in a well-protected (>30 years of enforcement) 10 km² no-take MPA in the north coast of Israel and in a nearby unprotected control site. Using diving visual census (transects), and tagging of individual lobsters, they found significance increase in the abundance, density, and sizes of male and female lobsters in the reserve compared to the control (Fig. 2). These outcomes may also benefit lobster fishery since the reserve can supply propagules as well as

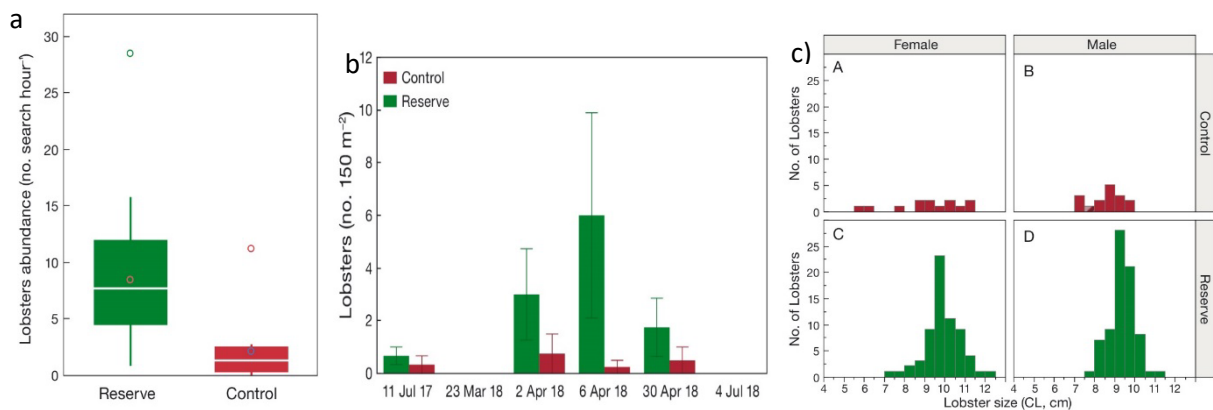


Fig. 2. Number of *Scyllarides latus* detected per search hour inside the “no-take” reserve and in the control site (a), mean densities (number of lobsters per 150 m²) detected in transects inside the reserve and at the control site (b) and carapace lengths (CL) of females (A, C) and males (B, D) lobsters in the reserve and control sites (c) (from Miller et al., 2023).

juveniles and adults via the process of “spill over” to unprotected areas. Ohayon et al. (2021) recommended the no-take MPA to be at least 10 km² and as round as possible, to reduce the proportional area of the total MPA size degraded by “edge effect” (Fishing pressure at the MPA perimeter that caused depletion further inside the MPA). Combinations of various management tools should be considered together with no-take MPAs and may result in improved protection of the target species. Decisions which management strategy is most effective, however, requires balancing what is ecologically desirable with what is economically and socially feasible. Successful implementation of MPAs and their ongoing maintenance will only occur with the full participation of the affected community, including the fishers.

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KEY WORDS:

Habitat destruction, artificial reefs, marine protected areas, spill over.



Tenth International Symposium

**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

The Mediterranean Slipper Lobster - The Known and the Concealed in the Ecology of a Threatened Species

Session:

FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT:

The Mediterranean Slipper Lobster, *Scyllarides latus* (Fig. 1) is the largest decapod crustacean in the southeastern Mediterranean coast and one of the largest lobsters in the whole Mediterranean. It has a wide geographical distribution in the entire Mediterranean Sea and the east-central Atlantic Ocean. Adults can reach a maximum total length (TL) of 45 cm. However, studies suggest that sizes in recent years have become smaller, with a TL not exceeding 30 cm, likely due to the selective fishing of large lobsters. Their relatively large adult size, and their high market value have made them a target for intensive fishing in several countries (e.g., Spanier and Lavalli, 2013a) it has become rare on many coasts due to overfishing. In some European nations, fishing has been restricted following observations of a decline in yield and size of *S. latus* specimens. In some countries it is a protected natural value and a flagship species, yet it is threatened by overfishing, the destruction of the adults' habitat, and climate change. Despite their large geographical distribution and their high commercial value, biological and ecological information on this important species is limited. The objectives of the present paper are to outline the present knowledge of *S. latus* and to point to aspects that should be explored and clarified. In the winter in the Levant, they shelter during the day in rocky dens in the underwater sandstone ridges, as an adaptation against diurnal predators such as the Mediterranean Triggerfish. Its nocturnal activity, its thick external armor, its camouflaged color, its ability to cling to the rocky substrate, and its quick escape swim in an emergency, are among its additional adaptations against predation. It feeds mainly on bivalves, that it gathers at night outside the den, opening their shells with its strong toenails. Breeding season is in the spring and females lay tens of thousands of tiny eggs that they carry on their abdomens. From each egg hatches a leaf-like, transparent, tiny phyllosoma larva that lives and feeds in the open sea. The phyllosoma spends about a year offshore, going through several molts until it metamorphoses to a benthic form (Spanier and Lavalli, 2013b) and sinks to the deep-sea floor. As it grows, it gradually moves towards the shallower water where it finally joins the adult population.



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Figure 1. Two Mediterranean slipper lobsters in the north coast of Israel (Photographed by Andry Aronov)

In the hot seasons, the adults in the Levant migrate to deeper and colder waters where conditions are more suitable for molting that allows their growth. However, in a study in the Balearic Islands (Díaz et al., 2020) a different seasonality was found - the absence of *S. latus* in the relatively shallow waters (0-50 meters) in winter. Based on 10 acoustically tagged lobsters, it was concluded that *S. latus* range of movement is limited, and in winter their activity is low, when they hibernate deep in underwater caves where water temperature was significantly higher than outside. Are the differences in the assumed seasonality and movement between the eastern and western Mediterranean associated with the different climate regimes in these areas or there is an alternative explanation? There is inadequate knowledge about the chemical, mechanical, and visual senses, and almost nothing is known about the biology and ecology of the early life stages of this lobster. There is a need to broaden and deepen the research in these facets. Increasing seawater temperatures in the southeastern Mediterranean elicited increased activity in these lobsters (Goldstein and Spanier, 2023). It is imperative to learn more about the effects of climate change on *S. latus*. To properly protect a threatened species, it is necessary to have as much information about its biology and ecology as possible. An attempt is underway to mobilize the community of sea enthusiasts to provide information to scientists about some of the questions that remain open regarding this important species using citizen science.

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KEY WORDS: FLAGSHIP SPECIES, OVERFISHING, GLOBAL WARMING, SEASONALITY



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: EFFECTS OF ABIOTIC (SALINITY) AND BIOTIC (ECTOPARASITE) STRESSORS ON *CORIS JULIS* (LINNAEUS, 1758) IN IBIZA, BALEARIC ISLANDS: A BIOMARKER ANALYSIS

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

AUTHORS: ANTONI SUREDA^{1,2}, AMANDA COHEN-SÁNCHEZ¹, GUILLEM MATEU-VICENS¹, PERE FERRIOL¹, LLORENÇ GIL¹, ANTONIO BOX³, SAMUEL PINYA^{1,2}, SILVIA TEJADA^{1,2}

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Anthropic activity represents a continuous challenge for species that are constantly subjected to different stress situations. Stressful situations include abiotic factors such as exposure to hypersaline waters derived from desalination plants and biotic factors such as infection by new parasites introduced by human action or an increase in the infectious load favoured by pollution. In the Balearic Islands, high human pressure, especially in summer, associated with tourism causes an increase in water demand that cannot be met by the natural water reserves and, it must therefore be met through the osmosis industry. Recently, the presence of an ectoparasitic trematode of the genus *Scaphanocephalus* has been observed in Ibiza that affects the skin of fish from the wrasse family causing 'black spot disease'. Any factor that causes stress to organisms induces an activation of the metabolism to face this new situation. This fact translates into an increase in the production of reactive species (ROS) which, in turn, induces the activation of antioxidant defence mechanisms. Furthermore, any element exogenous to the body induces an activation of immune defences to protect the body. Therefore, the analysis of biomarkers allows to evaluate the potential effects of different stressors on organisms by determining the same parameters.

Objectives

the objective of the present work was to study the effects of an abiotic factor (salinity) and a biotic factor (ectoparasite) on the small coastal wrasse *Coris julis* (Linnaeus, 1758). Specimens were obtained in three areas of the Island of Ibiza (Balearic Islands): control area, area influenced by the desalination plant and area with high levels of parasite infection. Biomarkers of oxidative stress in the gills, liver and epithelial mucus were analyzed, as well as immunological markers in the mucus.



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Main findings, results, and indications of the proposed work

The two stress factors induced a differential response, with a greater effect of salinity on the gills and a greater effect of the parasite on the liver and mucus. In general, an increase in the activities of the antioxidant enzymes, catalase and superoxide dismutase (SOD), and in the production of ROS was observed in the gills of fish affected by salinity, while this increase was greater in the liver in fish affected by the parasite. The activity of the detoxification enzyme, glutathione s-transferase (GST), was increased in both tissues and under the two stressors, while no changes were observed in malondialdehyde (MDA) levels as an indicator of oxidative damage. Lysozyme and alkaline phosphatase activity increased in the mucus of fish under the influence of salinity and parasitism, and immunoglobulin levels increased only in the presence of parasite. In conclusion, *C. julis* specimens affected by salinity and an ectoparasite respond with an increase in antioxidant and immunological defence mechanisms, preventing the appearance of oxidative damage. The analysis of biomarkers allows monitoring studies to be carried out when responding to stressors of different nature.

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KEY WORDS (MAX 4)

BIOMARKERS, BALEARIC ISLANDS, OXIDATIVE STRESS, IMMUNE RESPONSE



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: FISH IMMUNE AND OXIDATIVE STRESS REACTION TO EMERGING PARASITE IN THE BALEARIC ISLANDS

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

AUTHORS: SILVIA TEJADA^{1,2}, AMANDA COHEN-SÁNCHEZ¹, JOSÉ MARÍA VALENCIA³, ANTONIO BOX⁴, GIL LLORENÇ¹, SAMUEL PINYA^{1,2}, ANTONI SUREDA^{1,2}

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Global change has a profound impact on the distribution and prevalence of diseases in fish, leading to the emergence of new pathogens. A recent observation on the Island of Ibiza in the Balearic Islands has highlighted the presence of black spot disease linked to a digenean fluke belonging to the genus *Scaphanocephalus* in *Xyrichthys novacula* specimens. In fact, black spot disease has been described as one of the most common characteristic of ectoparasite infections. In addition, a rise of the environmental temperature could imply higher reproduction taxa for parasites which could accelerate transmission and increase its abundance.

Objectives

This study aimed at assessing the antioxidant and immune responses in both mucus and spleen of *X. novacula*, with a focus on the extent of infection by *Scaphanocephalus* sp.

Main findings, results, and indications of the proposed work

The study involved capturing fish in two distinct areas in waters of the Ibiza island (Balearic Islands), the first one devoid of the parasite, serving as a control site (Sa Mola); and another one where the parasite was observed to be present so as it was considered the infected area (Es Cubells). The animals were captured during October 2022 and classified into two groups based on the severity of infection: low infection (from 1 to 15 spots) and high infection (>15 spots). When the sample size was achieved (10 for controls and 20 for infected), the other captures were returned to the sea. Under anesthesia, weight and size were measured, and mucus and spleen samples were obtained. As the degree of infection increased, a noticeable decline in the body condition index was observed, indicating the detrimental impact of *Scaphanocephalus* sp. One significant finding of this research was the increasing activity of antioxidant enzymes in the mucus, including catalase, superoxide dismutase, and glutathione peroxidase, as the infection level increased. This increase in antioxidant defenses aimed to counteract the oxidative stress imposed by



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the parasite. However, despite these efforts, higher infection levels led to an elevation in malondialdehyde levels, a marker of lipidic oxidative damage, particularly in the group with the most extensive infection. In addition to the antioxidant response, the study also revealed a corresponding increase in various immunological parameters as the infection severity rose. These parameters included lysozyme, alkaline phosphatase, myeloperoxidase, and immunoglobulins. Also, lysozyme and ALP activities in the spleen of the higher infected specimens of *X. novacula* were observed although no differences were observed in the low infection. Altogether, this immune response was indicative of the fish's attempt to combat the infection by *Scaphanocephalus* sp.

In summary, the presence of *Scaphanocephalus* sp. in *X. novacula* triggers both an immune response and a state of oxidative stress in the mucus as the infection becomes more severe. These changes in the physiology of the fish are accompanied by a decrease in their overall body condition. The potential effects that this ectoparasite can have on affected *X. novacula* populations highlight the need for continued with the studies, and a more extensive research to monitor and understand the long-term impact of this infection.

Funding: This work has been partially sponsored and promoted by the Comunitat Autònoma de les Illes Balears through the Direcció General de Recerca, Innovació i Transformació Digital and the Conselleria de Economia, Hisenda i Innovació via Plans complementaris del Pla de Recuperació, Transformació i Resiliència (PRTR-C17-11) and by the European Union- Next Generation UE (BIO/006). Nevertheless, the views and opinions expressed are solely those of the author or authors, and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission are to be held responsible.

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KEY WORDS (MAX 4)

OXIDATIVE STRESS; IMMUNE SYSTEM; PEARLY RAZORFISH; ECTOPARASITE



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FORM FOR ABSTRACTS PRESENTATION

TITLE: MONITORING EU HABITAT TYPES OF COASTAL DUNE SYSTEMS IN SOME CRITICAL SITES IN SOUTHERN ITALY

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Coastal Dune Systems (CDS) provide a wide range of ecosystem services such as, among others, prevention of coastal erosion and protection from extreme events. Nevertheless, the maintenance of CDS is strictly related to the conservation status of plant species and community types (Van der Biest et al 2017). In many parts of the world, and especially in the Mediterranean area, CDS are under severe pressures leading to different forms of degradation, such as introduction of invasive species, pollution, habitat reduction and fragmentation. In this scenario, continuative and consistent monitoring programs are fundamental to implement effective management policies and conservation strategies. The combination of in situ surveys with remote sensing methods and techniques has proven to be a robust approach in the monitoring of coastal ecosystems on large spatial and temporal scales (Adamo et al 2016; Tomaselli et al 2023).

Objectives

We addressed our study to three Natura 2000 sites in southern Italy (Puglia and Calabria regions), namely: IT9110015 – “Duna e lago di Lesina-Foce del Fortore” (northern Puglia); IT9130006 – “Pinete dell’Arco Ionico” (southern Puglia); IT9320102 – “Dune di Sovereto” (eastern Calabria). All three sites are characterized by extensive CDS hosting many different habitat types under the 92/43 EEC Directive, even though they are subject to various threats and pressures. Surveys were focused on the priority habitat type 2250* - “Coastal dunes with *Juniperus* spp.”. Activities included field surveys and the analysis of remote sensing products (i.e., satellite images and orthophotos, from both aircraft and drone), as well. The first ones were mainly aimed at characterizing the morphology and the structure of the habitat, the second one at achieving an automatic habitat-tailored mapping system, from also multi-temporal images (diachronic analysis). Field work involved the execution of vegetation plots and transects, according to the Italian Manual for the Monitoring of species and habitats of community interest (Angelini et al 2016), which allowed to assess dune standard zonation, as well. The remote sensing approach followed different strategies, from the simple visual interpretation of aerial multi-temporal orthophotos, to the classification of Very High Resolution (VHR) satellite images by a Knowledge-Driven Object-based (KDOB) approach deriving from expert knowledge of the sites, up to the combined use of machine learning techniques and ground truth data obtained both through field campaigns and Unmanned Aircraft System (UAS) acquisitions. Finally, a set of selected Landscape Metrics (LMs) was applied to habitat and vegetation maps, across multiple spatial and temporal scales, to evaluate spatial patterns and assess their changes in both target and adjacent habitat types.

Main findings, results, and indications of the proposed work

The habitat 2250* was characterized and mapped. Both UAS acquisitions and KDOB procedures produced very promising results with a view to automatic mapping of the habitat in terms of coverage (distribution area) and occupied volume (biomass). Based on the diachronic analysis of the maps, as well as of the application of the LMs, a generalized reduction of the habitat 2250* turned out, whose causes seem to lead back to the frequency of fires, rather than to the coastal erosion, the latter appearing as an ongoing event in all the study sites, nevertheless.

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KEY WORDS (MAX 4): COASTAL DUNES, VEGETATION MONITORING, HABITAT MONITORING, SOUTHERN ITALY



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FORM FOR ABSTRACTS PRESENTATION

TITLE: IDENTIFICATION OF FATTY ACID PROFILE AND LIPID BIOMARKERS IN TWO HOLOTHUROIDEA SPECIES FROM DIFFERENT LOCATIONS ALONG THE ITALIAN COAST

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT:

Sea cucumbers belong to the phylum Echinoderms, with species found on seabeds around the world. They play a key role in sea floor dynamics, mixing and processing sediments (Purcell et al., 2016). At the same time, they represent an important economic resource in the food and pharmaceutical sectors, especially in the Asian markets. The phenomenon of intensive fishing in the Mediterranean Sea is recent; unregulated and intensive harvesting (hundreds of tons) can cause negative impacts both on stocks' conservation status and on benthic ecosystems, compromising their functionality and biodiversity. In Italy, fishing, keeping on board and landing sea cucumbers are currently prohibited by the Ministerial Decree 660655 of 23.12.2022 of the Ministry of Agriculture, Food Sovereignty and Forests (MASAF). In fact, it is believed that unregulated and intensive harvesting can cause negative impacts not only on sea cucumber stocks, but also on benthic ecosystems, compromising their functionality and biodiversity. Finding a methodology such as distinctive biomarkers to infer the origin of the harvesting area would give useful information for their conservation and management. In this framework, as part of the "Holothuria" project, funded by MASAF and aimed at identifying and evaluating the state of *Holothuria* spp. stocks along the Italian coasts, 285 samples belonging to *H. polii* and *H. tubulosa* from ten coastal sites were analyzed. The lipid component of the body walls was extracted according to a modified method proposed by Lang et al. (2011), and then characterized by gas chromatography (GC-FID) and confirmed in gas chromatography-mass spectrometry (GC-MS) to: *i*) identify any distinctive fatty acids (FAs) of the sampling areas (geographical biomarkers) and *ii*) select potential trophic biomarkers. In our findings, the most abundant fatty acids were C20:4-n6 arachidonic acid (22.6 ± 4.5%), eicosapentaenoic acid C20:5-n3 (12.3 ± 5.9%), C20:1-n9 eicosenoic acid (9.3 ± 1.8%), palmitic acid C16:0 (7.3 ± 2.3%), palmitoleic acid C16:1-n7 (5.9% ± 2.8%), stearic acid C18:0 (5.2% ± 1.2%), and nervonic acid C24:1-n9 (5.2% ± 1.0%). The Principal Component Analysis (PCA) returned a distribution of individuals consistent with the geographical location of the sampling sites. Palmitoleic acid, palmitic acid, arachidonic acid, and eicosapentaenoic acid were found to contribute more to the distribution of



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the observations in the PCA space, applying to be used as potential "geographical" biomarkers. Furthermore, the abundances of some fatty acids, notoriously representative of specific trophic sources (Alfaro, 2006) were evaluated to provide indications on the different sources of nutrients in the diet of sea cucumbers and to see how these may vary according to the geographical area and/or according to the species. The present study represents the first attempt to use FAs to discriminate the different Italian subpopulations of *H. polii* and *H. tubulosa* and to obtain valuable information on the ecology of these species in a broader framework of sustainable stock management.

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KEY WORDS

SEA CUCUMBERS
FATTY ACIDS
GAS CHROMATOGRAPHY
BIOMARKERS



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FORM FOR ABSTRACTS PRESENTATION

Title: Development of methodology for the Ecological Quality Status assessment in the Croatian coastal waters using macrozoobenthos according to the European Union
Session: Flora and Fauna of coastal ecosystems: protection, management, monitoring
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): This presentation provides an overview of the implementation of ecological quality status (EQS) along the eastern coast of the Adriatic Sea (Croatian coastal waters), using Biological Quality Element benthic invertebrates (BQE BI). It presents development of typology reference conditions (RC) and classification system, both in early phase implementation of WFD and subsequent national monitoring of EQS over the 2012-2017 period. In the initial phase of WFD implementation, RC in Croatian coastal waters were selected using historical data/information, corresponded to totally and/or near-totally undisturbed conditions. Historical data set included information on the composition of soft-bottom benthic invertebrates from 17 sites, obtained between 1973 and 1986 in Limski zaljev, Rovinj coastal area, Raša Bay and Kvarner region. It was a baseline for the analysis of functional structure of benthic communities, calculation of biotic indices (AMBI, M-AMBI), definition of national reference conditions (NRC) and assessment of ecological quality status. Due to low amount of historical data and the absence of full environmental gradient, classification was performed using original classification setting (REFCOND, 2003). Based on preliminary analysis, we described 1 st generation of NRC, in accordance with WFD normative definition. Development of methodology for the EQS assessment in the Croatian coastal waters was based on the analysis of 100 macroinvertebrate samples, taken during 25 sampling tours from 23 sampling sites within 17 coastal Water Bodies (WB). The results of the analysis generated 2 nd /provisional generation of NRC and enabled revision of EQR boundaries setting. The Republic of Croatia did not participate in the intercalibration exercises (IC) of the Mediterranean Geographic Intercalibration Group (MED-GIG) due to late accession to the EU, so the subsequent development of the methodology was needed in order to harmonize within MED-GIG. Since, Croatia and Slovenia are neighbouring states that geographically share the eastern Adriatic coast, it can be assumed their coastal waters have the most similar ecological conditions and benthic communities. Therefore, and due to compliant method related to the analysis of taxonomic composition we decided to harmonize methodology by acceptance of reference values and class boundaries for Slovenian coastal waters, developed during MED-GIG IC as follows: $EQR_{M-AMBI} > 0.83$, $AMBI = 1.3$, $H' = 5.8$, $S = 110$ that is, class boundaries $H/G = 0.83$ and $G/M = 0.62$. To achieve that goal we revised previous analyses, i.e. we calculated new EQR_{M-AMBI} (3 rd generation) for Croatian data set using Slovenian RC and BC values. Two sites



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with the highest values of revised M-AMBI index are selected as the reference sites. In this presentation we provide the procedure and results of revised National Boundary setting including EQS classification scheme with corresponding EQR intervals, as well as description of the biological communities at High, Good and Moderate Ecological status. Methodology was accepted by EC authorities in March 2021.

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KEY WORDS (MAX 4) CROATIAN COASTAL WATERS, WFD MONITORING, ADRIATIC SEA



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

FLORA AND HABITATS ON ALGIER'S COASTLINE (ALGERIA) : STATE OF KNOWLEDGE AND CONSERVATION ISSUES

SESSION: FLORA AND FAUNA OF COASTAL ECOSYSTEMS: PROTECTION, MANAGEMENT, MONITORING

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coastal ecosystems are characterized by their uniqueness and complexity, harboring an exceptional biodiversity of plant and animal species adapted to the environmental conditions of the area. These ecosystems play a vital role in maintaining ecological balance (Asensi et Diez-Garretas, 2017). The degradation of the coastal environment is a major concern, requiring sustainable conservation and management measures to preserve the biodiversity and ecosystem services offered by this coastline. Among coastal habitats, dunes are particularly studied. They are considered in conservation status assessments, especially in Mediterranean biogeographical regions where they represent the most vulnerable habitats due to human and natural pressure.

Littoral ecosystems have a great ecological and socio-economic importance, playing a crucial role in preserving biodiversity and protecting against coastal erosion. They can act as storm barriers and water filters. They also help to stabilize sediments and preserve the characteristics of coastal vegetation (Martinez et Psuty, 2004).

Nowadays, the preservation of sand dune habitats is of paramount importance, particularly when considering the rising conflict between human activities near the coastal zones (residential and related to tourism, which is highly important for the local economy) and the preservation of the unique plant diversity of coastal sand dunes.

The Algerian coastline stretches for 1,622 kilometers along the southern shore of the Mediterranean Sea, and extends over a strip of land at least 800 meters wide, comprising all the islands, islets, as well as the continental shelf (Kacemi, 2013). This coastline is characterized by a remarkable diversity of landscapes, ranging from imposing dunes to depressions between them, stony areas, rock formations, coastal cliffs and coastal plains. They are home to various plant communities, including grasslands, scrublands and forests.



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However, despite its richness and diversity, the Algerian coastline faces a number of challenges and threats. The concentration of the population especially on summer season, the development of economic activities and coastal infrastructures are having a significant impact on this fragile ecosystem. The result is an intense degradation of the sites, a coastal erosion accentuated by the effects of climate change and a real threat to flora and habitats characteristics of Mediterranean environments. *In situ* and *ex situ* conservation actions are required.

The aim of this study is to assess the current state of dune and pre-forest habitats through an inventory of coastal flora around the capital city Algiers. Such habitats, with high dynamic potential, represent home to a specialized Mediterranean flora but are subject to various threats. The coastline flora is of major conservation interest, particularly in light of the effects of climate change. Station assessments and transect monitoring are carried out from the embryonic dunes to the fixed grey dunes with a focus on certain key coastal species as *Pancratium maritimum*, *Achillea maritima*, *Juniperus phoenicea* subsp. *turbinata*, *Ephedra fragilis*, which are present on both shores of the Mediterranean Bassin at varying frequencies.

The floristic inventory and diagnosis carried out on the coastal flora, which is subject to numerous pressures; provide a major indication of its state of conservation. They will serve as a reference for conservation and/or restoration studies, particularly in the current context of global changes.

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KEY WORDS : Dune ecosystem- Coastline preforest- South shore Mediterranean –Monitoring.

SESSION

**GEOGRAPHY, TOURISM AND LANDSCAPE
OF THE COASTAL AREAS.
ENHANCEMENT, SAFEGUARDING
AND DYNAMICS OF THE TERRITORY**

ORAL PRESENTATIONS



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Living in a fragile and dynamic territory: the contribution of environmental and geoarchaeological mediation to the appropriation of new ways of living in coastal areas.

SESSION:

Geography, Tourism and Landscape of the coastal areas. Enhancement, safeguarding and dynamics of the territory

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UMR 5140 ARCHEOLOGIE DES SOCIETES MEDITERRANEENNES

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The aim of the research is to identify and evaluate the levers and margins of progress for environmental and geoarchaeological mediation in raising user awareness of changing practices and ways of living in coastal areas. The study is based on a contemporary and forward-looking approach, drawing on heritage and the memory of spatial practices. How can we encourage citizens to take action on environmental issues, particularly in terms of changing coastal practices?

Observing and understanding the landscape, as a reflection of the evolution of spatial practices over time, helps to change our relationship with the world by rethinking the relationships between living and non-living beings (Descola, 2022; Charbonnier, 2020). To change our relationship with the world, we need to give citizens back their ability to act on it. So we place the provision of knowledge and the nourishment of representations that contribute to individual awareness at the heart of the issues at stake in a political recomposition of the Anthropocene.

However, the studies, analyses and numerous reports published over the last 30 years by scientific and civil society players are little or not taken into account in environmental, economic and social policies. Contributing to the formation of conscious individuals situated in time and space (Puech, 2010) is therefore an essential step towards changing practices in coastal areas.

Based on these various observations, we seek to define and test creative and renewed links between Science and Society through two case studies, mobilizing the arts & sciences approach in the Thau Basin area. The results underline the complementary nature of artistic and media creation. The artists' sensitivity and the mediators' humanist commitment express an original style of writing, appealing to the representations and emotions of individuals and reflecting the current social context. The trans-disciplinary approach to environmental issues provides access to a range of postures and views of the world, inviting individuals to make their own choices, in a reassuringly emotional context conducive to landscape prospective.

In addition, we recognize that the diversity of approaches and types of media supports the plurality of sources and forms of access to information. The artistic medium, through contemporary creation, mobilizes other mechanisms of sensitive appropriation, notably through the effect of aesthetic emotion. As with early-learning pedagogy and the playful approach, the challenge is to arouse the desire to act through a positive experience in the natural environment (Navarro Carrascal, 2022). The idea is to mobilize the



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notion of pleasure associated with hope, an emotion essential to civic action. In particular, the collective action framework (Ion, 2012) enables individuals to remake society on the basis of the environmental challenges of the Anthropocene, and thus contributes to the emergence of the "new ecological class" (Latour, 2022).

This research project is part of a multi-scalar and transdisciplinary spatial dynamic, involving local cultural policies, civil society and the university. The involvement of local authorities and institutional players testifies to the dynamics of participative, situated research. We may well wonder how these links between the arts, sciences and society can be sustained in the short term as part of a co-production of knowledge. A structural basis with strong upward potential for global ecological governance, towards the sustainable habitability of the earth.

3556 Characters

REFERENCES: (MAX 4)

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3. Latour, 2015, 2020, 2021
4. Navarro Carrascal, 2022

KEY WORDS (MAX 4)

ENVIRONMENTAL MEDIATION / LIVING / COASTLINE / CLIMATE CHANGE



Tenth International Symposium

MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

**Monitoring Transformations of Urban and Natural Landscape in
Mediterranean Cities by Promoting Landscape Setting Archetypes**

SESSION:

Coastline Geography and Coastal Landscapes: Territorial Dynamics and Integrated Protection

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The research phenomenon of the 'urban and natural landscape relation' which is identified as the landscape setting of cities, testifies to 25 centuries of urban culture in the Mediterranean. It is a multidimensional changeability process that integrates spatial, temporal, and perceptive character, as well as functional and holistic principles fostered by the spatial planning point of view. The phenomenon of landscape relation is a layer of the *Urbanscape Emanation* concept [1] understood as the impact of the city systems on its landscape. The research premise considers planning the landscape transformation as a necessary tool for making natural and urban conditions more holistic, resilient, and sustainable.

Determining landscape relations as a multidimensional phenomenon and changeability process implies the need to overlap different research approaches and regard various (scientific and art) disciplines. Opening a need for a comprehensive approach to landscape relations presents a challenge in application to spatial planning where research questions arise. How to address the complex phenomenon and process of landscape relation in an interdisciplinary (scientific and artistic) manner? How to apply the overlapping of different approaches to landscape settings for spatial planning enhancement?

The landscape itself defies precise definition, categorisation, and delineation. The nature of landscape exists equally in reality (physical) and representation (metaphysical) dimensions that aware of various landscape values (and encourage different levels of the experienter landscape



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consciousness). Thus, the hypothesis introduces archetypes as an approach that moves between various fields of research, theoretical framings, empirical observations, collective perceptions, and the classification rules upon which landscape research, management plans [2], and art are based. Archetypes are used as conceptualisation principles that embody the (metaphysical) representation of landscape within (the reality of) the physical world.

The research objectives are twofold: (i) to determine the main research fields that address reality and representation of landscape relations and (ii) to establish landscape setting archetypes for monitoring transformations of urban and natural landscape. The research approach applies conceptualisation and synthesis of main research fields to identify the landscape setting archetypes that enhance spatial planning practices. The theory-based landscape setting archetypes are verified on the Mediterranean cities of Dubrovnik, Ancona, and Livorno, settled between two strong natural elements – the sea and the mountains. The three case cities represent the intensive encounter of the urban and natural landscape in East Adriatic, West Adriatic, and East Ligurian Coast.

The theory-based research sets research fields of spatial planning, psychology, and photography that integrate landscape representation with reality and arise from the multidimensional determination of the urban and landscape relation. The spatial planning field is complemented by collective psychology [3] and art photography [4] for establishing landscape setting archetypes. Their application on case study cities verifies the urbanscape and the natural landscape as prime landscape archetypes. The urban and natural landscape exist only as an abstract conceptualisation because, in landscape reality and representation, each of them consists of the constituents of the other.

The landscape archetypes help us to deal with the complex nature of landscape relations by acknowledging the values found in (different intensities) in all landscapes. The variety of urban development and the natural landscape evolution as landscape transformations originate the landscape setting archetypes. The spatial (planning), collective (psychology), and art (photography) fields promote landscape quality and the quality of life, contribute to raising collective and landscape consciousness, and foster a holistic and resilient landscape for sustainable development.

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KEY WORDS (MAX 4)

Landscape Reality, Landscape Representation, Adriatic, Liguria

Quantifying and mapping the human footprint across Earth's coastal areas

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Abstract

Hundreds of millions of people live, visit and work in coastal areas globally, with most of the world's countries having coastal areas. Coastal ecosystems incorporate both marine and terrestrial environments on the two sides of the coastline. Coastal areas are diverse, provide a wide range of ecosystem services and support rich biodiversity. However, coastal areas are also impacted by many stressors, originating from both marine and land sources. Mapping and quantifying coastal stressors globally in a systematic way is thus important in order to help direct and prioritize conservation efforts in coastal areas, and to understand the spatial relationships between the distribution of marine and land-based stressors across coasts globally.

To address these challenges, we quantified, mapped and examined the human footprint across Earth's coastal areas, covering ten major terrestrial stressors (e.g., population, tourism, energy and extractive processes, land conversion and human accessibility) and ten marine stressors (e.g. marine traffic, pollution, oil and gas infrastructure, fishing and changes in sea surface temperature). We calculated all data layers at a 1 km² resolution, to allow our coastal footprint to be comparable with existing footprint indices. We normalized each of the individual stressor layers relative to the maximum score of each stressor and calculated the cumulative score of the normalized stressors with a radius of 10 km for all coastal grid cells. We quantified the level of coastal protection for all countries globally, as well as for ten major coastal ecosystems. These included three marine-based ecosystems (coral reefs,

seagrass beds and kelp forests), four terrestrial-based ecosystems (saltmarshes, coastal wetlands, tree areas flooded by fresh or brackish water, and shrub areas flooded by fresh, brackish or saline water) and three cross-realm ecosystems (mangrove forests, tidal flats and sandy beaches). We compared the protection class coverage and its correspondence with conservation targets using the IUCN protected area classes.

Globally, we found that 97% of all coastal grid cells had at least one major stressor present. Sandy beaches (which attract the public) had higher coastal footprint scores than non-sandy beaches. At the country-sea scale, the coasts of Belgium, Monaco and Singapore had the highest overall coastal footprint globally, whereas Antarctica and the Arctic had the lowest coastal footprint scores. Running stepwise regression models of the coastal footprint at the country level, we were able to explain more than 65% of the variation in the coastal footprint scores, with population density having the highest standardized coefficients. GDP per capita and the ratio between a country's population and the number of coastal grid cells also had positive standardized coefficients in all regression models they entered. The marine-based stressors that had the highest contribution to the coastal footprint scores were trends in sea surface temperature, which also had the widest global spatial distribution, shipping and nutrient pollution, whereas for the land-based stressors the most prevalent pressures were population, roads, and tourism. We found that ~20% of coastal areas globally were located within protected areas, yet only 7% were included within areas assigned to the stricter IUCN management categories (I-II). At the global scale, six of the ten major coastal ecosystems examined have reached 30% spatial protection, yet all ten major coastal ecosystems had less than 10% of their global extent within strict protected areas. We found significantly lower footprint scores in protected areas as compared with unprotected coastal areas. Beyond the polar coastal areas, we identified 160 areas of "low human pressures" (areas > 25 km² composed of coastal grid cells in the lowest decile), of which only 38 (24%) were fully encompassed within protected areas, while 63 coastal areas of "low human pressures" (39%) were entirely unprotected. We highlight the need to create platforms targeting both marine and land-based threats to coastal environments to further address the gaps in coastal area conservation and management.

Keywords: Coastal human footprint; land-sea; coastal areas; stressors; conservation targets



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FORM FOR ABSTRACTS PRESENTATION

TITLE: SEA LEVEL RISE PROJECTIONS: RISK AND IMPACTS ON POPULATIONS IN THE MEDITERRANEAN BASIN

SESSION:

GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The JRC (Joint Research Center) provides various scenarios of sea level rise based on climate models and future projections. These scenarios take into account factors such as global warming, glacier melting, ocean thermal expansion, etc.

Sea level projections are essential to understand the effects of climate change on coastal areas. They represent a fundamental assessment tool to determine the level of risk coastal communities are exposed to and to plan and manage these territories as effectively as possible. In this discussion, scenarios RCP4.5 and RCP8.5 are considered for projections in the Mediterranean region by the year 2050 and 2100, respectively.

Firstly, sea level projections allow for the evaluation of impacts on land use. Knowing the extent of sea level rise in a specific area helps to understand which parts of the land will be subject to coastal flooding and therefore what amount of available space will remain for human activities. This information is of crucial importance for urban planning and to avoid the construction of infrastructure or the location of settlements in high-risk areas.

Secondly, sea level projections provide indications on the need to plan for the construction of new infrastructure. Climate change and sea level rise will likely require civil engineering works to address new risks and needs arising from coastal erosion and flooding. Knowledge of future sea levels is therefore essential to guide infrastructure planning and enable the construction of effective coastal defense systems.

Finally, sea level projections are crucial for developing strategies to adapt to future climate change. Sea level rise will have significant consequences for coastal communities, as millions of people live in these areas and are therefore exposed to risks from events such as storm surges and floods. Knowing future sea levels allows for the development of strategies to reduce the



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vulnerability of coastal communities and protect people, property, and the environment from potential damages.

Regarding flooded areas and population exposure, it is important to consider noise reduction criteria. These criteria are based on proximity to hydrological basins and can be applied using geostatistical methods. The use of such methods helps to avoid overestimation of areas that could be affected by coastal flooding, thus reducing the level of population exposure.

Another important development of sea level projections is population growth modeling.

Assessing climate risk and vulnerability in coastal communities must consider not only sea level rise but also population growth in these areas. Modeling population growth in the medium and long term allows for the updating of coastal population data and obtaining a more accurate understanding of potential future impacts.

In conclusion, sea level projections are an essential tool for the planning and management of coastal areas. These projections allow for the evaluation of impacts on land use, planning for new infrastructure construction, and the development of strategies to adapt to future changes. It is also important to consider noise reduction criteria to avoid overestimation of flooded areas and to model population growth in order to update coastal population data. By doing so, it will be possible to effectively and sustainably address the risks posed by sea level rise and protect coastal communities and the environment.

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4. Hardy, R. Dean, and Mathew E. Hauer. "Social vulnerability projections improve sea-level rise risk assessments." *Applied Geography* 91 (2018): 10-20.

KEY WORDS (MAX 4)

COASTAL VULNERABILITY, SEA LEVEL PROJECTIONS, URBAN PLANNING, SOCIAL VULNERABILITY



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FORM FOR ABSTRACTS PRESENTATION

TITLE: UNRAVELLING THE OFFSHORE WIND ENERGY TOURISM: FIRST EVIDENCE AND PERCEPTIONS IN FRANCE.

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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Abstract:

Offshore wind farm (OWF) development leads major change in marine ecosystems, landscapes and territories. As far as tourism and recreational activities are concerned, knowledge focuses mainly on tourists' perceptions of potential impacts on landscapes or the attractiveness of OWF sitting areas, and how these perceptions affect tourists behavior and flows ^{1,2}.

However, OWF impacts on tourism cannot be summarized only as a change in visitors number, nor from the viewpoint of "end-users" preferences only. OWF may also affect both local practices and tourism development strategies of a wide range of tourism providers. Unravelling OWF impacts on tourism from the perspective of the providers of the tourism services is a way of filling the gap in the current literature and providing a holistic view of the OWF impacts on tourism. Thus, we question *how coastal tourism destinations can evolve in the context of offshore wind energy development?* Such a questioning presupposes to develop and test a methodology to assess the potential impacts of OWFs on tourism activities and tourism providers.

The chosen approach is essentially geographical, with contributions from sociology, involving a diagnosis of touristic activities, interviews, and spatial analysis to i) map identified OWF impacts on touristic activities, flows and strategies and ii) assess the perceptions of tourism providers. The aim is to characterize the "*offshore wind energy tourism*", by identifying its components and manifestations as well as its relationships to other forms of tourism. In this respect, we conducted field investigations in three French OWF between May and October 2023 to provide a comparative analysis: i) 'Banc de Guérande fixed OWF' in the Atlantic (in operation since 2022), ii) 'Calvados fixed OWF' in the English Channel (construction planned in 2024) and iii) 'Leucate' floating OWF in the Mediterranean (construction planned in 2024). In total, we carried out 41 semi-structured interviews with tourism operators, tourist office managers and elected representatives in municipalities located within the OWF visibility areas.

The results are highly heterogeneous across the case studies. In the Atlantic, changes in touristic activities can already be observed. Some providers benefit from these changes and develop a specific touristic offer integrating OWF and boost the local economy. Other providers are more cautious, perceiving OWFs as a



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potential threat, leading to a reduction in landscape quality and activities.

This duality is also visible in the English Channel, although the OWF is not operating yet. Tourism providers are strongly committed to the development of offshore wind energy tourism, following the example set in the Atlantic.

In the Mediterranean, tourism providers do not express their willingness to develop specific activities relative to offshore wind energy tourism, although they are open to proposition from industrialists. They believe that OWF will have no significant impacts on tourism because the behaviors of local recreational boaters and local identities.

The comparative analysis shows that OWF impacts on tourism are generally perceived through other filters: fishing activities, landscape, biodiversity, employment. They are perceived as benign to positive by tourism providers, considering the intense development dynamics of coastal areas, and the minor role of OWF in these dynamics.

The results also reveal the importance of local appropriation of OWF projects by tourism providers, and the place of OWF in local identities. Offshore wind energy tourism can generate significant benefits for local communities, by notably driving a new tourism offer.

This first study on OWF impacts on tourism offer and activities in France reveals the interweaving effects of OWF on evolving socio-ecosystems. Such an approach supports the need for long-term and interdisciplinary monitoring to which the methodology developed and tested in this study can address.

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KEY WORDS

Offshore wind energy tourism, Monitoring tourism development, Mapping practices, social perceptions.



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TITLE: “LIGHTHOUSE FAMILIES” IN GREECE: THEIR CONTRIBUTION TO FORMING AND PRESERVING COASTAL CULTURAL IDENTITIES

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The Hellenic Lighthouse Network (HLN) is one of the most historic and best organized coastal and open sea lighting systems worldwide. It includes more than 1.600 lighthouses, beacons and buoys that were installed between 1822 and 1926, i.e., after the beginning of the Greek War of Independence against the Ottoman Empire (1821), and were gradually incorporated into the national marine and defense infrastructure. Some of those traditional built lighthouses and beacons have been characterized as Monuments of Modern Cultural Heritage since they were erected at least one hundred years ago.

The majority of Greek lighthouse complexes and buildings are found in locations of natural beauty and architectural interest; some of them are situated within world heritage sites and conservation areas. Greek lighthouses are humble, almost handmade, albeit remarkable and multifaceted structures that encapsulate tangible and intangible qualities; they represent local, national and global connotations, as well as monumental, technological, practical, social, aesthetic and symbolic values. They are perceived as an integral part of coastal cultural identities to many regions and the whole country despite their practical utility being minimized due to the automation of their operation. Still, they enchant people pursuing sophisticated and reclusive activities beyond the mass tourism spectrum.

Lighthouse keepers are associated with the history, existence and protection of lighthouses. Each one's experiences, narratives, perceptions or feelings are unique, but lighthouse keepers' collective habitus, memory and expertise have comprised a sui generis cultural ecosystem. As a social group, lighthouse keepers in Greece have been influenced by the roughness of the Greek landscape and the isolation of their profession. At the same time, their autonomous and self-dependent communities, the so-called “lighthouse families”, have substantially contributed to the construction and preservation of coastal natural and manmade cultural resources over time. Notwithstanding, the modernization and digitization of shipping equipment and navigational aids have simplified lighthouse keepers' routine. Their profession is considered obsolete, or even



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unnecessary, but their regular presence at lighthouses seems to ensure the sustainability of buildings, surrounding environment, land and seascapes.

The paper seeks to delineate the cultural capital and tourism potential of life at lighthouses; it also underlines the significance of Greek lighthouse families' role in protecting, refreshing and rebranding the inherent and authentic cultural characteristics of coastal areas. The survey was conducted in the context of a doctoral thesis and was based on qualitative research methods. Study visits at lighthouse zones, combined with interviews with professionals in the field and persons emotionally connected with lighthouses, produced results that confirmed our hypotheses. Knowledge, skills, utensils, artifacts, food seeking, preparing and storing practices, kids' education, games and toys, everyday, festive and mourning customs, attitudes towards nature, spiritual concerns, formal and ethical rules of living and collaborating, intercultural communication, intergender and intergenerational relationships, oral history and legends regarding Greek lighthouse keepers are some of the topics that were discussed and were regarded as worth recording, evaluating, interpreting and disseminating under the scope of distinct coastal identities forming and preserving in Greece.

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KEY WORDS: (MAX 4)

1. HELLENIC LIGHTHOUSE NETWORK
2. LIGHTHOUSE KEEPERS
3. LIGHTHOUSE FAMILIES
4. COASTAL CULTURAL IDENTITY



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

AGRICULTURAL TERRACED SYSTEMS OF THE TUSCAN ARCHIPELAGO: TYPOLOGICAL ANALYSIS AND RECOVERY POSSIBILITIES OF DRY STONE WALLS

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks:

Dry stone walls result from a great secular work and a "stone culture" that has developed in the various territories of the Mediterranean basin in relation to the peculiarities of natural and economic resources, as well as to mutable historical circumstances, maturing formal expressions intimately linked to places. This is a fragile cultural heritage, as preservation passes through constant maintenance operations that, apart from a few rare cases, are no longer exercised. This is determined by changed conditions in land use (abandonment of traditional agriculture) and in socioeconomic development (rural depopulation), which are divergent from the motivations for realizing these structures. Nevertheless, the contrasting action against phenomena of hydrogeological destabilization and the strong connotation that terraced systems and drystone walls give to places keep current their importance and are amongst the reasons for their preservation. These works are a recognition element by the local population due to the work done by previous generations, giving terraced landscapes a sense of identity and historical memory. In the context of the 7 islands of the Tuscan Archipelago, from inland to coastal areas, dry-stone walls represent an extensive cultural heritage in a significant state of structural and cultivation abandonment. In this sense, the multifunctionality recognized to surviving terraced systems needs to be safeguarded through field surveys aimed at providing a typological characterization of the walls present and, in addition, indications for possible recovery interventions.

Objectives

Starting from a preliminary quantitative analysis of terraced landscapes, a qualitative characterization of the most significant realities on the archipelago's territory was carried out in terms of both density of artifacts and public interest (proximity to public roads, areas of high frequentation, etc.). These sample areas have been analyzed by studying the dimensional parameters, hydraulic layout, accessibility, conservation status and spatial organization of the constituent elements. After locating the most significant areas, a survey sheet was prepared using a dedicated smartphone application for the point survey of the mapped sites. This form was necessary to simplify and standardize field operations of data collection. The in-situ survey was also supplemented by applying photogrammetric techniques conducted with UAVs.

Main findings, results, and indications of the proposed work

Analyzing the database derived from survey sheets of the sample areas provided a general picture of the constructive, functional aspects and state of conservation of the Tuscan Archipelagos dry-stone masonry heritage.



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The terraced areas classification showed a considerable structural and typological variability of the artifacts present in the 7 islands of the Archipelago; dimensions were found to vary significantly depending on physical factors, such as slope gradient, size, shape, lithology of the stone elements that constitute the wall. The various types of drystone masonry that can be identified find complete expression in the structuring of true complex systems, in which the types of works and their structural relationships define the identities of places. A variety of construction and management techniques has been found, the result of different knowledge, mainly hydraulic and agronomic, evolved in harmony with the characteristics of the territory.

Analyzing the state of conservation, it appears that there are strong differences even between neighboring fields in the same area: on one side farmers and virtuous private individuals who maintain the terraces, on the other side, abandoned public and/or private areas where the decay of dry-stone walls produces a fragmentation of the landscape continuity and originates, especially near settlements and public roads, non-negligible potential danger situations. In recognition of this, technical indications are proposed for the restoration of degraded structures in areas identified as requiring priority interventions. All this is done following the typical characteristics of the places and the related legislation in effect.

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KEY WORDS (MAX 4): DRY STONE WALLS, FEATURES ANALYSIS, STATE OF CONSERVATION, LAND ABANDONMENT



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FORM FOR ABSTRACTS PRESENTATION

TITLE: Visibility analysis in wetland protection processes

SESSION: Geography, Tourism and Landscape of the coastal areas. Enhancement, safeguarding and dynamics of the territory.

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ABSTRACT:

Wetlands as areas of high naturalness exhibit a high biodiversity value; these areas are not only crucial for the survival of a high number of animal and plant species but they are also strategic to support the migratory routes of aquatic bird species (UNESCO, 1971).

In order to preserve their biological diversity, there are various protection regimes for these areas such as Ramsar sites, parks, reserves, SCI and SPA sites. The establishment of protected areas regulates human activity and establishes a land use compatible with nature conservation to prevent the animal and plant species loss. The environmental and ecosystem values are maintained by monitoring the quality of water bodies, the conservation of habitat and species of community interest through standardized methods. This approach is essential to guide conservation measures.



Figure 1. View of Pantano Morghella, Pachino, SR

However, protective regimes sometimes prove to be insufficient in effectively reducing anthropogenic pressures on wetlands among which the coastal ones are the most vulnerable, primarily threatened by the widespread urbanization and coastal erosion. Outside the boundaries of protected areas, intensive agricultural areas, infrastructure, urban settlements, industrial sites and landfills become landscape detractors of wetlands to various degrees. The introduction of perceptual analysis within wetland conservation processes can guarantee the protection of the landscape value. This analysis has been applied to the case study of the southeastern Sicilian wetlands, whose landscape value is highly threatened by their proximity to highly urbanized areas. The methodology of perceptive analysis, standardized and adaptable to individual territorial realities, proposed in this contribution, uses GIS tools in order to create intervisibility



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maps between wetlands and surrounding landscape components. The intervisibility maps measure how much a portion of land is visible from previously identified points, thus highlighting both visual and nonvisual existing interactions. Considering the variability of the size of the water bodies, whose dimensions are subject to seasonal variations, in order to cover all possible observation points a method of discretization from the wetlands has been proposed to define the final viewshed of any wetland. The result of this process provides a single-band raster where each pixel value is assigned a specific color. Each color gradation, and each value as well, indicates the recurrence of the event, i.e. how many points are perceptible on the surface of the discretized wetland area from a specific point in the surrounding territory.

The proposed methodology not only provides an assessment of the quality of the observed landscape and the size of the perceptive basin but also, in relation to the land use map and the presence of landscape detractors, it aims to identify critical perceptions and so proper interventions and requirements to regulate the use of land in the surrounding areas in order to preserve the landscape value of wetlands.

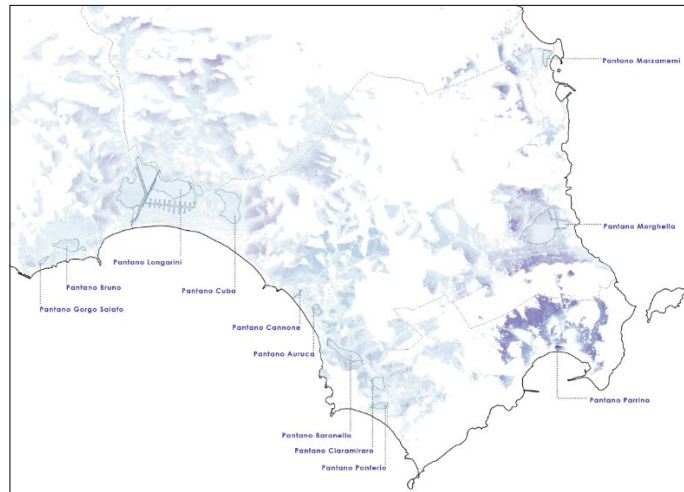


Figure 2. Intervisibility map of the wetland system of south-eastern Sicily

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KEY WORDS: (MAX 4)

1. Protected Natural Areas
2. Anthropogenic and natural landscapes
3. Sustainability of marine and coastal ecosystems



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FORM FOR ABSTRACTS PRESENTATION

TITLE: FROM A LOVELY COAST TO A DESIGNATED BATHING BEACH: STEPS, CHALLENGES, LEGISLATIVE FRAMEWORK

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS

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Offering good quality bathing beaches to the public is a necessity faced by Local and Tourist Authorities of coastal areas. Recreation by the sea or inland waters offers multiple benefits to local communities: health, physical and social activities, the local economy through the attraction of tourists. Designated beaches have become coastal areas historically used at the time when the then European Union established the first Bathing Water Directive, in 1976, demanding monitoring of bathing recreational areas. At the time the majority were not far from urban areas and holiday resorts. The increase of population in the coastal zone, the areal expansion of cities, the increased availability of transportation, the rapid increase in tourist visits (the most fast expanding and profitable economic sector in many countries), the improvement of the standards of living allowed people to travel farther away in pursuit of a coast to swim. These days a multitude of coasts used for recreational purposes are not designated beaches. The potential benefits of their inclusion as designated bathing waters is substantial, because the regular microbiological monitoring safeguards public health. Additionally designated, monitored beaches become visible to international tourists through the relevant sites (i.e. European Environment Agency - Yearly publication of the State of Bathing Waters). This produces an emerging need for new monitored beaches.

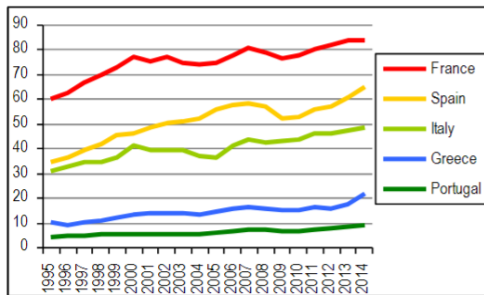
The objective of this presentation is to set the framework of action necessary to transform a coastal recreation area to a designated bathing beach, suited for use with no health concerns. In this systematic, analytical, step by step Coastal Zone Management approach, we guide and support the competent authorities (Local authorities, Tourist Boards, Public Health officials, owners and operators of recreational beaches) to design and develop a new bathing beach in a correct manner, adhering to current safety and sanitary requirements, with the least inconvenience and delays. We start from the issue identification and conclude with the final implementation.

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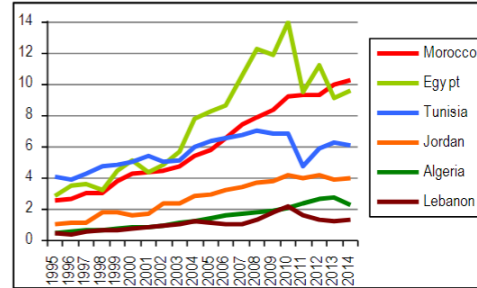
The assessment criteria for a prospective bathing beach are presented, analyzed and discussed: location, swimmer loads, microbiological water quality, sanitary surveys, location and identification of potential sources of contamination, anticipated developments that might cause pollution, safety requirements, access roads, car parking, potable water supplies, wastewater disposal, watershed characteristics, electrical and telephone services, availability of facilities such as toilets, showers, waste bins, signage, safety equipment, beach water slopes, depth of the water, bottom material, beach material, water level variations, boat traffic, marinas, fishing activity and much more. The legal framework is presented in representative countries of the Mediterranean. The standards set by the European Union, the World Health Organisation, other international bodies and non-European Mediterranean countries are compared and discussed.

International Tourist Arrivals in the Mediterranean
Selected advanced economy destinations Europe (million)



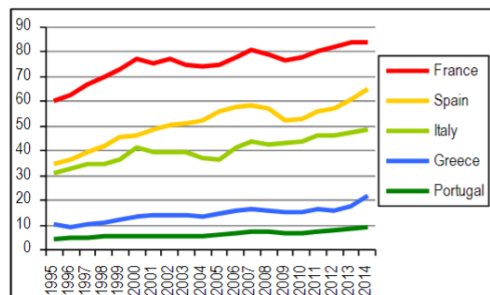
Source: World Tourism Organization (UNWTO) ©

International Tourist Arrivals in the Mediterranean
Selected MENA destinations (million)



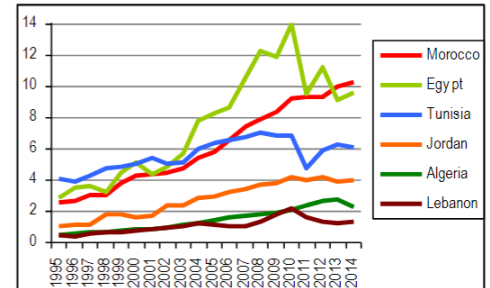
Source: World Tourism Organization (UNWTO) ©

International Tourist Arrivals in the Mediterranean
Selected advanced economy destinations Europe (million)



Source: World Tourism Organization (UNWTO) ©

International Tourist Arrivals in the Mediterranean
Selected MENA destinations (million)



Source: World Tourism Organization (UNWTO) ©

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KEY WORDS: RECREATIONAL BEACHES, DESIGNATED BATHING WATERS

POSTER PRESENTATIONS



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: EVALUATING THE INFLUENCE OF SUSTAINABLE TOURISM (3S) ON THE COASTAL AREA WITHIN THE FRAMEWORK OF ICZM THROUGH THE LENS OF SUSTAINABLE DEVELOPMENT IN THE COASTAL REGION OF NORTH CYPRUS

SESSION: SUSTAINABILITY OF COASTAL AREA

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Abstract:

This paper aims to investigate the impact of tourism on the coastal areas in view of ICZM approaches to sustainable conserving the coastal areas in North Cyprus. The state of integrated coastal zone management (ICZM), is justified as a strategy for managing coastal resources concerning increasing pressures from tourism, farming, climate change, urbanization, population growth, etc. In the case of island states, the impact of 3S tourism is the use of coastal areas as commons, and ICZM as a governance strategy has been established for a long time; however, the implementation of ICZM has remained a challenge due to the forces of global mass tourism and unsustainable resource use in island states. This study will focus on views of the coastal communities in North Cyprus, which are in constant interaction with coastal ecosystems for their livelihood. Moreover, the communities are sources of knowledge concerning ICZM and its implementation, and they are the main actors in the creation of institutions for collaboration towards the collective action that is essential for the implementation of ICZM (Ostrom, 2000, 2009).

There are some gaps in the earlier literature that do not incorporate the local social structures, values, and environmental capacities of communities in the context of a larger socio-ecological system also, fewer have questioned how these connections may affect a society that adapts to tourism development, and the end, with the continuation of human migration towards coastal zones and the growing trend of coastal tourism, sustainability of coastal areas has become a complex and task.

It is inevitable, that populations in the place are increasing yearly, and the place has attracted many investors, using the Island as a second home.

For the analytical purposes will use quantitative and qualitative approaches to find out the view of some nation's communities who lived in the coastal line. survey questionnaires were administered along the coastal areas. Data analysis will be conducted using descriptive statistical analysis with a post hoc test. Socio-ecological systems (SES) and Ostrom's collective action principles guided the study as the main theoretical framework. The study revealed that if the Island approach to the ICZM strategy which has been neglected according to the view of coastal communities, then will lead to protection of those areas. Furthermore, the study revealed that tourism development has been the major activity of the Anthropocene in coastal areas without a proactive coastal development strategy that is supposed to consider the vulnerability of coastal ecosystems, it should be remarkable that tourism is the mainstay and significant contributed to the income of this Island.

1. Introduction

During 2012& 2019, Dahl and his colleagues highlighted the most productive yet highly threatened ecosystems in the world. The world's coastal zones represent some of the most diverse and productive ecological and social systems. About two-thirds of the world's population lives within 60 km of the coast (UN Atlas of the Oceans: Subtopic, n.d.). Gerhartz Abraham et al. (2016, p. 69), highlighted that 'as a result of a burgeoning population, human activities such as fishing, aquaculture, oil and gas exploitation, tourism, agriculture, coastal development, and shipping continue to put considerable pressure on the world's ocean and coastal environment'.



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The coastal environments that communities in various coastal locations face are influenced by factors such as tourism, population expansion, erosion, climate change, and general development. However, in the case of island states, where tourism is the main source of income, it puts additional strain on the few available coastal areas and the local populations. "The economic and social activities in the island states tend to be concentrated in coastal areas and there is a high degree of interconnectivity between the political, social, cultural, environmental, and economic spheres, in addition to their limited resources" (Nesticà & Maselli, 2020, p. 1).

Since these communities are the first to be affected by tourism-related changes in coastal ecosystems, it is critical to learn about their perspectives and the difficulties they encounter in order to help facilitate a potential integration and peaceful coexistence between anthropogenic activities and community survival. Consequently, before it's too late, strategies to assist coastal change governance in the framework of ICZM and group action are essential (Adger, 2009; Raemaekers & Sowman, 2015).

The immediate benefits of mass tourism, particularly 3S (sun, sea, and sand) tourism Honey & Krantz, 2007 which depends on coastal areas, have, however, compromised the area's long-term management and protection in a number of locations, particularly island states (Alipour et al., 2017; Dodds, 2007; Lazzari et al., 2021; Wright et al., 2019). Alternative tourism, which "improves local conditions be it environmental, cultural, or socio-economic," has been overlooked as mass tourism has received attention despite its demonstrable detrimental effects (Conway & Timms, 2010, p. 331). Urbanization along the shore has also increased the strain on coastal ecosystems.

There are 23 megacities having a population of more than 10 million people worldwide. 16 of them are located along the coast (Wright et al., 2019, p. 86). As the most popular type of mass tourism worldwide, coastal tourism places a variety of pressures on coastal zones, including lodging, hotels, condos, transportation, cruise ships, and various forms of pollution. These pressures are reminiscent of Davenport and Davenport's (2006) earlier claim that tourism is currently the largest single economic sector in the world. The effects of tourism and leisure travel on the coastal environment have grown significantly (and are expected to do so in the future) in a non-linear manner that is very challenging to control or regulate (Wright et al., 2019, pp. 94–95).

Partelow & his colleagues in 2018, and Sole and his colleagues in 2019, argued that the establishment of coastal regions as socio-ecological systems (SEs) in the context of the Anthropocene is well-established (Partelow et al., 2018; Solé & Ariza, 2019). "The Anthropocene argument is supported by the existence of climate change, among many other attributes of environmental change and degradation on an unprecedented scale" (Spector & Higham, 2019, p. 1).

Meanwhile, where the future of the community is concerned, the harmonious coexistence and balanced utility of SEs are essential to the long-term viability of tourism. It is impossible to separate the dynamism of people and habitat from "SEs as an interdependent and co-evolutionary process, in which social and ecological domains are linked by ecological knowledge, governance arrangements, and ecosystem services" (Andrachuk & Armitage, 2015, p. 2). Integrated coastal zone management (ICZM), another name for coastal zone management, was created as part of Agenda 21 in the 1960s to teach countries how to preserve and manage their coastal areas sustainably (Sorensen, 2002).

The effectiveness of ICZM in reducing the negative effects of 3S tourism in North Cyprus is debatable because the main resources in the region are its coastal areas, which are particularly vulnerable to both the risks and the negative effects of mass tourism. The communities that regularly engage within these resource categories were the main focus of this work.

Ostrom in 2000 & 2009, mentioned that it is presumed that the communities that are being targeted are knowledgeable sources about ICZM and its application. In addition, they are the main players in the construction of institutions that foster cooperation in the pursuit of collective action, which is essential to the implementation of ICZM. Ostrom (2000) and (2009). Consequently, it is worthwhile to invest in the growth of 3S tourism as well as other tourist segments that visit North Cyprus for other reasons but still use coastal region resources. Though much of the earlier literature does not take into account the local social structures, values, and environmental capacity of communities in the context of a wider socio-ecological system, tourism development has had an impact on the nearby communities and has been discussed in the literature. As a result, very few tourism studies have examined the complex relationships that exist between people and their surroundings, and even fewer have asked how these relationships might change as a society adjusts to tourism development, according to Movono et al. (2018, p. 452). Furthermore, the sustainability of coastal areas has become an increasingly difficult problem due to the ongoing migration of people towards coastal zones and the growing trend of coastal tourism. Consequently, in order to



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accomplish the aims of sustainability, every strategic endeavor must take into account the social, economic, institutional, biophysical, and legal components (Christie, 2005). Regrettably, effective measures have remained uncommon in the majority of communities that rely on coastal resources, even with the development of ICZM during the past few decades. By moving away from a narrow perspective on tourism development, we expect that this study will offer a new strategic direction for coastal tourism in general and island coastal management in particular in a vigorous and sustainable manner (Nordbø et al., 2014).

The main problem in the Island is its condition. The situation in the coastal zone area of the TRNC has been getting more and more touristic in recent years. This is because of the region's extraordinary reliance on the tourism sector, which has drawn many investors to an inefficient and dispersed method of increasing the consumption of natural resources. As a result, there is more competition for scarce resources, which can lead to conflict. However, TRNC also has a strong desire to preserve its natural resources because it is well-known for being a popular tourist destination with regard to environmental scenery, especially 3S tourism, which is extremely important to the government and the people of the region.

Thus, appropriation procedures to offer a policy, governance frameworks, and COM practices are required in the context of those ones. Additionally, all stakeholders, communities for coastal areas, and marine life must be involved. Locals felt that the distance between the coastline line's common resources and its inhabitants became wider by the day.

Furthermore, the nation's foundations in charge of ecological management are being scrutinized and examined for their lack of knowledge, lack of local community involvement in the planning and management of environmentally significant assets, and lack of public duty to preserve. Among many other factors, the dry season, urbanization, and land surrender are the main drivers of ecological problems.

North Cyprus struggles to balance economic growth with ecological quality; finding solutions to reach this goal necessitates careful planning, strategic thinking, and certain administrative processes, such as COM, which form the foundation of the ICZM.

The assets of the destinations may be severely jeopardized by issues that occur in coastal areas (also known as commons) as a result of numerous man-made and natural dangers. It takes effective steps to protect and repair coastal areas because of the natural riches and economic opportunities they offer. "Coastal Integrated Management" is the response to "Design Coastal Protection and Management."

2. The aim, objective, and research questions

This study looks into the situation in North Cyprus, where the coast is the primary resource and is extremely susceptible to the negative effects of mass tourism in addition to other dangers. We focused on a few towns for this study because they regularly interact with coastal resources and locations. Realizing that the targeted communities are potential sources of firsthand information on the condition of coastal regions, the potential for a framework of coastal governance, including ICZM, and how they may be implemented in relation to 3S tourism. In addition, they are the primary players in the development of unofficial institutions for cooperation in the direction of the group action required for the execution of ICZM or comparable frameworks (Ostrom, 2000, 2009). The paper following these objectives:

1. Identify the ICZM views the preservation or conservation of coastal habitats.
2. Determine the ICZM's stance on any planning pertaining to land and marine coastal zones.
3. Determine the effects that visitors have on coastal regions.

Deep reliance on the tourism sector in the TRNC led to the usage of coastal regions as the site of locational economic advantages from trade, transportation, defense, and food access. The environments along coastlines are very different from one another because, while every city has a unique biodiverse that is highly desirable in terms of cultural, historical, and economic significance, the island's natural beauty, flora, and fauna may be largely attributed to environmental preservation efforts. For developing the objectives of the paper, these research questions will support the objectives of this paper.

1. How does the application of ICZM for preserving and defending coastal ecosystems operate?
2. which strategy can be used to manage coastal areas on land and in the sea?
3. What effects does tourism have on coastal communities?



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North Cyprus and certain countries benefit greatly from tourism, but one of the main issues is the unplanned construction of resorts, hotels, and other tourism-related businesses along coastlines. This results in improper wastewater treatment and plastic pollution, which worsens the condition of the Mediterranean Sea.

Coastal policy development and implementation planning require a paradigm shift due to the significant economic impact of coastal tourism. In light of the growing pressure on beaches and the heightened hazards associated with natural catastrophes and climate change, this would allow coastal areas and their vacation destinations to flourish.

3.Coastal zone &Context of ICZM

3.1. Coastal zone

The area that separates land from sea is called a coast. Fluid dynamic processes primarily shape its geomorphology by acting upon an underlying, occasionally (partially) remnant morphological pattern. Morpho dynamics as a result entail intricate mutual adjustment of shapes and processes. The coast is therefore regarded as a morpho dynamic system (Augustinus ,2003).

A coastal zone is a constantly changing area where the land, sea, and land subsystems come together to form an ecosystem. Waves, tides, different water depths and sediment movement, as well as marine habitats like coral reefs, are what define the marine subsystem. The beach, foreshore, and naturally occurring coastal protection systems like dunes and mangroves are all part of the coastal subsystem. The land subsystem, which is close to the coast, is primarily defined by its topography, surface and ground water resources, wetlands, and built environments (Augustinus ,2003).

3.2. Context of ICZM

In order to prepare and implement a program for the conservation and sustainable development of coastal environments and resources, the International Coastal Zone Management (ICZM) process brings together various levels of government, the community, science, and management sectoral and public interests. In order to achieve and maintain the desired functional and/or quality levels of coastal systems, as well as to bring the costs associated with coastal hazards down to levels that are acceptable, the overall goal of ICZM is to improve the quality of life for the communities that depend on coastal resources and to provide for necessary development, particularly development that is dependent on the coast, while preserving the biological diversity and productivity of coastal ecosystems. (Pages 3-5 of Sorensen, 2002). The link between land and water (sea-land) interactions is depicted in Graph 3.1.

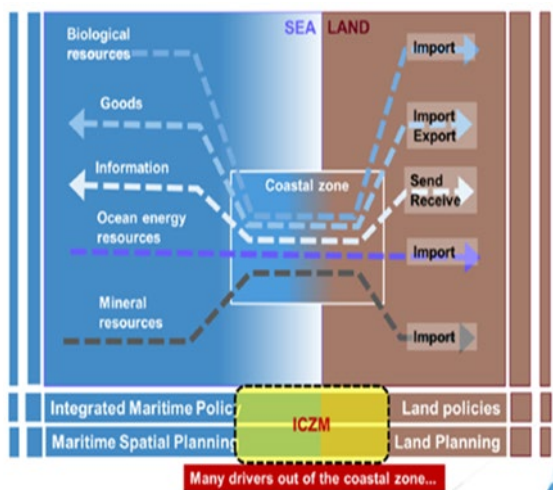


Figure 3.1: Land -sea and sea -Land interactions

Source: google.com/European commission 2017

3.3. Integration of Marine Protected Areas (MPA) and Coastal Zone Management (ICZM) in TRNC

The third-largest island in the Mediterranean Sea, TRNC, has stunning and distinctive scenery that is ideal for promoting coastal tourism. Coastal communities rely on coastal resources. Additionally, it appears that recent government regulations and public requests for lodging and recreational areas have sped up the growth of coastal tourism.



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The island's coastline zone boasts abundant species with significant ecological significance, 772 kilometers of sea cliffs that are incredibly rare, some rocky (pebble) beaches covering 54% of the substrate, 46% covered by sandy beaches, and several small bays.

Cyprus's coastal belt includes sand dunes, salt flats, salt lakes, salt marshes, and freshwater wetlands, despite certain portions being off limits. These are coastal zone cover features that are limited to twenty-two locations. (Et al., Hadjichambis, 2003).

Tourism activities have induced erosion over the past 22 years and have changed the shape of beaches (low & narrow), which are now a small supply of sediments due to damming construction.

The Mediterranean spans 3,900 km (2,400 mi) from east to west and has a maximum area of 1,600 km (990 mi) and 2,509,000 sq km (969,000 sq mi). Its coastline stretches 648 km (402.6 mi) in length, encompassing the Persian Gulf as well as the Aegean, Adriatic, Mediterranean, Black, Red, and Caspian seas.

Cypriots should keep in mind the distinctive features of their island when thinking about biodiversity conservation and research. They also should keep in mind the necessity of studying and safeguarding not only the species and habitats that are designated by European directives, but also the distinct species, subspecies, varieties, cultivars, and habitats that are specific to Cyprus.

According to a global perspective, Cyprus' assessment of biodiversity studies can help ensure that biodiversity is used sustainably throughout Europe. (Source: accessible on December 12, 2019). Therefore, coastal areas are rich and valuable and must be used to develop strategies and policies in order to achieve sustained ICZM.

4. The role of the coastal area and 3S tourism in the Island (TRNC)

A decline in coastal function may indicate increased dangers to coastal properties, the occurrence of flooding, or the dwindling of wildlife populations. The technique for ranking coastal impacts that are provided here aids in determining target areas for conservation as well as regions that have the highest likelihood of being restored. Also, Islands are merely fragments of a larger whole by nature. The size, seclusion, and vulnerability of islands to significant shocks have helped ecologists to understand their nature. In biogeographic studies, islands are frequently examined as groups or archipelagos; however, investigations of the effects of development are typically restricted to local scales due to national boundaries.

According to cited of Barbier & et al., 2011 and Kemp & Boynton, 2012), Significant studies on island ecology in the tropical Atlantic over the last 20 years have demonstrated the connection and integration of ecological function across land-sea barriers (Barbier et al., 2011, Kemp and Boynton, 2012).

Particularly in hot, dry areas with limited surface water supplies, coastal processes at the land-sea interface regulate sediment, nutrients, and runoff characteristics (Ray and McCormick-Ray, 2004). Changes in land use or physical modifications to the shoreline will have an effect on coastal processes, particularly on the nearby marine populations (Sealey, 2004). Ecosystem functions, especially shoreline stabilization, can be impacted by the loss of biological variety, beach erosion, and mangrove areas (see summary in Nagelkerken, 2009).

The importance of the coastline lies in the fact that it is the location where techniques for classification and evaluation were created, enabling a quick assessment of the biological richness, stability of the coast, and habitat quality of species. Using numerical scores for four impact categories and land plant surveys, a system of coastal ranking is offered to assess the intactness of the coastal ecosystem, which is closely linked to climate change. Thus, it is essential to preserve and safeguard the regions.

One of the primary elements that could significantly harm the beaches on small islands is 3S tourism. The foundation of the visitor experience is 3S tourism. According to Trauer & Ryan (2005), p. 482, "In fact, it is the creation and interpretation of images that are purchased, anticipated, and consumed by the 'experience hungry' tourists of the 21st century." Consequently, 3S tourism captures a significant amount of the experience that makes up TDI, which is composed of elements of a package (i.e., an experience) (Vainikka, 2013). In places like North Cyprus 3S tourism will continue to be the primary draw for travelers. Due to the concrete and intangible aspects of this specific attraction, it is necessary to comprehend visitor views in order to design travel destinations, manage coastal zones, address environmental issues, and implement protective measures (Garrod, 2008).

The Small Islands, with their pale sand, clean sea, and longer sun hours, may rival several well-known tropical tourist locations just by virtue of their 3S offer.

Also, it is one of the most popular tourist destinations due to its rich biodiversity and excellent environmental management; yearly tourism numbers there will have an impact on North Cyprus Island (Mestanza-Ramón & et.al., 2020).



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In addition, the national and local government bodies in charge of managing and promoting tourism should concentrate their efforts on enhancing the natural, cultural, gastronomic, and architectural aspects of the region, as their diversity is a potential resource for strengthening 3S tourism in the coastal zone. Here, highlighted tools like ICZM are needed to protect and conserve the areas (Mestanza-Ramón&et.al., 2020).

Lastly, in order to implement and strengthen this methodological paradigm and enhance upcoming comparisons and discussions, more research in 3S tourist locations is required, ideally in the tropics (Mestanza-Ramón&et.al., 2020).

5. Methodology

Taking into consideration the idea of coastal communities as a result of 3S tourism in TRNC, and also, describes the strategy and method used to support the goals and provides an answer to the main research question on the potential contribution of ICZM to sustainable tourism development and sustainable conservation of coastal areas.

The population of the area will inevitably grow each year, and many investors have chosen to use the island as a second home.

I'll employ both quantitative and qualitative methods for analysis in order to learn about the perspectives of some of the country's coastal towns. Surveys were conducted throughout the shore using questionnaires. Descriptive statistical analysis was used to analyze the data, along with a post hoc test.

6. Conclusion and expected findings

In light of ICZM approaches to sustainable coastal area conservation in North Cyprus, this study will look into the effects of 3Stourism on the coastal environments. For expanding the study, will use quantitative and qualitative approaches together. The expected results will demonstrate that mass tourism, on which this study only focused on three tourists, generally has an insignificant negative impact on coastal areas. Nevertheless, it is impossible to ignore the tourism sector because TRNC is heavily dependent on it; therefore, strong controls are needed to try and advance sustainable tourism while protecting the green space and our national treasure. The sole instrument available for assessing, monitoring, and managing the adverse effects of the tourism sector on the destination is ICZM.

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Tenth International Symposium

**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

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Key words (MAX 4): ICZM; COASTAL ECOSYSTEMS; 3S TOURISM; COMMUNITY;
NORTH CYPRUS



Tenth International Symposium

MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

THE MARANO LAGUNARE'S RIVA SAN VITO. A *BOULEVARD* BETWEEN LAND AND WATER.

SESSION:

GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

Those proposed are the results of a study done for the City of Marano. A masterplan that integrates a collaboration between University, Local Authority, and professionals to research and to build visions for the future, possible new spatial and functional axes for Marano Lagunare. A masterplan that starts from the project of transforming a significant place, a portion of the urban fabric, an overlook on the lagoon, which is a public and social space, but which is also a technical and working space, fishing, lying between the land and the water of the canal of Porto Marano: the Riva San Vito.

Marano Lagunare is a historic settlement, for centuries suspended between coast and lagoon, between millennia-old history and the everyday contemporaneity of lagoon sailors and fishermen.

The San Vito shore insists on an island whose conformation was consolidated only in the last two centuries. It was dry land, wetlands and *extramoenia* sandbanks. The bridge and Riva San Vito itself graft onto what used to be the "Porta del Mar," the oldest route to the sea.

Today the Riva San Vito is a ribbon of asphalt, location of flows, activities, and spaces that are not always defined, all of which face, on one side, toward the "Millenaria" tower, the bell tower on the Provveditori square, and on the other side toward the lagoon, the inland islands and salt marshes, and the beginning of the wildlife oases.





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Objectives

This is where the masterplan and its objectives start: the transformation and redefinition of the road space and the technical landing space, which today are simply side by side, toward a more articulated sequence, equipped and also open to other uses, given the location of the area in relation to the urban and landscape surroundings and the strategic value of the place. Thus, the project proposes a rearticulation of space toward successions of specific locations (viability, parking, services, landings, docks and moorings) and equipped with shared and hybrid locations, mixing strolling and working areas. In summary, the masterplan prefigures for the Saline district a new urban space that accommodates areas of work related to fishing and boat mooring (piers and technical spaces equipped for fishermen), venues for different flows, public spaces (green galleries, tree-lined squares, rest areas, water overlooks) and areas equipped for leisure and tourism (small architectures, pavilions serving new and old activities). Riva San Vito become a new "lagoonfront promenade," with an average cross-sectional width of 30-35 meters and with an extension of about one kilometer. It is a new promenade that we have named *Lagoon Boulevard*.



Main findings, results, and indications of the proposed work

Decoding the characters of the existing, framing the limits in context, identifying underutilized areas, giving definition to spaces, finding coherence between areas of different natures, sizing and measuring, coordinating new functions to old spaces and vice versa, delimiting and reopening, connecting, mending relationships and flows, but also disconnecting flawed links and practices, in short, finding the rules for a transformation over time of the inner parts of the urban fabric, and redefining relationships with other more established and historically-based parts were the themes of the master plan. If the plan aims to identify the rules of the game, transformations of space over time, and the architectural project must by statute give formal and material response to the now, the master plan stands in the middle, assuming the investigation, the analytical work, and the foreshadowing of transformation in an operational interpretive framework. Because the masterplan first and foremost is interpretation, and interpretation is already a design choice that operationally reorders analysis. That is why the master plan is perhaps one of the tools in which analysis and design are most integrated, precisely because of the interpretative dimension.

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KEY WORDS (MAX 4)

WATERFRONT; ARCHITECTURE IN THE COASTAL ENVIRONMENT; DESIGN OF PORT SETTLEMENTS; SUSTAINABLE TOURISM AND WATER SPORTS.



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Tourism territories 4.0. New opportunities for tourism revitalization of expanded coastal territories.

**SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS.
ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY**

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks

The tourism sector was dramatically affected in 2020 as countries around the world followed the confinement measures and travel bans to stop the spread of the COVID-19 pandemic. The worldwide decline in economic activity and travel began in the second half of March 2020. Air travel, as well as sea, road and rail travel, experienced a drastic drop in activity. At the same time, cruise ships were stranded at sea due to the closure of ports and borders to stop the spread of the disease. All regions of the world were affected. After Asia and the Pacific, the first to be impacted by COVID-19, Europe was the second most affected region, with a 66% drop in international tourist arrivals. During the summer of 2020, some countries in the Mediterranean region experienced a recovery in visitor numbers, while continuing to suffer health restrictions. However, tourists preferred to stay in their home countries and avoid air travel abroad. According to UNWTO estimates, before the 2020 pandemic, tourism should have grown by 3-4%, whereas it has declined considerably.

Objectives

The United Nations World Tourism Organisation (UNWTO) has outlined scenarios of what the industry can expect in the coming months, based on various estimates of the spread of COVID-19. However, a return to the pre-pandemic level of 2019 is not expected for three to four years. The first scenario predicts a recovery by mid-2023, the second by the end of 2024.

The only consistent trend in the near future is the recovery of tourism within European countries. Due to travel restrictions, border closures and airborne transmission risks, travellers favour intra-regional and domestic tourism. Indeed, OECD forecasts for 2021 show that domestic tourism is the backbone of the tourism industry, with 75 per cent of tourism expenditure coming from domestic travellers. Domestic tourism is the one that will drive the industry's recovery.

This situation has therefore led to a different rediscovery of our coastal and back-coast territories, as a different attention to the territory, not necessarily generating new mass tourism but the rediscovery of places close to home with a lot of potential. In the next few years there is an opportunity to re-launch certain territories in a synergic manner through strategic planning that focuses on the enhancement of excellence, so as to first capture domestic tourism and then stabilise with the contribution of foreign tourism as well.

Main findings, results, and indications of the proposed work



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The paper aims not so much to frame what has been done so far from the political point of view for the recovery of the tourism sector, but to represent, also through some case studies, the opportunity for joint strategic planning between different subjects, aimed at creating a planning of tourist territories, able to bring new economies to those places that had lost their attractiveness and to succeed above all in transforming or integrating the mass tourism of our coasts with more responsible tourism. In this perspective, synergic work between coastal and inland territories becomes fundamental for a new tourism planning capable of responding to both economic and cultural needs, as well as to the dilution of tourism pressures and the generation of new opportunities for residents. This research is part of a broader picture of how international 'dream cities' have evolved over the last 10 years and how coastal territories are attractive and distributive territories.

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KEY WORDS (MAX 4) DREAM CITY, COASTAL TOURISM, RESILI(G)ENT TERRITORY



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

The European Charter for Sustainable Tourism (ECST) as a model of best practices and participatory governance.
The case study of the Asinara National Park

SESSION:

Geography, Tourism and Landscape of the coastal areas. Enhancement, safeguarding and dynamics of the territory

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Climate change and strong anthropization are just examples of the many factors that contributed to the current global scenario, particularly impacting the delicate coastal Mediterranean context. Such considerations need the urgent implementation of targeted interventions simultaneously harmonized according to a unified logic. Among the objectives, safeguarding natural heritage and local reality is pivotal. Accordingly, the development of appropriate governance models is associated with biodiversity conservation; the related management is associated with integrated approaches and innovative financing mechanisms, translating into urgent actions. So, the aims are to achieve greater ecological coherence, strengthen systems for protecting environmental peculiarities, and ensure the sustainability of European natural and cultural heritage and its resources.

As the representative body of European protected areas, the EUROPARC Federation is the collective voice of all the natural and landscape realities. It aims at creating a stronger and more cohesive network capable of supporting its members and effectively addressing current and future challenges. In line with these objectives, the European Charter for Sustainable Tourism (ECST) meets the need for a shared governance model. It is a voluntary management tool as well as a certification that promotes the implementation of sustainable tourism for both the environment and local communities, as well as for all the stakeholders (e.g., firms, tourists); the principles of the ECST emerge as an essential guide for designing policies respecting the environment and actively involving the local community. The ECST provides three phases (i.e., Phase I, II, and III), each corresponding to a further step of the process. Phase I focuses on the certification of the protected area and is directly managed by the EUROPARC Federation; Phase II certifies local tourism enterprises operating in the relevant protected area; Phase III exclusively targets agencies and tour operators operating in destinations awarded the certificate during Phase I.

The present work focuses on the Asinara National Park (Porto Torres, Sardinia) as a case study of the ongoing application of the ECST. Specifically, the study will conduct a field investigation within a doctoral research project and aims to detect the ECST progress stages directly; actually, the Park is in the context of the renewal phase of Phase I and the initiation of applications related to Phase II. The objective is twofold: (1) to identify the strengths and weaknesses related to confirming Phase I; (2) to isolate the motivations leading a firm to obtain the ECST certificate. The research methodology involved analysing official documentation and data collection through a dedicated questionnaire about the Park's entrepreneurial landscape. The results suggested a systemic vision of stakeholder involvement in creating a model for best practices to qualify the socio-economic network. Promoting participatory and



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inclusive governance could ensure a balance between sustainable tourism and environmental conservation in the delicate Mediterranean coastal landscape and on the island of Asinara.

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KEY WORDS (MAX 4)

Protected Areas; Governance; European Charter for Sustainable Tourism, Stakeholder



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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FORM FOR ABSTRACTS PRESENTATION

TITLE: GAIOLA UNDERWATER PARK: SMALL-SCALE FISHERIES MONITORING AND MITIGATION OF ILLEGAL FISHING WITHIN THE FEAMP PROJECT

SESSION: Geography, Tourism and Landscape of the coastal areas. Enhancement, safeguarding and dynamics of the territory

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This work is conducted in the context of the FEAMP 2014-20 Misura 1.40 project, considering the whole coastal sector of the Municipality of Naples, with particular attention to the areas affected by the establishment of the Marine Protected Area (MPA) Gaiola Underwater Park and the Special Area of Conservation (SAC) IT8030041, Gaiola-Nisida Seabed. Despite the urban context in which it is located, this area is of extreme environmental interest (1), being characterized by a high seabed geomorphological complexity, that results in the presence of 15 different biological communities in a few hectares of sea, most notably the extensive Coralligenous biocenosis (2).

Alongside the analyzed coast, small-scale fisheries (SSF) are still active, with a fleet of about 29 boats, mostly located in the Mergellina harbour.

However, illegal fishing (IF) activities are also highly present, committed by unregistered and unlicensed boats, that often use illegal gear and methods, affecting available fish stocks and damaging both local SSF and the preservation of protected habitats.

Since 2015, in collaboration with the maritime police, the MPA is committed in a regular activity of monitoring, data-collection and mitigation regarding IF. This has brought to a significant reduction, about 97%, of IF in the MPA (3). Furthermore, since 2020, the application of the sustainable fruition model of the MPA has contributed also to the eradication of other anthropic disturbances in the area, connected to massive bathing activities and dispersion of waste at sea (4).

This work, edited by the MPA Gaiola Underwater Park, aims to investigate the local SSF sector and its relation to the areas adjacent to the MPA or SAC, also to evaluate possible positive effects on the SSF due to the safeguard activities and the eradication of IF in the MPA.

The objectives of this study are to collect data on the fishing effort of the local SSF fleet and on the size and distribution of the fish stocks in the Municipality.

From August to October 2023, 12 boats of the local SSF fleet were monitored, considering species, size and weight of the catch during the landing phases, the gear used, how long it was left at sea, the fishing area, the target species and the bycatches.

The boats participating in the project were given a GPS to collect information on the fishing area as accurately as possible. Moreover, information on the "health condition" of this ancient craft was collected through interviews to the fishermen and socio-demographic data-collection.

Simultaneously, monitoring and mitigation against IF have been implemented, through stakeouts in the most critical hours and the usage of the surveillance cameras that allow 24h data-collection.

The analysis shows that the most used fishing gear are: Gill Nets (GNS), Purse Seine Nets (LA), Trammel (GTR), Combined Nets (GTN) and Creels (FPO). In terms of number of individual fish and bycatch weight, FPO and GNS are the most selective gear. Regarding the diffusion of the different fishing activities, there is an uneven distribution along the coast. However, some areas are more frequented. This allows to divide the whole coastal sector into 5 fishing macro-areas. The distribution map (Fig. 1) shows a clear preference for areas near to the MPA (Gaiola-Posillipo), where more than 35% of the monitored fishing activities with all the gear analyzed have been detected. Catch data shows why the most preferred areas are those near to the MPA, since both total weight of caught species and diversity are higher compared to the other sectors (Fig. 2).

Moreover, the analysis on singular species shows that the areas away from the MPA display high undersized fish species percentages.

These results highlight a higher fish abundance, and so a higher productivity, in those protected areas and where IF is actively contrasted. In conclusion, since 2015 illegal fishing is declining in favour of SSF activities.



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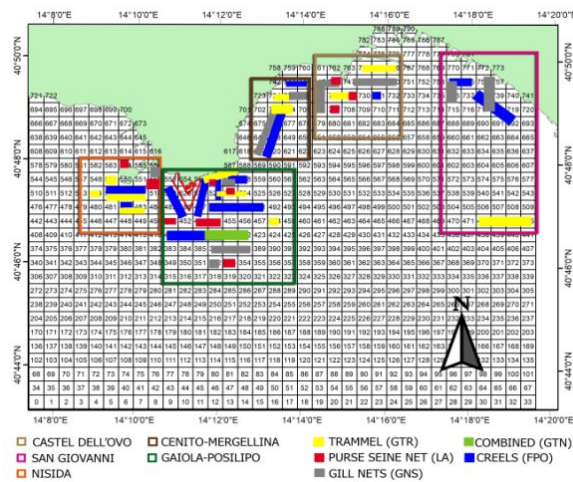


Figure 1

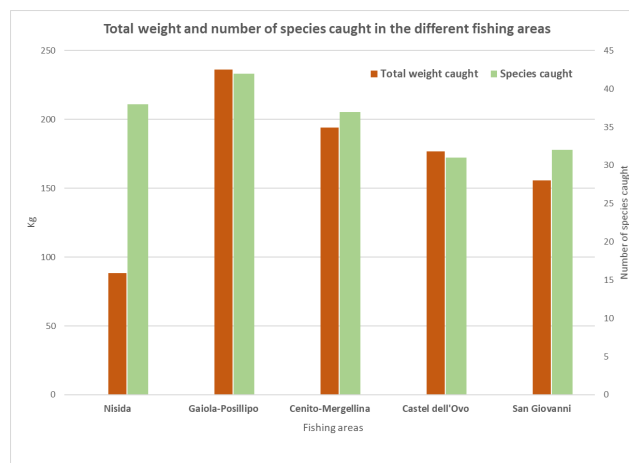


Figure 2

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KEY WORDS (MAX 4): Gaiola, Marine Protected Area, Small Scale Fisheries, Conservation



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: Economic valuation of coastal blue carbon stock's dynamics. An study in NW Spain using land cover transitions and InVEST

Session: Flora and fauna of coastal ecosystems: Protection, management, monitoring

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Abstract:

General frameworks

Blue carbon refers to the carbon (C) stored in marine ecosystems. Unlike in terrestrial ecosystems, sediment deposition in coastal habitats as seagrass, tidal salt marshes and mangroves does not saturate, it grows vertically with sea level rise (SLR) and can persist for millenia. Consequently, C sequestered in coastal ecosystems can be up to ten times greater than that in their terrestrial counterparts.[1]

Regulating CO₂ fluxes is a crucial ecosystem service (ES) for climate change adaptation and mitigation. Coastal Blue Carbon (CBC) habitats play a significant role in this ecosystem function by either capturing or emitting CO₂ into the atmosphere. The integrity of CBC pools is not only threatened by the physical impacts of climate change, but human-induced land use and land cover changes can also shift these highly efficient CO₂ sinks into sources.

Objectives

The economic valuation of ES is essential, not only to recognize the benefits derived from natural capital but also to provide valuable information to policymakers, aiding in decision-making and contributing to the conservation of nature and the mitigation of climate change. Utilizing the Simplified Marsh Response Model (SMRM), Sea Level Affecting Marshes Model (SLAMM) and Coastal Blue Carbon model within InVEST software, we conducted a case study of SLR impacts on Galician (NW Spain) salt marshes and their C pools.



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We aim to identify regions where marshes have either increased or decreased and are either sequestering or releasing C. We will assign an economic value to these dynamics pricing the tonne of emitted CO₂ according to the social cost of carbon. The Net Present Value (NPV) is determined as the sum, for each year of the time series, of the net sequestration (C captured minus emitted) in tCO₂e/ha, multiplied by the price of emitted ton for that year, and corrected by a discount rate of 3.5%. It's important to note that the model assesses net sequestration and not C stocks.

Main findings, results, and indications of the proposed work

LULC maps and other parameters are necessary to simulate the natural processes of C burial and CO₂ emissions. Including the initial C stocks stored in the marshes (1163.4 tCO₂e/ha)[2], the burial rate (6.17 tCO₂e/ha/year) [3], and a C half-life set to 7.5 years based on a literature review.

We find that the impact of SLR on marshes is greater than the variance introduced in the model by the uncertainty of our input data. In 2050, marshes lose about 20% of their previous surface which results in emissions of 25% of the C that would have been sequestered under a no climate change baseline scenario. The text also explored a sensitivity analysis on C accumulation rates using InVEST CBC model simulations. Variations in soil C stocks were observed between simulations with upper and lower limits of accumulation rate confidence intervals. The study aimed to verify if the impact of climate change exceeded the uncertainty introduced by this parameter. The InVEST CBC baseline scenario, projecting unchanged marshes until 2050, showed a sequestration of half a million tons. SSP2-4.5 and SSP5-8.5 scenarios stored approximately 0.37 million tons, indicating 0.13 million tons less CO₂e than the baseline due to SLR.

The main novelty of this study is the comparison of a widely used model to test SLR effects on CBC ecosystems, to a recently created and simpler model as SMRM while performing sensibility analysis to account for uncertainty introduced by parameters simulating the ecological and biophysical processes in marsh environments.

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: COASTAL LANDSCAPE AND “DISAPPEARING” TERRITORIES
SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY
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ABSTRACT: <i>The climate has always been a fundamental factor for tourism. The close relationship between climate and tourism is particularly evident in coastal tourism, mountain tourism, and nature tourism. Tourism is considered a highly climate-dependent activity, much like other essential economic sectors such as agriculture and transportation, to name a few. Additionally, tourism contributes to the production and emission of greenhouse gases through its various activities and requirements. Environmental conditions are a crucial resource for tourism. Changes and transformations resulting from environmental change generate a range of effects on tourist destinations. Direct effects are noticeable in the increase or decrease in tourist flows, depending on (un)favorable climatic conditions. These changes can impact the availability of water, loss of biodiversity, modification of landscapes, and alterations in agricultural production, which, in turn, affect aspects like food and wine tourism.</i> <i>Indirect impacts of climate on tourism include the exacerbation of erosion phenomena, leading to the disappearance of coastal areas and critical infrastructures related to tourist activities. There is also the threat of desertification, decreased water resources (resulting in a higher risk of fires), growing competition for alternative energy resources (resulting in increased costs for tourist services), and demographic surges of organisms like algae and jellyfish, which are difficult to reconcile with tourism. Moreover, the rising incidence of extreme events has an impact on tourist flows in the most affected areas. Out of growing concerns about issues such as global warming, loss of biodiversity, and the melting of glaciers, which threaten some of the planet's natural wonders, a form of tourism known as “Last Chance Tourism” (LCT) has gained popularity. This phenomenon involves travelers who visit threatened or vulnerable destinations, eager to experience unique and precious places before they are irreparably damaged or “disappear” due to climate change, environmental degradation, or other factors, such as disasters (Lemelin et al., 2011).</i> <i>This study aims to critically examine the implications of climate change for tourism in coastal areas. In the context of this discussion, the study's purpose is to explore LCT in detail in the literature, discussing it with the help of appropriate case studies related to Italian territories. The</i>



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study also aims to identify potential last-chance destinations, with a particular focus on coastal areas. To achieve this, we will conduct thorough literature searches and utilize online search tools with keywords such as “threatened places”. Visual techniques will also be employed to highlight territories at risk of disappearing.

Last chance tourism often highlights the need for sustainable and responsible travel practices. Efforts to mitigate the threats to these coastal landscapes in Italy include implementing conservation measures, regulating tourist numbers, and encouraging eco-friendly tourism practices. It’s crucial to balance the desire to experience these endangered destinations with the need to protect and preserve them for future generations.

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KEY WORDS (MAX 4): PRESERVATION; OVER-TOURISM; EXTINCTION; CASE STUDIES



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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: VULNERABILITY ANALYSES OF COASTAL TOURISM CAUSED BY SEA LEVEL RISE DUE TO CLIMATE CHANGE IN KUŞADASI, TÜRKİYE.

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coastal tourism is highly vulnerable to the impacts of climate change, particularly sea level rise, extreme weather events, and ocean acidification. These threats can damage coastal infrastructure, erode beaches, and degrade marine ecosystems, all of which can make coastal destinations less attractive to tourists. Kuşadası coastal area, located in the Aegean Sea of Turkey, is a dynamic and versatile coastal region characterized by its natural beauty, historical significance, urban development, and a combination of various economic activities. Although tourism and related industries dominate the economic landscape in the research area, other sectors such as agriculture and manufacturing also maintain their importance (Kuşadası Chamber of Commerce (KUTO), 2015). Among the numerous tourism assets in the study area, Ephesus Ancient City, one of the world's largest ancient cities, and the House of the Virgin Mary, a sacred site for Christians, have the highest potential to attract visitors. Ephesus Ancient City alone draws over 1.5 million tourists annually (Ministry of Culture and Tourism, İzmir Provincial Directorate of Culture and Tourism, 2023). Additionally, from 2011 to 2015, an average of 800.000 visitors per year visited the House of the Virgin Mary Nature and Culture Park (Selçuk Chamber of Commerce, Tourism Sector Report, 2016). The aim of the vulnerability analysis is to assess the potential impact of sea level rise, attributed to climate change, on coastal tourism in Kuşadası, Turkey. This study seeks to identify vulnerabilities within the coastal tourism sector and provide insights into potential risks, allowing for the development of adaptive strategies. In this research, the site location of the destination in Kusadasi was analyzed using the physical vulnerability index (PVI) approach. For the calculation of the total vulnerability score (TVS), nineteen parameters; coastal slope, relief, relative sea level change, shoreline erosion/accretion, mean tide range, mean wave height, landform, geomorphology, landuse/landcover, population, population density, population growth, tourist arrivals, road-transportation, cultural heritage, distance from/to coastline, tourism assets, leisure, and city amenities of destination were used in accordance with the method. After the data collected from different data sources were transferred into a geo-database, basic geographical information systems analyses were applied (reclass, buffer, subset, slope, overlay, classify, count, map



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algebra, etc.). TVS results have been presented as maps and tabular values using a scale of 1 (Very Low) to 5 (Very High). Thus, the vulnerability score of the destination was determined. Through the vulnerability analysis, a comprehensive assessment of the vulnerability of coastal tourism in Kuşadası to SLR was revealed, including; Vulnerability maps: Maps showing areas with very high, high, medium, low and very low vulnerability to SLR. Quantitative estimates of potential impacts: The potential impacts of SLR on tourism assets and values have been estimated. Adaptation strategy recommendations: Recommendations for adaptation strategies to minimize the impacts of SLR on the tourism sector have been developed, including infrastructure improvements, policy changes and capacity-building measures. The findings of the vulnerability analysis are expected to provide valuable information to policymakers, tourism stakeholders and local communities in Kuşadası to develop and implement effective adaptation strategies to ensure the resilience of coastal tourism in the face of climate change and sea level rise.

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KEY WORDS (MAX 4): COASTAL TOURISM, COASTAL VULNERABILITY, SEA LEVEL RISE



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

**TITLE: TOURISM TERRITORIAL RESILIENCE IN GALICIA (SPAIN).
EXPERIENCES AND POTENTIALITIES OF THE MUSEUMS OF THE SEA**

**Session: Geography, Tourism and Landscape of the coastal areas. Enhancement,
safeguarding and dynamics of the territory**

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Over time, museums have been responsible for different relevant educational functions, that we can sum up as collecting, preserving and sharing objects and traditions. Therefore, they have contributed to safeguarding and supporting the survival and development of communities and, most of all, they have been relevant to preserve local identity (Hein, 2005). This role has turned them into central endogenous paving the way to a proper territorial regeneration and cohesion. While performing these functions, museums have also nourished local narratives and discourses that communities recognized and assume as key strategies to promote their identity and territorial belonging (Bodo, Gibbs and Sani, 2009).

Recently, the availability of public funds for the sustainable development of fishing communities in Europe has enabled the implementation of numerous and diverse initiatives that are playing a relevant role in the reconsideration of the profession of fisherman (Piñeiro and Lois, 2019). No less important, all of these efforts help to recover the traditions and traditional knowledge linked to fishing. Among these initiatives, the creation of museums focused on the study of the sea and its environment as a means of life that determines those societies that focus their economic activity on tasks and trades of a maritime nature stands out.

Given these premises, the main objective of this proposal is to explore and define the social, cultural and economic dynamics that create and ensure the use and enhancement of Galician maritime heritage: the so-called Museums of the Sea. Our case study refers to the Spanish autonomous Community of Galicia. In this regional scale, we pretend to analyse how these cultural and economic initiatives recognize and reappropriate the legacy maritime and cultural to support local sustainable development strategies.

Regarding the methodology, we will introduce a comparative study based on field research among the Galician maritime museums. Our analysis will start from the first experiences at the beginning of the 20th century, supported by private companies or public administrations, to the latest initiatives at the local level, and with the support of funds from the Common Fisheries Policy (CFP), directly related to the valorisation of the Maritime cultural heritage as a tourist resource. We will point out the functions of each one of them, in order to clarify and explain their discourses and their management models. As a result, the role of these museums is evaluated both in the visibility and conservation of maritime heritage, as well as in improving the perception that fishermen have of their profession and their contribution to the culture of coastal communities. Finally, we reflect on the future directions of these initiatives in terms of success and territorial branding.

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**KEY WORDS (MAX 4) TOURISM RESILIENCE; MUSEUMS OF THE SEA; SUSTAINABLE
DEVELOPMENT OF FISHING COMMUNITIES; GALICIA**



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**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

**Combating coastal erosion in tourist territory: the case of Sant'Alessio Siculo (province of Messina)
(POSTER)**

**SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL
AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE
TERRITORY**

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

An estimated 60 percent of Sicily's 1,600 km of coastline is at risk of erosion. Effects not only of nature: according to a study conducted by Legambiente, coastal erosion is strongly influenced by land consumption attributable to unrestrained urbanization, with a massive presence of housing (mostly illegal), bathing and tourist establishments, industrial poles and, very widespread, waterfront roads and railway lines a few meters from the sea. Defense works (breakwaters and barriers) have also created an imbalance with the surrounding context, with loss of large volumes of beach. This profound cementification has altered the natural littoral dynamics with the risk that ongoing climate change will exacerbate the phenomenon.

Erosional phenomena can be divided into two categories: short-term coastal erosion, which is reversible in nature and usually produced by the transport of sediment offshore, associated with storm surges with seasonal periodicity; and long-term coastal erosion, which is normally due to imbalances in the sediment balance originating from littoral solid transport. Natural causes of coastal erosion Natural factors play by far the predominant role in coastal erosion, especially in the long term. The most important ones are winds and storms, currents near beaches, sea level rise, land subsidence, and the liquid and solid input of rivers to the sea. Coastal erosion, as the natural destructive action operated by the sea can be defined, is carried out through a series of processes that include the degradation operated by sea water on contact with rocks and sediments of the shorelines, the taking in of loose debris, the mechanical action associated with the impact of the wave on the coast, and the abrasion action exerted by the debris taken in by the waves and dragged to the bottom or hurled against the coast. The action of abrasion, in addition to contributing to erosion, also has the effect of progressively reducing the size of clasts (sedimentary rocks, so-called "pebbles") that are produced by erosion itself or brought to the sea by other morphological agents (rivers or glaciers).

Anthropogenic Causes of Coastal Erosion Human-induced ("anthropogenic") factors that fuel coastal erosion include the use of the coastal strip with the construction of infrastructure and works for residential, industrial and recreational settlements; land use and alteration of vegetation the extraction of water from the subsoil; the cleaning of the beach by mechanical or heavy means; the undermining and destruction of the dune; works for the regulation of watercourses, for the defense of the soil and for the same withdrawal of the resource for drinking, irrigation and industrial use; and the extraction of aggregates from rivers for use in construction. Such anthropogenic actions destabilize the complicated and delicate balances that preside over the constitution of beaches and their evolution. In summary, coastal erosion is the result of several anthropogenic factors: the intense anthropization of the coasts (with the construction of ports, housing, structures and infrastructures); the depletion of the solid material supply of the rivers caused by the massive extraction of material from the riverbeds and by the interventions of river regulation; and the defense interventions themselves: this is because, when planning and designing a coastal defense work, it would be necessary to take into account not only the effectiveness of the work itself in combating erosion, but also the effects that its presence may generate on the surrounding emerged and submerged environment.

The coastal area of Sant'Alessio Siculo, province of Messina (Sicily) constitutes an interesting case study in that it combines the relevant attractive perspective, inherent in tourism dynamics, with a frontier of coastal preservation and protection policies. Prominent among these is undoubtedly the substantial planning associated with the nourishment of the shoreline, which is plagued by erosive phenomena. The contribution, moving from a geographical approach, aims to restore the complex of dynamics present in the area.

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**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

KEY WORDS (MAX 4) COAST, TOURISM, EROSION, NOURISHMENT



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: FISHING TOURISM IN TUSCANY: CURRENT SITUATION AND FUTURE DEVELOPMENTS

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Professional fishing plays a crucial role in the development of the Tuscan economy. Currently, this sector involves more than 1500 people and 583 boats, producing around 11,000 tonnes/year of seafood products. Fishery in Tuscany is a multifaceted sector with solid cultural baseline that over the years has changed its own relationship with the sea. One of the major problems of this sector is the overexploitation of the resources (Murawski, 2000; Jackson, 2001), that may lead to irreversible changes in marine ecosystems (Pauly *et al.*, 2005) already degraded due to climate change, pollution and maritime activities.

In the last decade, fishermen and consumers have become aware of dangers that threaten the marine environment and in particular fish stocks. For this reason, fishermen and sector associations, assisted by fishery biologists, have decreased fishing effort and, at the same time, they invested in other activities to supplement their income.

Fishing tourism is a diversification of fishing activities and represent a sustainable activity for artisanal fishermen, combining environmental protection, maritime culture, an alternative profitability and, furthermore, a connection of fisheries with the world of tourism.

Fishing tourism is governed by national and local regulations, which describe in detail the characteristics of the boats or on-shore reception facilities, as well as the activities that can be carried out in full compliance with the safety of the guests.

Currently in Tuscany there are 47 active fishing tourism licenses distributed along the entire coast (including islands), mainly concentrated in the ports of Livorno and Viareggio. These are small-medium sized boats operating mainly with passive multi-purpose gear (gillnets and longlines) followed by trawlers. In the case of trawlers the law prohibits the use of the trawl net during fishing tourism and the activity takes place, almost exclusively, by taking tourists to fish with fishing rods. Boats with gillnets and longlines can use their equipment without restrictions, showing the fishing activity and having lunch on board, prepared with the fish caught..

Itti-tourism is a limited sector in Tuscany. Along the continental coast there are few companies that carry out this activity in which a fisherman's house is opened to guests to enjoy freshly caught fish and to spread the traditions of the local seafaring. On the islands of the Tuscan Archipelago, this activity is more developed but still with rather low numbers.

In this work, we present the case study of Viareggio. In the Viareggio seafaring, according to the declarations provided by the Port Authority, there are 8 boats dedicated to fishing tourism: 5 small-scale fishing boats and 3 trawlers. Furthermore, in Viareggio, from June 2023, there is an ittiobar which offers tastings of raw fish prepared with the catch supplied by local boats and where the fishermen take turns welcoming guests.



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From interviews carried out with fishermen, it can be seen that fishing tourism is considered an important activity capable of contributing to reducing fishing effort without compromising income and creating new opportunities and networks.

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KEY WORDS (MAX 4): ECOTOURISM, FISHERY, TUSCANY



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: SUSTAINABLE DEVELOPMENT IN VULNERABLE COASTAL ZONES: THE CASE OF ABRUZZO

SESSION: GEOGRAFIA, TURISMO E PAESAGGIO DELLA FASCIA COSTIERA: VALORIZZAZIONE, SALVAGUARDIA E DINAMICHE DEL TERRITORIO E TUTELA INTEGRATA

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coastal areas are one of the most complex and vulnerable nature environments. They play a strategic role in socio-economic and environmental context. Good climate conditions together with greater accessibility to technological and transport services certainly influenced the highest population density, that characterize these areas worldwide. This fact is more evident in a country like Italy, in which the morphological aspect takes on a leading role in the geography of urban settlements [1]. For these reasons, these areas are more subject to pollution and habitat loss. In addition, climate change makes them extremely prone to be vulnerable with a resulting high risk for the population who lives in those places. The study area of this work is the Abruzzo coast, specifically the 1km coastal belt has been considered. The work wants to show the urban transformation in the last decades and if these transformations can be justified by economical and demographic drivers. Another important objective is to understand the urban perspective of these areas. For these aims the PTM of the coastal municipalities has been settled. PTM means “planning tool mosaic”, it indicates the mosaicking of urban planning tool using a standardized legend. The designing of the PTM it is not easy, in fact it required the retrieval of plans at the institutional portals of the individual municipalities, the pre-elaboration (digitization, georeferencing, elaboration of the union framework) and the reclassification according to the homogeneous territorial zones defined by D.M. 2 April 1968, n.1444 [2]. One of the strengths point of PTM is that it allows to have a strategic view of the future potential transformation of these territories. In Italy municipal plans define the perspectives of the territories but in almost of the cases they do not consider what happen in the neighboring municipalities, and it is not uncommon to find opposite management policies regarding adjacent territories in which the only separation is the administrative border. Continuing to manage territories by referring only to administrative boundaries is a strong limit that deprives territories of their strategic potential. This work through the analysis of these tools aims to provide a deep understanding of the dynamics of the urban system and their redefinition in a sustainable way. A first result is to identify the areas with high environmental values (protected areas, agricultural soil ...), the second step is the definition of the degree of economic and demographic energy of each municipality. The contextual evaluation of these aspects makes it possible to identify if certain plans provisions are necessary and justifiable by socio-economic drivers. In this case, knowing the territory in their globality, allows to relocate plans areas in order to reduce the loss of certain ecosystem services such as crop production, water storage, carbon storage and sequestration. This kind of action following a detailed and comprehensive study of such a rich but vulnerable territory is extremely important to set up sustainable development scenario.



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KEY WORDS (MAX 4) *HUMAN AND NATURAL LANDSCAPE, SUSTAINABILITY OF COASTAL ECOSYSTEMS, URBAN PLANNING.*



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Coastal roads Atlas. Reshaping daily infrastructures for coastline adaptation

SESSION:

1. GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY
2. MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

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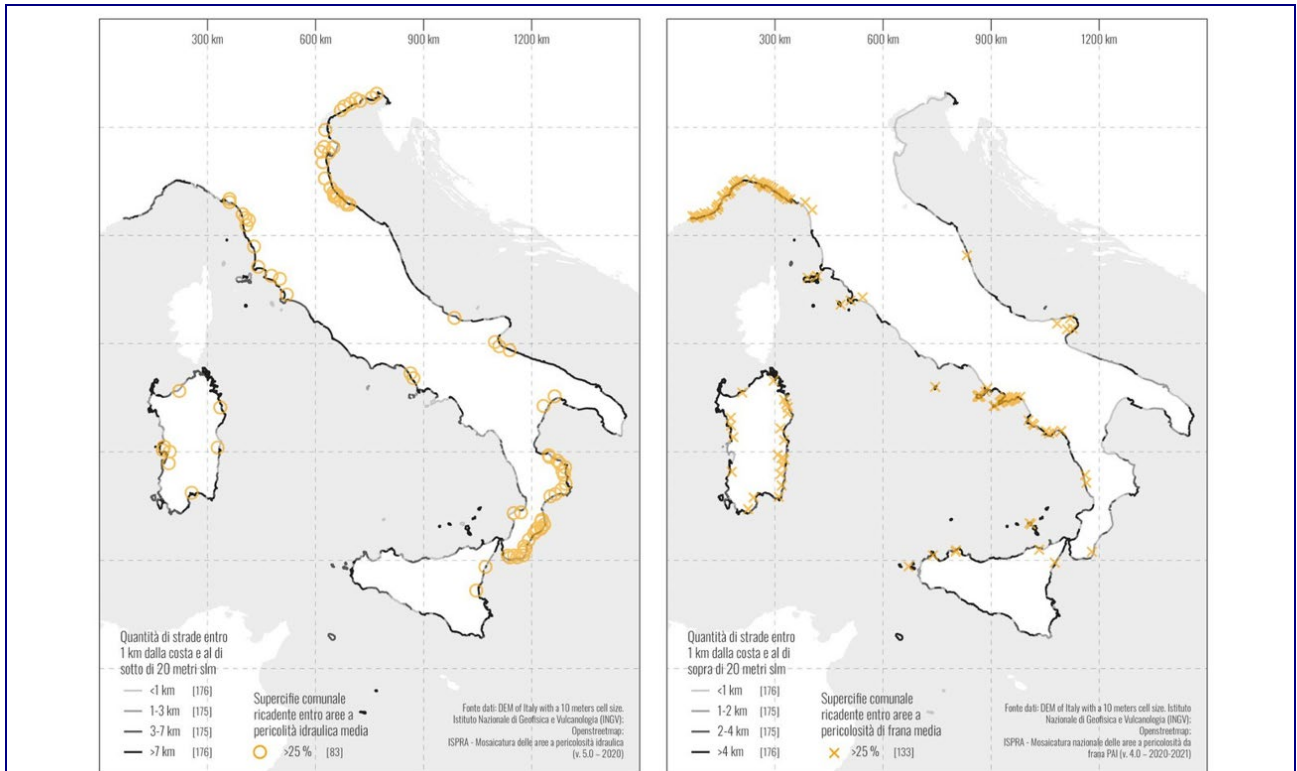
ABSTRACT:

The relationship between infrastructure, climate change and coastal territory can be regarded as one of the most important architectural themes for our peninsula. In the transition zones between inland areas and the sea, the interaction between anthropic and climatic pressures leads to conflicts in the balance between economic development, securing and environmental sustainability. The paper aims to set out the goals and initial outcomes of an ongoing research project supported by the REACT-EU FSE Program and led by the Department of Architecture and Urban Studies of the Politecnico di Milano in collaboration with Maudlab - PoliMi and Transform Transport. The research general topic focuses on road space as a crucial element for the socio-ecological transition of most fragile territories. By reinterpreting the streets, car parks and other contiguous open spaces, as a continuous artefact that characterizes the main background of our daily life, it is possible to pay attention to the quality and resilience of much of the territory crossed. This research hypothesis was tested in Italian coastal areas that are most vulnerable to anthropic pressure and to climate change phenomena. The fragilities and opportunities were analyzed within some significant buffers, including the coastal freeway and urban roads, which are crossed by different geomorphologic and settlement structures. The analyses are aimed at drawing up a trans-scalar Atlas, which relates Coastal roads to demographic, socioeconomic and environmental data, describing quantitative and qualitative aspects, showing criticalities and potentials in different national contexts. The Atlas of Coastal Roads is proposed as an operational tool useful for elaborating national-scale and place-specific interpretations, orienting stakeholders, policies, and projects toward systemic knowledge and actions, highlighting new scenarios. The methodology for the Atlas elaboration relates some coastal roads spatial dataset indicators with other demographic, socioeconomic and environmental indicators. The quantitative aspects, represents in a series of GIS national maps the aggregated indicators; the qualitative ones, through a bottom-up analysis on the case studies, looks closely at the morphologies of the roads, the land uses, the specific conditions. This methodology makes it possible to frame the national coastal system by aggregating phenomena that are often studied and viewed independently, to identify their interdependencies, and finally to assess the transformative and adaptive potential of the coastal everyday life infrastructures to contrast territorial fragility, abandonment, and marginalisation phenomena. The data collected and analysed from various national research institutes and public administrations are at the municipal scale and are represented within the Atlas, both at the national and local scale within certain focuses. The following table shows the main sources used to produce the maps.

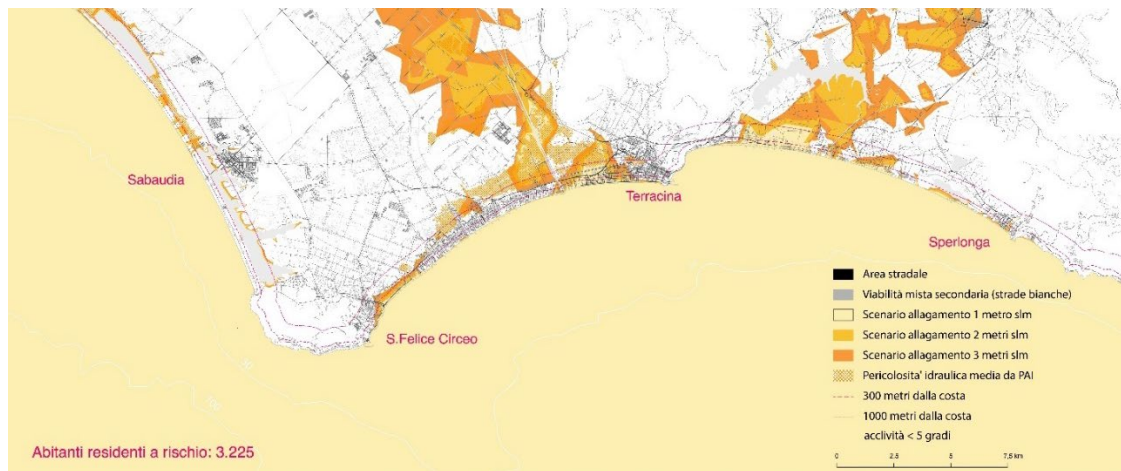


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Density of roads within 1 km from the coastline, below 20 msl and hydraulic hazard (left); Quantity of roads within 1 km from the coast above 20 msl and landslide danger (right). Lazio Focus (under). Road surface within the scenario of a sea rise of 1.2.3 m and with a terrain acclivity less than 5°, also related to medium hydraulic hazard (from PAI) and related to the inhabitants at risk involved in this focus.



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KEY WORDS: coastal roads, socio-ecological transition, atlas



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FORM FOR ABSTRACTS PRESENTATION

TITLE: HUB FOR WATER AND COASTAL MANAGERS: THE EXPERIENCE OF DELTAMED
SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): Deltas, lagoons and wetlands are home to an array of unique and delicate ecosystems, which are vital for both the environment and the communities residing around them. These regions confront escalating threats linked to climate change and human activities, such as saltwater intrusion, drought, and environmental degradation. The Mediterranean Delta Association (DELTAMED) was established in 2002 as a non-governmental, apolitical, and non-profit organization in response to the urgent imperative of addressing these intricate challenges, and is now at the forefront of efforts to understand, protect, and sustain these vital landscapes promoting sustainable development, and underscoring the critical importance of fostering a collaborative network among institutions and agencies responsible for managing these areas, as a dynamic international forum, facilitating in-depth analysis, discussion, and treatment of pressing issues afflicting critical ecosystems. DELTAMED's objectives include (i) the establishment and strengthen of an international network, engaging with institutions and academics into a hub for collaborative efforts, (ii) the accreditation and global engagement with European and global institutions, solidifying its role in Mediterranean environmental conservation and climate change response, (iii) research and study initiatives, prioritizing climate-related research and study activities, addressing challenges such as saltwater intrusion, drought management, water resource conservation, soil fertility, and ecosystem preservation, (iv) high-level training, developing initiatives for professionals within institutions, equipping them with the tools and knowledge to respond effectively to climate change challenges, (v) professional exchange and conferences, organizing initiatives to share



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knowledge and strategies among members and external stakeholders, (vi) promote twinning and partnership activities among organizations and institutions, enabling focused efforts on specific themes and projects.

Furthermore, the presentation will shed light on specific projects and partnerships that DELTAMED has embarked upon, showcasing successful case studies and innovative solutions for maintaining the ecological balance in these regions.

DELTAMED's innovative approach and dedication to sustainable development and environmental conservation in the Mediterranean region set it apart as a model for proactive change. This presentation invites to explore the association's invaluable contributions and gain insights into its strategic actions in addressing climate change impacts, thereby promoting collaborative actions that foster a resilient and sustainable future for deltas, lagoons, and related territories.

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KEY WORDS (MAX 4) DELTA, LAGOON, NETWORK, CLIMATE CHANGE



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ABSTRACT PRESENTATION

TITLE: ECOSYSTEM SERVICES AS SUPPORT TOOL OF URBAN PLANNING ACTIVITIES IN COASTAL AREAS

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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ABSTRACT:

In coastal areas, the increase in climatic and human pressures and the concession of natural capital translate into an excellence of biodiversity and ecosystem services. Therefore, the integrated and sustainable management of coastal areas represents a priority issue for public institutions and settled communities that requires careful evaluation of the interdependencies between the well-being of societies and the protection of ecosystems.

On the basis of these assumptions, the research activity, the first results of which are proposed, is oriented towards the definition of the “Blue Community” model: a model that looks at coastal areas as a place for experimenting with innovative planning strategies, aimed at integrated and sustainable management of the local urban-maritime and environmental heritage.

In order to support the definition of the model, the first phase of the research is aimed at building a solid theoretical framework of reference based on the critical analysis of the existing literature. For this purpose, the reference tool used is that of the Systematic Literature Review, correlated to a Cluster Analysis study, aimed at investigating in depth the elements of interrelation between the planning and design activities of coastal settlements and ecosystem services.

The application of rigorous literature extraction methods from the Scopus database, as well as correlation and co-occurrence techniques between the key words included in a bibliometric network composed of 757 scientific articles, has allowed us to obtain significant summary results that constitute the outpost for experimental research activity. In particular, the following 4 thematic clusters were statistically identified:

1. “*assessment methods of urban ecosystem service*”;
2. “*spatio-temporal analysis of land use and urban growth*”;
3. “*conservation of natural resource and environmental protection*”;
4. “*ecosystems in urban green spaces*”.

With reference to the first cluster, the analysis of the literature has revealed a growing interest in innovative methods of evaluating ecosystem services, which frequently clash with the lack of availability of data sampled at a detailed scale and necessary for traditional measurements, as well as with the request for huge resources for the collection of biophysical and economic data (Alam et al., 2016).

Land use and urban growth cause variations in vulnerability levels on a temporal and spatial scale (Liou et al., 2017) which is the subject of the second cluster. The evaluation of ecosystem services appears, in this context, as a useful reference for guiding soil transformations, guaranteeing the successful outcome of the planning and design processes of urban settlements.

The third cluster specifically concerns natural resource conservation and environmental protection activities, highlighting the need to integrate environmental considerations into urban planning, addressing challenges such as pollution and land degradation in an integrated way, balancing economic growth with sustainability and promoting social inclusion (Sopiana and Harahap, 2023).

Finally, the fourth cluster includes studies relating to urban green spaces, whose multifunctional character is integrated into the evaluation of urban ecosystem services (Charoenkit and Piyathamrongchai, 2019), proving useful to cope with



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growing urban pressures and to guarantee human well-being by guaranteeing regulatory, support, cultural and supply services.

The four aforementioned clusters, deduced from a deliberately vast and general bibliometric network, will be the subject of a specific in-depth content analysis in relation to coastal areas, aimed at exploring the reference parameters characterizing these contexts to be subsequently included in the definition of the Blue Community model.

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KEY WORDS:

1. coastal areas
2. ecosystem services
3. urban planning



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FORM FOR ABSTRACTS PRESENTATION

Title: Impact of Urbanization on Mediterranean Forest Ecosystems : A Case Study of the Suburban Forest of Mont of Bouzareah on the Algiers Coast (Algeria).

SESSION: GEOGRAPHY, TOURISM AND LANDSCAPE OF THE COASTAL AREAS. ENHANCEMENT, SAFEGUARDING AND DYNAMICS OF THE TERRITORY

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ABSTRACT :

The increasing urbanization poses a significant threat to Mediterranean forest ecosystems, with negative repercussions on biodiversity, air quality, water, and climate (Aguejdad, 2009). To illustrate this urban expansion, the suburban forest of Mont de Bouzareah, located in the coastal area of Algiers, 650 meters from the Mediterranean Sea, is characterized by precipitation not exceeding 580 mm/year. This pine forest, mainly composed of *Pinus halepensis* and adorned with various eucalyptus species, experiences a subhumid bioclimate with a warm variant. Since 1973, the growth of constructions has gradually restricted forest areas, sometimes legally, sometimes illicitly.

The main objective of this study is to examine the impacts of urban expansion on the Mont de Bouzareah forest. In 1973, it was initially believed that urbanization had only a negligible influence on the forest, as residences were only located to the north of the forest at that time. However, this perception has evolved over time. By 1984, ten years later, the growth of private residences had already expanded, further threatening the northern part of the forest (Figure 1).

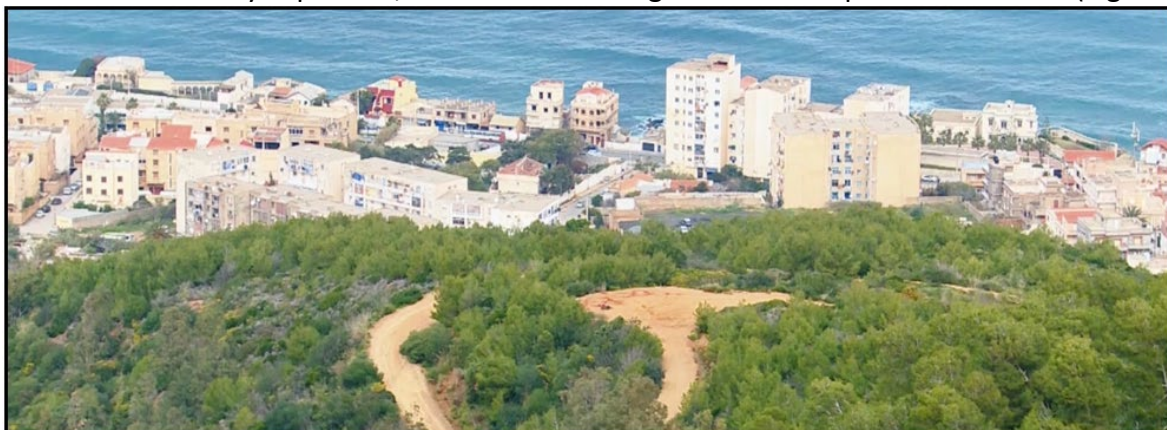


Figure 1: Extent of Urbanization in a Portion of the North Slope of the Bainem Forest
(Photo by Zanndouche Ouahid)



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In 2022, the risk of urbanization impact on the forest experienced a significant increase, rising from 1.33 km to 7.7 km for high risk, while the low risk, which was 9.5 km from the forest boundary in 1973, decreased to 1.25 km. The analysis of the urbanization risk dynamics in the Bainem Forest was made possible through the use of various tools such as aerial photographs from 1973 and 1984, Google Earth images, as well as satellite images from Landsat and Sentinel missions starting in the 2000s. According to Cornélis and Billen (2001), risk mapping requires a series of surveys on both hazards and vulnerabilities. The management and processing of this information are greatly facilitated by the use of computerized Geographic Information Systems (GIS). The integration of this data into GIS, facilitated by the use of the open-source software QGIS 3.4.9, allowed precise mapping of impacted areas and monitoring of urbanization risk evolution. Indeed, GIS has become an indispensable tool in understanding urban territories (Mineau, 2003).

The suburban forest of Mont de Bouzareah, on the urban fringe, sees the growth of private residences mainly expanding in marginal sloping areas or along the banks of the river. This dynamic urbanization continues to reduce spaces in close proximity to the forest. In 2009, the northern part of the Bainem Forest became extremely exposed, while the southern part began to be invaded by constructions. By 2022, the risks to the forest intensified along its west, north, and south boundaries. Only the eastern part remained relatively preserved, given its proximity to the June 19th Forest (Figure 2).

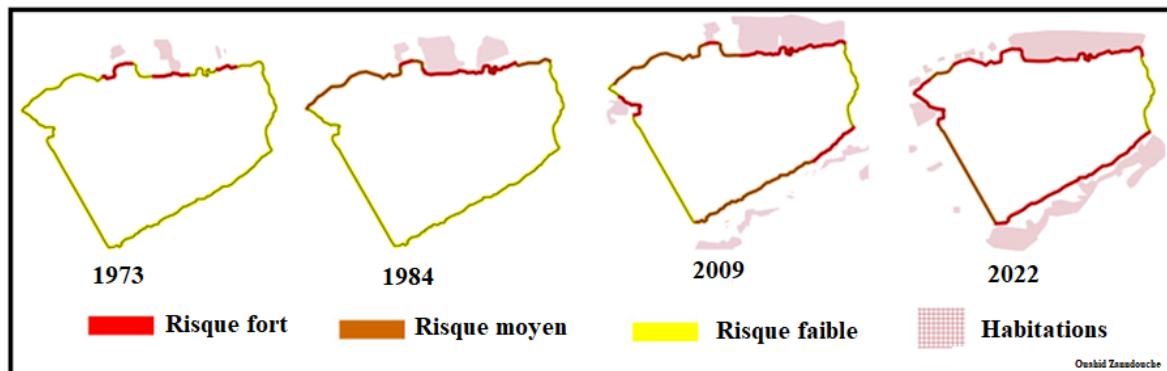


Figure 2 : Evolution of Urbanization Around the Bainem Forest

This study underscores the need for continuous monitoring of Mediterranean forests through modern technological tools. Preservation proposals for the Mont de Bouzareah forest encompass conservation measures, regulation of urbanization, rehabilitation of degraded areas, public awareness, and the implementation of local policies for sustainable land management. These combined actions aim to preserve this crucial natural heritage for the future, putting into perspective these spatiotemporal levels and updating regularly, which is key to effective forest management. This allows meeting the needs of urban populations while preserving the resource for future generations (Dellier, 2007).

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https://www.persee.fr/doc/bagf_0004-5322_2003_num_80_4_2356

Key words : Mont of Bouzareah, Mediterranean Forests, Urbanization, GIS (Geographic Information System)

SESSION

**UNDERWATER AND COASTAL
CULTURAL HERITAGE**

ORAL PRESENTATIONS



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Coastal archaeological evidence in the Bay of Naples: vulnerability and directions for conservation and enhancement

SESSION:

UNDERWATER AND COASTAL CULTURAL HERITAGE

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

There is no region in Italy and, perhaps, in the world that presents such a wealth of archaeological evidence, even underwater, as Campania and, in particular, along the coasts of the Bay of Naples: a site that includes all the territories bordering the gulfs of Naples and Pozzuoli, including the islands of Procida, Ischia and Capri.

It is precisely the extraordinariness of this richness that makes it a particularly complex case, bearing in mind that we are dealing with highly urbanised areas and, therefore, decidedly exposed to human action. We are faced with values of exceptional interest for the history of the civilisations that have succeeded one another in these territories, from the Greeks to the Romans, but also before, characterised, however, by great fragility and vulnerability, as they are exposed daily to damage, theft and tampering of all kinds by man, but also to the effects of natural events and calamities, such as the seismic and bradyseism events that have cyclically occurred throughout history and up to the present day.

Therefore, coastal archaeological evidence, even on an urban scale such as Pompeii, is an integral part of a palimpsest of artefact values in continuous transformation due to the combined action of nature and man, who intervene on them with actions that overlap over time, contributing to increasingly weakening the recognisability of these sites, which thus lose strength in the memory of the community and also risk their very perception. We witness, on the one hand, the alteration and loss of their spatial configuration caused by the intense exploitation of the coastline and, on the other, the continuous and incessant phenomenon of naturalisation of the ruins due to the dynamic action of coastal environmental conditioning; which, however, determine the charm of all the classical remains scattered along the Gulf of Naples coastline.



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It is evident how the conservation and valorisation of this archaeological heritage acquires a high level of complexity in relation to issues related to the perception and interpretation of pre-existences. Archaeological evidence in this context cannot only be understood as ruined material to be safeguarded for its documentary value, but active and integrated conservation and valorisation actions must make it possible to read these pre-existences as segments of histories to be recomposed and reconnected in the territorial context.

In the coastal area of the Bay of Naples, there have been a series of initiatives on this heritage, such as, for example, the establishment of the Submerged Park of Baia, significant for the recognition of identity and historical-documentary values, but lacking in the fragmentary nature of the interventions and the lack of similar resources with respect to the problems to be solved. Therefore, a new policy and a modern vision that aims at the creation of a true network, at national, regional and local level, for the protection, restoration, valorisation and enjoyment of local communities and national and international visitors is more urgent than ever.

This contribution attempts to outline the complex problems of the coastal archaeological areas, including underwater areas, in the Bay of Naples, starting from the definition of their consistency and varied typology and the phenomena of degradation that characterise them, to arrive at a definition of the risks to which they are exposed and to point out possible directions consistent with desirable urban regeneration processes: among these are the significant experiences of the submerged archaeological parks of Baia and Gaiola.

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KEY WORDS (MAX 4):

NAPLES BAY

ARCHAEOLOGICAL EVIDENCE

VALORISATION

CONSERVATION



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

COASTAL CULTURAL LANDSCAPES: ANALYSIS AND VISUALIZATION OF DATA.

SESSION: UNDERWATER AND COASTAL CULTURAL HERITAGE

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The theme of *tonnare* lends itself to a multiplicity of approaches and allows for the development of different research paths, all however integrated to form a single and extensive body of studies, intimately linked to the places where the factories were built. If, on the one hand, tuna fishing has recorded the transformations of land management and the evolution of socio-economic contexts and legal-administrative frameworks in the various historical periods, on the other, it has traced a continuous line of evolution of the civilization of the sea in a symbiotic relationship between man and nature. Moreover, the fact that this type of fishing was carried out between the coast and the sea has meant that many of the traces produced by men are still legible on the seabed in close symbiosis with the processing facilities on land. These aspects have suggested a new approach to the study of the signs, tools and contexts related to the *mattanza*, strongly interdisciplinary and supported by an active use of digital technologies for the production and management of information. The study currently underway along the coasts of south-eastern Sicily, born from the collaboration between the Federico II University, Stanford University, Brock University and the Soprintendenza del Mare della Regione Siciliana, intends to develop a research methodology focused on the analysis of spaces, both architectural and natural, in relation to the processes of use that have occurred over time.

The activities included an initial phase of three-dimensional digitization using laser scanners, Lidar from UAS and terrestrial and underwater photogrammetry of the *tonnare* of Capo Passero, Marzamemi and Vendicari, as well as the areas of Punta delle Formiche and Morghella in the municipality of Portopalo di Capo Passero. The data were processed and segmented to support the subsequent geospatial analysis activities of the models both within modelling software and within a GIS platform. The georeferenced models, in fact, provided an accurate representation of the built heritage, of the settlement traces along the coastline, of the submerged archaeological features, and of the geomorphologic characteristics of the area, which in the various epochs have conditioned the dynamics of landscape use, also in relation to the continuous transformation of the places due to natural and anthropic actions. These study phases have made it possible to correlate data relating to recent changes in the coastline, to the seabed in



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correspondence with archaeological targets, models of areas characterized by the presence of wrecks, ancient architectural structures and referable to more recent tuna fishing activity, providing matrices of interaction between the elements that make up the cultural landscape of this area of Sicily.

The models produced have also been optimized to support new forms of communication of scientific data, both through temporary exhibitions in the villages of Marzamemi and Portopalo, and through an innovative immersive installation project in the Magazzini and in the Tonnara Tower of Vendicari, in collaboration with the Riserva naturale orientata Oasi Faunistica of Vendicari.

Future research activities envisage an intensification of seabed survey activities for the production of an extended model of the seabed beyond the limits of the areas facing and close to the archaeological targets, and the optimization of the information processing and analysis workflow through the development of a sequence of tools using the *ModelBuilder* within the ArcGIS Pro platform, to support the study of more complex spatial interrelation patterns of the collected data.



Fig.1 3D Lidar drone survey of the Vendicari coastline





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Fig.2 View of a load of ballast from a wreck near the Vendicari coastline

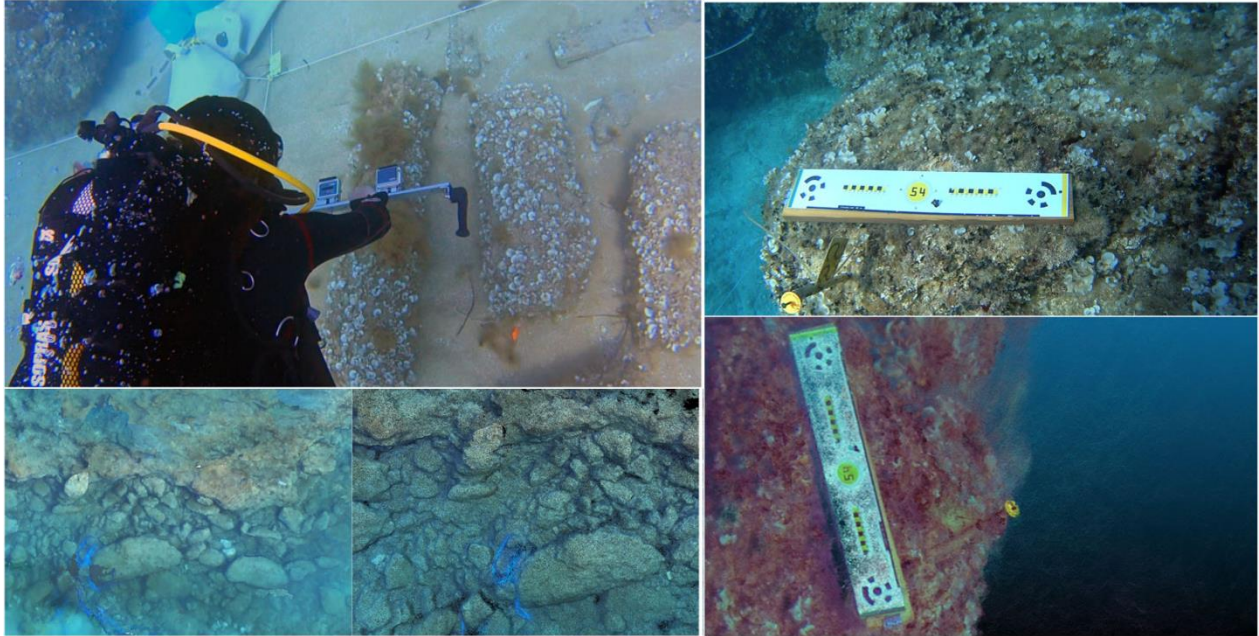


Fig.3 High-resolution underwater 3D survey phases of the Marzamemi II wreck using a stereophotogrammetric system



Fig.4 Digital model of the tower and tonnara of Vendicari



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Fig.5 Temporary exhibition at the Marzamemi village (Pachino)

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KEY WORDS (MAX 4)

DIGITAL SURVEY, DATA VISUALIZATION, UNDERWATER GEOARCHAEOLOGY,
CULTURAL LANDSCAPE



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Archaeological markers below the lagoon waters

SESSION:

UNDERWATER AND COASTAL CULTURAL HERITAGE

AUTHORS: COSTA ELISA¹, LUCARINI CARLOTTA^{1,2}

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coastal stretches are rich in archaeological evidence that testifies to the long-lasting interactions of ancient communities with the aquatic environment. These areas are vulnerable to different kinds of variations, which affect the environment and archaeological remains with increasing intensity. In order to study and understand these modifications, archaeological evidence in micro-tidal areas can provide significant information. Especially ancient coastal structures, such as maritime villas, piers, fish tanks, and building foundations, can be crucial. In particular, the analysis of submerged and semi-submerged archaeological contexts in lagoon waters can testify not only to the impact of anthropic modifications on the landscape but also to permit the establishment of significant archaeological markers of ongoing environmental changes.

The lagoon of Venice is a very at-risk ecosystem. It needs to be protected and monitored, not only from an ecological and environmental point of view but also from an archaeological one. Conducting underwater surveys and excavations in such a peculiar situation is not always easy, but modern technologies (multibeam, topographic survey, photogrammetry, DEM, etc.) permit to study, document, monitor, and analyse the archaeological context with a very high level of detail (Fig. 1).

From 2020 the team of Maritime Archaeology of Ca' Foscari University coordinated by Prof. Beltrame is working on the northern part of the Venice lagoon, focusing on some submerged sites of Roman times. An important part of the project is carried out in collaboration with geomorphologists of the University of Padova, to deeply analyse and reconstruct the paleo-environment of the lagoon and the relative sea level changes. The study has been conducted on the well-cistern in the San Felice channel, on the broken pier in Ca' Ballarin, and on a vivarium associated with other structures in Lio Piccolo (Fig. 2). We had the chance to document different markers: in the case of the cistern and piers, the foundation poles and structures are clear indicators of the level of buildings of the complex in Roman times, while in the case of the vivarium we had the chance to measure and document two different kind of markers. The basin with the oysters was originally realized underwater and the structure's foundation had to be built in dry conditions.

The impossibility of creating underwater museum trails or snorkelling tours in such a difficult situation makes it essential 3D models, interactive maps, WebGis, and virtual reality. GIS software, nowadays indispensable in the archaeological field, allows the management of the whole data for easier and more immediate consultation and visualisation, and the effective dissemination of the



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research results.

The comparison between different lagoonal landscapes and wet environments along the Adriatic Sea and the western Mediterranean is an additional factor to deeply analyse the anthropic settlements in Roman times.

Thanks to digital techniques, despite the difficulties of application in a lagoon context, it is possible to produce an entire overview of the underwater archaeological sites, which implies enormous advantages for its understanding and appreciation, in particular in this specific case, where a site is never completely visible. Furthermore, the use of these tools is crucial to monitoring the state of conservation and degradation of the archaeological sites.

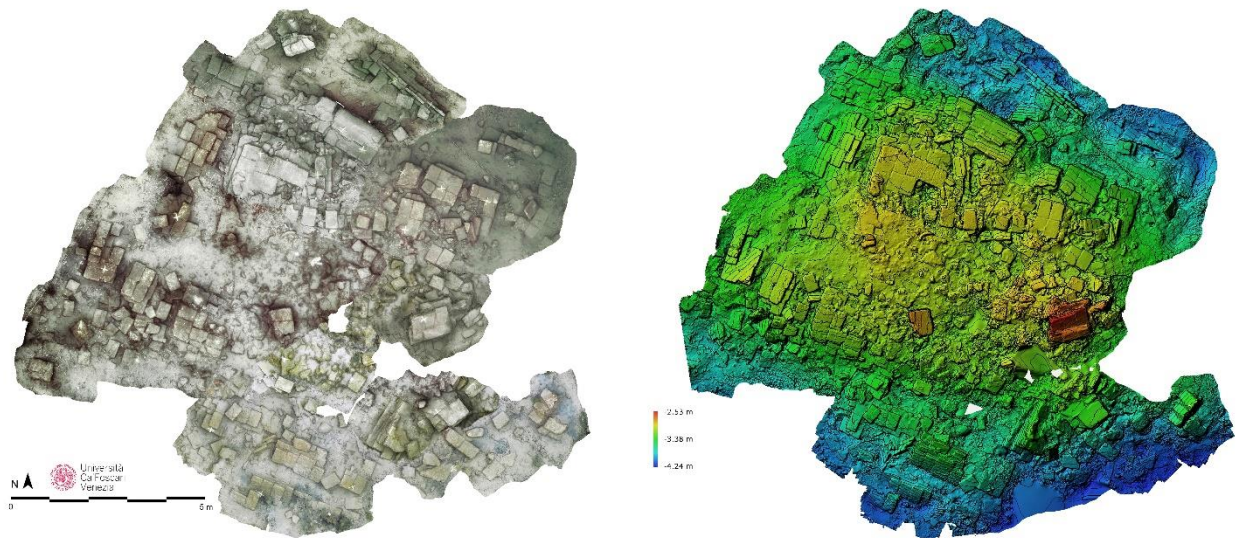


Fig. 1. Photogrammetry and DEM of one of the case studies in the Venice lagoon.

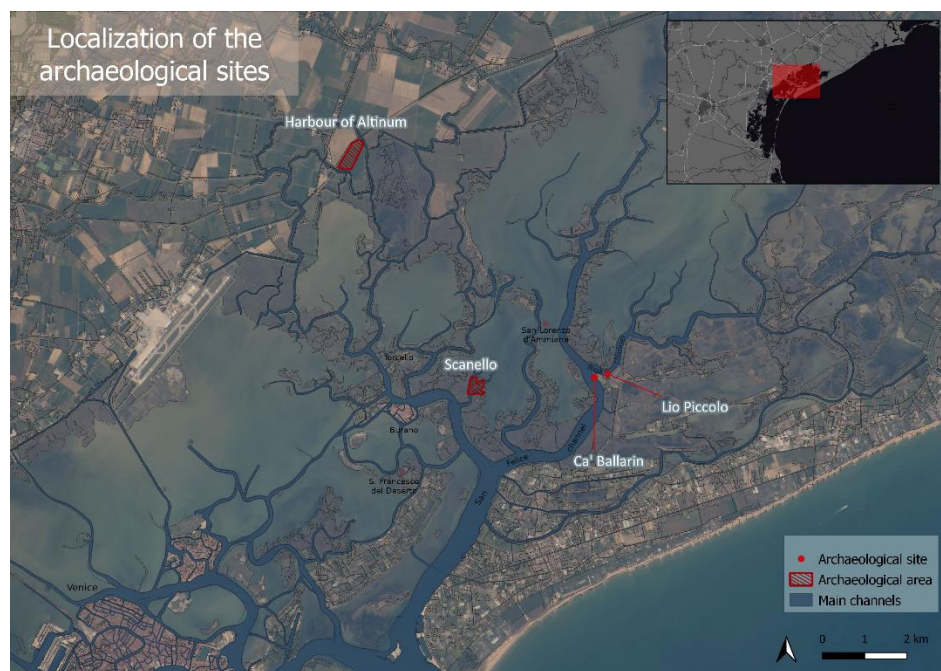


Fig. 2. Map of the archaeological case studies in the Venice lagoon.



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KEY WORDS (MAX 4)

UNDERWATER ARCHAEOLOGY, DIGITAL TECHNIQUES, LAGOONAL LANDSCAPE



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

THE EXPLORATION OF THE COASTS OF PERINTHOS: WHAT DOES THE MULTIBEAM BATHYMETRY SURVEY TELL US?

SESSION: UNDERWATER AND COASTAL CULTURAL HERITAGE

AUTHORS: BERIL KARADOLLER¹, CANER IMREN¹, ZEYNEP KOCEL ERDEM²

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Archaeological excavations carried out for the exploration and discovery of historical artifacts hidden under the ground require a very meticulous process and take a considerable amount of time. Knowing the location and structure of buried objects not only accelerates archaeological studies but also provides the opportunity to make reliable conclusions about these objects even before excavation. In this sense, it is valuable to utilize the power of geophysics, which sheds light on archaeological studies and provides guiding results. Land-based geophysical methods used in archaeological sites have become popular today. However, there is a need for more case studies, especially for the study of marine archaeological sites. The ancient city of Perinthos (Marmaraeğlisi/Tekirdag/Turkiye), where excavations were initiated by Mimar Sinan Fine Arts University with the permission of Turkish Ministry of Culture and Tourism in 2021, has the potential to accommodate both marine and land-based studies in a comprehensive approach.

Perinthos has a historical background dating back to the colonizers from the Samos according to ancient sources (Sayar, 1998), but according to archaeological findings, it dates back to 3000 BC. During the Roman period, Roman domination began in the region, and in 46 AD, when Thrace became a Roman province, Perinthos was chosen as the capital of the Thracian Province by Emperor Claudius (Koçel-Erdem, Z. 2022). During this era, the city became splendid, enriched, and equipped with numerous buildings and artifacts. It also became the center of the Roman navy, responsible for the security of the Propontis (Marmara Sea) with its sheltered harbor structure. Thenafter, the Byzantine domination, increased repair activities in the city and initiated a new period of reconstruction. However, over time, as the importance of Istanbul increased, the city turned into a religious center.

In 2022, to investigate the traces of archaeological remains in the archaeological site, an integrated geophysical survey was designed. As part of the project, a comprehensive multi-beam bathymetry study was carried out in the city's offshore zones, while geophysical studies were carried out on land. The bathymetry study aims to model and investigate the detailed seafloor morphology of the coast of the Perinthos. Accordingly, this study will be able to detect ancient remains such as shipwrecks and artifacts on the seabed. It is also envisaged that the high-resolution multi-beam bathymetry study will reveal the route to the harbor, which was used as the naval base of the ancient city.

The seafloor morphology modeled using high-precision data gave us a unique opportunity to investigate the mysteries of the ancient city of Perinthos. Multi-beam bathymetry data in over 1000 hectare, acquired with 400 and 700 kHz central frequency sensors, were positioned by a post-processed kinematic system. In addition, SVP (sound velocity profiler) data acquired during the survey was used to apply the velocity corrections at the processing stage.



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Furthermore, patch tests were performed, and filters were applied. Throughout the procedure, the "International Hydrographic Organization Standards for Hydrographic Survey" were adhered to. Finally, morphological imagery of the seafloor was obtained. The resolution of these images, produced using high technology, varies between 10 cm and 1 meter depending on the depth.

One of the most remarkable discoveries in the region is a shipwreck 1500 meters off the city's coasts, at a depth of about 60 meters. With a length of 25 meters and a width of 10 meters, this shipwreck is quite imposing and structurally different from modern boats. One of the other main findings is a cylindrical trench with a maximum elevation difference of 5 meters from its surroundings and a width of approximately 200 meters. It is highly plausible that this structure is connected to the inner harbor where the Roman navy anchored, as mentioned in the literature. This study is a significant contribution to the high-resolution identification of ancient cultural heritage through the multi-beam bathymetry in marine archaeological sites.

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KEY WORDS (MAX 4)

MULTI-BEAM BATHYMETRY

PERINTHOS

ANCIENT THRACE

MARINE ARCHAEOGEOPHYSICS



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

THE QUARRIES IN THE COASTAL MUNICIPALITIES OF WESTERN LIGURIA: REFLECTIONS ON LANDSCAPE PROTECTION WITH A VIEW TO THEIR RECOVERY

SESSION:

COASTAL AND UNDERWATER CULTURAL HERITAGE

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The coastal landscape, and in particular, to the extent of interest in the present work, that of western Liguria, constitutes one of the most delicate territorial areas that has undergone the greatest and most significant transformations. The coastal processes of industrialisation and urbanisation, linked above all to seaside tourism, have induced radical transformations, directly linked to the development of the railway, which in the 19th century drew a strongly built coastal landscape with bridges, tunnels, support works, and allowed the settlement and development of industrial (shipyards, industries, mining activities) and commercial (hotels, holiday homes, campsites) settlements. Among these economic activities, mining activities, and in particular open-cast quarries, have contributed to the transformation of the landscape, due to their strong impact on the morphological structure of the territory. What we often read today as 'wounds' of the territory, have fed strategic sectors for the national economy, such as construction and infrastructure, with motives that are no longer economically relevant or sustainable from an environmental and landscape point of view, and need to be 'healed'.

In Italy, the phenomenon of disused quarries concerns more than 14,000 sites that are no longer productive, with more than 15% of municipalities having at least one disused quarry on their territory; in Liguria there are 383 disused quarries that, although small to medium-sized, represent a significant challenge. In western Liguria, out of 224 disused quarries, 78 are currently reused for tertiary or industrial or artisan purposes, 64 are spontaneously renaturalised, 11 are restored to their natural state and 71 are abandoned without plans. Most of them are located in the province of Savona, with about 46% of the total number. Most municipalities in the province have an abandoned quarry and, in geographical terms, the quarries are equally distributed between the coastal and inland municipalities.

While regional legislation currently stipulates that the recovery of abandoned quarry areas is the responsibility of the party that submitted the extraction plan, those that closed before this obligation have entered a sort of regulatory limbo. Many situations represent an environmental and landscape problem, even in Liguria, where legislation has provided for the drafting of recovery plans since the 1980s. How to act? If in most cases the scars left on the territory are largely 'healed', through their renaturalisation or reuse, there remains a significant percentage of totally abandoned quarry sites that can, indeed must, become resources and challenges for development. The questions that arise are many: from the fundamental issue of landscape protection to the need to govern new and current further transformations.

Through the analysis of a number of case studies, their formation, evolution and decommissioning, such as the Ghigliazza quarries in Finale Ligure, this work aims to draw attention to and stimulate reflection on the role



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that landscape protection can play in governing and directing the choices of reuse of particularly delicate situations from a landscape, environmental and economic point of view.

The issues that emerge through the examples of western Liguria - ranging from the total or partial filling of the quarry void, to the possible reuse in the form of services or for residential or tourist purposes, as places for scientific observation and educational dissemination or as examples of industrial archaeology, but also as geological and geomorphological assets, or water catchment basins - involve multiple aspects, from planning to the definition of guidelines, criteria and directives for reuse, from the productive, urban planning, environmental, historical-cultural and hydro-geomorphological points of view.

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KEY WORDS (MAX 4)

Protection – Enhancement – coastal areas - quarries



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

ABSTRACTS PRESENTATION

TITLE:

The Latium coast from Ostia to Circeo: settlement dynamics in a peculiar context

SESSION: Underwater and Coastal Cultural Heritage

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The contribution aims to investigate the settlement dynamics of the Latium coast between Ostia and the Circeo. It is a coastal stretch of about 100 kilometres characterized by peculiar geomorphological and hydrographic features: low and sandy dune coast and a system of lagoons which in ancient times occupied about half of the entire coast strip. The flat conformation of the coast, which is interrupted only by the modest relief of Capo d'Anzio and by the Circeo promontory on its southern edge, has been decisive in the context of settlement dynamics over the long term (**fig. 1**).

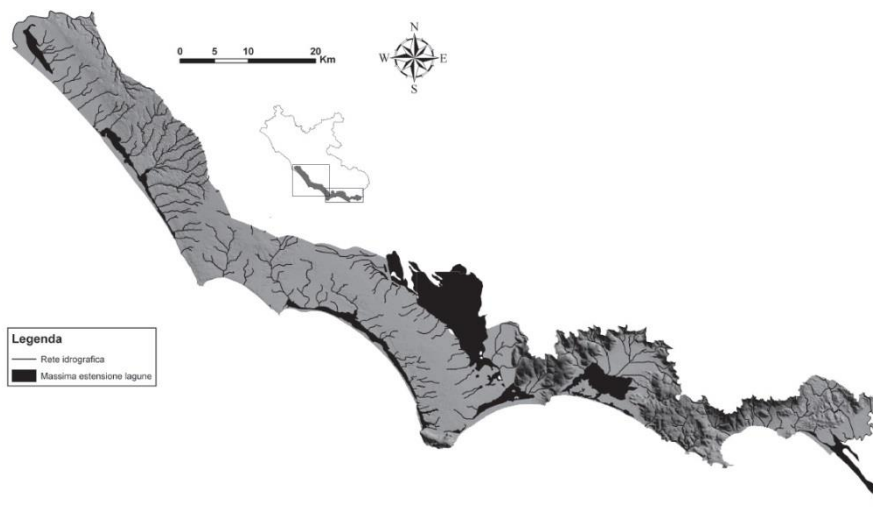


Fig. 1 – Southern coastal Latium with maximum extension of the lagoons (da ALESSANDRI 2007, p. 40)

The aim of the research is the diachronic investigation of the population dynamics of this stretch of coast considering the fundamental relationship between man and the environment in a territory with such characteristics and in which the dominant element is the water: lagoons, rivers, ditches, historic channelings.

In fact, on the one hand water was an element to be contrasted, as demonstrated by the numerous reclamations works undertaken over the centuries from the ancient age up to very recent times, on the other hand it was instead an unifying element from a settlement point of view.

The oldest evidence of human presence, attributable to the Lower Paleolithic, are located along the Astura river, those of the Middle and Upper Paleolithic along the Moscarello ditch. The abundant lithic industry testifies the assiduous attendance in the Upper Paleolithic of the internal dunal system, located behind the coastal lagoons.

After the protohistoric settlement process, also defined by the presence of watercourses and basins, the Latin cities developed in the coastal and para-coastal strip and found their economic basis in the combination of the control of the landings.

Coastal basins and their landing places and watercourses are fundamental elements in the definition of economic processes and territorial control. The urban centres develop in their internal relationship between the inhabited area and the port (**fig. 2**): *Lavinium* / *Sol Indiges* sanctuary at the *Numicus* river (Campo Ascolano), *Ardea* / *Castrum Inuii* sanctuary, Colle Rotondo / S. Anastasio ditch, Antium / Capo d'Anzio, *Satricum* / landing at the mouth of the



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Astura river, *Circeii* / harbour of *Circeii*. Although there are no stable and defined settlements on the Pontine coastal region south of Astura, the *Clostris*/ Rio Martino binomial is a fundamental topographical junction. In all cases the coastal settlement develops at the mouth of a watercourse: river, ditch or built canal.

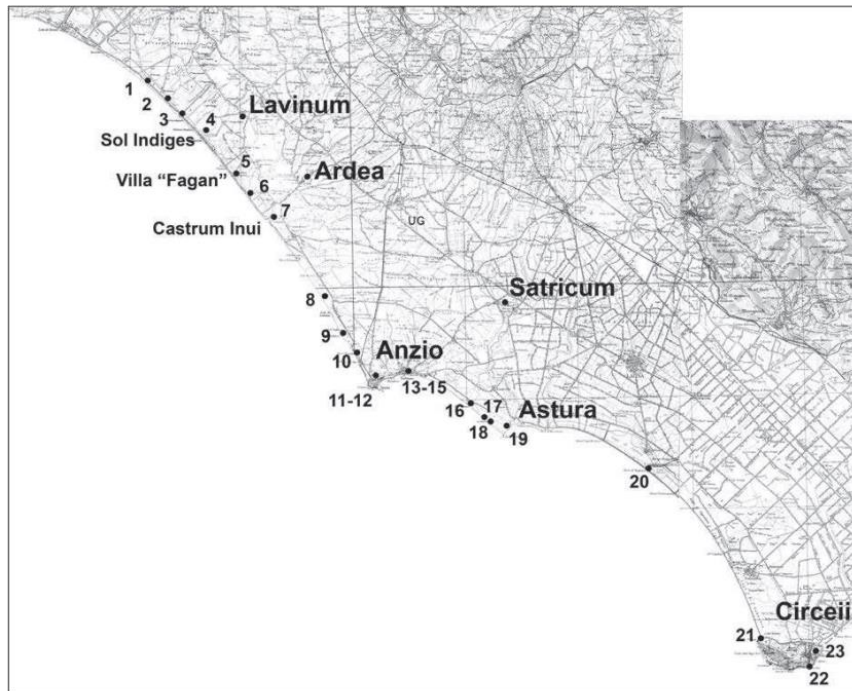


Fig. 2 – Porti e approdi tra il Tevere e il Circeo: 1. Fosso del Pantanello, 2. Fosso del Tellinaro, 3. Fosso di Guardapasso, 4. *Sol Indiges*, 5. Villa “Fagan”, 6. Foce del Rio Torto, 7. *Castrum Inui*, 8. Fosso di S. Anastasia/Colle Rotondo, 9. Tor Caldara, 10. Fornace Paiella, 11-12. Porto di Anzio e Villa Imperiale, 13-15. Fosso di Loracina e tre ville con peschiere, 16. Villa delle Grottaacce, 17. Villa con peschiera di Saracca, 18. Villa con peschiera della Banca, 19. Astura, 20. Torre Fogliano – Rio Martino, 21. Porto canale di Torre Paola e cd. Piscina di Lucullo, 22. Villa con peschiera di Torre del Fico, 23. *Circeii*.

Fig. 2 – Landings and harbour on the coast between Ostia and the Circeo (da JAIA 2017, p. 217)

The fundamental caesura of the settlement process for this area is 338 BC. The Roman conquest will determine a series of dynamics that will be highlighted in the contribution proposed in the light of the relationships of the urban centres with Rome and with each other.

The aim of this research is the reading of the dynamics of the population in a diachronic key by considering the historical aspects and those known from the archaeological data (materials from surface surveys and excavations), interpolating the data with the peculiar geomorphological and hydrological aspects of this coastal sector of southern Latium.

In this context, the analysis of the exploitation until very recent times of water courses and lacustrine basins will also be fundamental, considering their multiple roles as connections such as waterways and internal cabotage, as collectors for stagnant waters in subsequent works of hydraulic regimentation, as well as basins for fish exploitation.

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PROBLEMS AND MEASUREMENT TECHNIQUES**

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KEY WORDS (MAX 4)

Latium coast

Ancient Topography

Settlement dynamics

Lacustrine areas



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: DIAGNOSTICS AND CONSERVATION OF COASTAL ARCHEOLOGICAL SITES: THE CASE STUDY OF THE ROMAN VILLA OF CASIGNANA, REGGIO CALABRIA (ITALY)

SESSION: UNDERWATER AND COASTAL CULTURAL HERITAGE

AUTHORS: MARIA ANTONIETTA ZICARELLI, DONATELLA BARCA, MAURO F. LA RUSSA, ANDREA MACCHIA, LUCIANA RANDAZZO, MICHELA RICCA, SILVESTRO A. RUFFOLO

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ABSTRACT

The conservation of coastal archaeological sites is a critical endeavor that aims to preserve and protect the rich cultural heritage embedded in these locations. One such site of great historical significance is the Roman Villa of Casignana, a testament to the ancient Roman civilization that once thrived along the shores. The Roman Villa of Casignana, located in the Calabria region of southern Italy. Dating back to the 4th century AD, this coastal villa has endured centuries of natural and human-induced threats, ranging from erosion and rising sea levels to modern urbanization. The site is characterized by several valuable mosaics. Preserving such a site demands a multidisciplinary approach that encompasses archaeology, environmental science, engineering, and community engagement. The archeological site is crossed by the 106 Ionian Road and by the railway as well. Some structures of the Villa are submerged close to the seashore. In the last years the University of Calabria, through the Restoration academic course, and the Heritage Science research group, is focusing its effort on the conservation and the valorization of this site. For this reason, several research theses are carried out, they were focused on the conservation of the mosaics which suffer several degradation forms such as salt crystallization, deformation, deposits and lacks. This activity is assisted from the diagnostic analysis of the mosaic tesserae in order to gain information about the composition and the provenance of the stone materials that constituting the tesserae.

In addition to these activities, within the framework of the national PNNR project called Tech4U, the Villa of Casignana has been chosen as a pilot site for the development of innovative technologies for the conservation of cultural heritage, also taking into account the evolution of conservation problems related to climate change and the evolution of coastal lines. Such problem is quite critical in the case of Casignana, due to the proximity to the sea, therefore here the coastal erosion represents a significant risk. It is in itinere an experiment on the use of innovative and environmentally sustainable products for the mitigation of the biodeterioration, based for example on essential oils and agricultural by-products. In addition, an experiment is underway on the use of restoration mortars made with agricultural waste. In particular, we are studying the possibility of adding olive stone as a filler and co-aggregate for the production of restoration mortars. By using this material, it would be possible to obtain a final product with a lower density and a



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higher resistance to salt weathering. In addition, as the olive stone is reduced to ash, it can provide a natural hydraulic feature to the mortar. These ongoing technologies, once validated in the laboratory, will be tested in the field.

All of the above activities will be disseminated to the local community, as community involvement and education play a key role in the sustainable conservation of coastal archaeological sites. Local communities are often the stewards of these heritage sites, and their active involvement is crucial for long-term success. Educational programs, guided tours, and outreach initiatives not only raise awareness of the historical significance of the Roman Villa of Casignana, but also foster a sense of ownership and pride among the local population.

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KEY WORDS:

Coastal Archaeological site; Roman villa of Casignana; Diagnostics; innovative materials for restoration

POSTER PRESENTATIONS



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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: Strategie di tutela del patrimonio archeologico e ambientale in ambiente costiero. Un modello di museo diffuso sperimentale per la Laguna Nord di Venezia

Session:

- PATRIMONIO CULTURALE SOMMERSO E COSTIERO

AUTHORS: ROBERTA ALBIERO

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Tema dell'intervento è la proposta di un modello sperimentale di museo ambientale e archeologico diffuso nella laguna nord di Venezia. Le tracce del passato, ormai quasi invisibili e documentate nei musei archeologici di Altino e Torcello, dove sono in corso campagne di scavi, sono immerse nell'acqua della laguna e che l'erosione ha sottratto, in molti casi per sempre, alla possibilità di essere mostrate. Alcuni manufatti, come parti di strade, resti di edifici, frammenti di vetro, mosaici, documentano l'intensa attività e popolosità presente in età romana (Canal, 2015). Le fonti storiche (Livio, Strabone, Cassiodoro, Procopio) raccontano di numerose opere idrauliche realizzate, come la creazione di canali e *fossae transversum* che consentivano il passaggio endolagunare assicurando gli scambi tra i centri maggiori: Padova, Altino, Aquileia. Nel corso dei secoli gli interventi dell'uomo sulla laguna si sono fatti via via più importanti culminando ai tempi della Serenissima, nella deviazione delle foci dei fiumi. Il patrimonio sommerso, che ha contribuito a riscrivere la storia dell'origine di Venezia, ci parla di una laguna nord ricca di vita in sintonia con i cicli del tempo e dell'acqua. Immaginare a un futuro della laguna di Venezia significa richiede oggi una riflessione più complessa.

Attraverso la nozione di "conservazione inventiva" (Donadieu 2002) gli interventi site-specific ipotizzati mirano a tenere insieme la conservazione di elementi esistenti di valore storico, archeologico, economico, naturalistico e ambientale con l'introduzione di funzioni attuali di conoscenza e fruizione del paesaggio, incrociando tutela e innovazione, cura e cultura, tradizione e nuovi sviluppi, memoria e futuro. Questa idea di un museo ambientale per frammenti, costituiti da dispositivi spaziali non



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immutabili al punto da poter essere completamente reversibili, grazie all'uso di tecnologie low-tech e materiali del territorio, intende sostenere lo sviluppo di un turismo alternativo, attivo e consapevole.

The intervention is focused on the proposal for an experimental model of an environmental and archaeological museum distributed in the Northern Lagoon of Venice.

The traces of the past, today hardly visible, are documented in the archaeological museums of Altino and Torcello, while excavation in submerged sites of the lagoon subjected to erosion are subtracted forever to knowledge and dissemination. Some artifacts, such as parts of roads, remains of buildings, glass fragments, mosaics, and horse skeletons, document the intense activity and population present in Roman times (Canal, 2015). Historical sources (Livy, Strabo, Cassiodorus, Procopius) tell of numerous hydraulic works carried out, such as the creation of canals and fossae transversum that allowed endolagunar passage ensuring trade between the major centers: Padua, Altino, Aquileia. Over the centuries man's interventions on the lagoon became more and more important, culminating at the time of the Serenissima, in the detour of river mouths. The underwater heritage, which has helped rewrite the history of Venice's origin, tells us of a northern lagoon rich with life in tune with the cycles of time and water. Imagining to a future of the Venice lagoon means requires more complex thinking today. Through the notion of "inventive conservation" (Donadieu 2002), the hypothesized site-specific interventions aim to bring together the preservation of existing elements of historical, archaeological, economic, naturalistic, and environmental value with the introduction of current functions for understanding and experiencing the landscape, merging conservation and innovation, care and culture, tradition and new developments, memory and future. This idea of an environmental museum made up of fragments, composed of spatial devices that are not so immutable as to be completely reversible, thanks to the use of low-tech technologies and local materials, aims to support the development of an alternative, active, and conscious tourism.

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KEY WORDS (MAX 4) VENICE, LAGOON , ARCHEOLOGY, HERITAGE



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

THE WATER SUPPLY SYSTEM OF LAKE GARDA LEMON HOUSES: A CLOSE CONNECTION BETWEEN IRRIGATION AND THE LANDSCAPE

SESSION:

PATRIMONIO CULTURALE COSTIERO E SUBACQUEO

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Lemon houses (locally, limonaie) are ancient terraced citrus gardens that still shape the landscape of a wide area along the NW shore of Lake Garda (Northern Italy). Here, thanks to lake's microclimate, to SE exposure of the gardens and to the development of an original labour—intensive agricultural technique, typical of the wider Mediterranean basin [1], lemon houses allowed a fruitful and international citrus trade that, already settled during the 16th Century – and despite the sensitivity of lemon trees to cold temperatures – , flourished during the Little Ice Age and reached its maximum development between the 18th and 19th Century. Most of the lemon houses were irrigated, because, as already referred by the Renaissance agronomist Agostino Gallo in the Seventh day [2], the irrigated trees produced much more numerous, beautiful and early fruits than the not—irrigated ones. Gallo cursory refers that gardeners who don't have commodity of sources, wells or cisterns nearby the garden, devote a great labour to bring the water to the trees, because – he says – anyone of them requires a considerable amount of water, estimated in more than 100 liters per irrigation. This amount is a lower limit of the more recent practice of providing between 100 and 300 liters per irrigation in the warm season, and, accounting for the great number of trees for each garden, it suggests an idea of the structural role played by the irrigation in the citrus cultivation along Lake Garda. The note reported by Gallo is even more valuable because enlightens that – despite some gardeners still did not irrigate the trees – already in the middle 16th Century a complex system of water supply structures was used to provide water for the gardens. After Gallo's age more gardens were built and this required to capillary develop the water supply system in a complex network of channelization that joined groups of lemon houses together in view of



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optimizing the water usage. These works are in turn of three types: direct water intake from a stream, storage tanks and natural or artificial sources. The direct intake from a stream was separated from the irrigation channels by a stilling basin, from which the water was usually taken by means of a submerged intake.

Aiming at contributing to enlighten the complex network of relationships between the lemon houses and their landscape, in this paper we will analyze two systems of irrigated lemon houses, i.e. the system on the right of the Fosso dei mulini and the system of the Valle di san Martino, both in Gargnano. These systems distributed the water to many gardens with a complex structure of flumes, cisterns and stilling basins, which is nowadays partially recognizable. Some parts of the hydraulic structure are still functioning or they were recently renovated. It was quite common that, when there was a source in the garden, the water was supplied both by the stream and by the source. For the Valle di san Martino system a precious 1719 map was found in the Archivio di Stato di Venezia [3], that depicts the stream intakes at the beginning of the 18th Century and the diritti d'acqua (water rights) which ruled the system and regulated the timing of the irrigation shift. The performed analyses depict a landscape deeply innervated by a dense network of vital fluxes that contributed to let the citrus trade flourishing for more than three centuries.

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KEY WORDS:

1. ANCESTRAL AND TRADITIONAL IRRIGATION
2. LAKE GARDA LEMON HOUSES
3. LABOUR INTENSIVE LANDSCAPE
4. CITRUS CULTIVATION



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FORM FOR ABSTRACTS PRESENTATION

TITLE: NAVIGATION AND MEDITERRANEAN COASTAL METEOROLOGY, IN THE ANCIENT WORLD

SESSION: UNDERWATER AND COASTAL CULTURAL HERITAGE

AUTHORS: FABRIZIO BENINCASA, MATTEO DE VINCENZI, GIANNI FASANO*

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

For a long period, Greeks, Phoenicians, and Etruscans frequented, at the same time, the Mediterranean Sea. This forced their seafaring to behave, at the same time, as pirates at sea, to break down competition, and as traders in the *emporia*, to sell their goods.

Navigation, at the time, was based on the experience of sailors since there were no instruments and methods to estimate sailing parameters. The empirical knowledge of seafarers was based both on the observation of environmental and astronomical daymarks, and on their ability to perceive and interpret signals from the atmosphere, and from animals that inhabited the sea areas.

The ships, for the approach to the ports, or in tricky routes, or in the coastal navigation, used the oars that they supplied a greater agility of maneuver than the sails. Sailing was prevalent in all other situations; the prevailing winds allowed movement, in a straight line, between the various landing places and therefore influenced the trade routes [1].

Sea currents also had a significant influence on sea trips within the Mediterranean because, with them, it was possible to navigate even in unfavorable winds.

The merchant vessels, on the high seas' routes, sailed exclusively in the period between March and October, that is, in stable weather conditions and with clear skies which allowed night navigation by orienting themselves by the stars; the small cabotage did not know stops.

Navigation was mainly carried out at such a distance from the coast as not to lose sight of it; but in the Mediterranean Sea the coasts, often mountainous, allowed to have in sight elevated points of reference, which also allowed the offshore navigation.[2].

It is also known that the Phoenicians sailed at night on the high sea, taking the Pole Star as a reference which, for this reason, the Greeks called the *Phoenician star*.



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Merchant vessels were not as fast as combat or patrol ships against piracy, but they could carry large loads of various types to be sold in various *emporia*.

The average speed of a ship was around 5-6 knots, therefore the longest voyages, for example the about 1600 nautical miles that separate the Phoenician city of Tyre (in the current Lebanon, the easternmost part of the Mediterranean) and Gadir (the current Cádiz on the Atlantic coast of southern Spain, the westernmost point of the Phoenician settlements) could require, considering stops for rest and bad weather, more than ninety days [3]. In this case the journey required a winter stopover and the navigation continued into the following season.

Hesiod in *Works and days* [4] urged the sailors: *Don't wait [to sail] for the new wine, the autumn rain,/ Oncoming storms and Notos' awful blasts;/ He stirs the waves, and with him comes much rain/ From Zeus at fruit time, and the sea is rough.*

From these recommendations we understand the importance of “weather forecasting” which could be done with a careful analysis of the warning signs that came from the sky, from the flight of birds and the behavior of fish and other aquatic animals.

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KEY WORDS (MAX 4)

Navigation; Ancient Meteorology; Sailing techniques; Celestial Navigation



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FORM FOR ABSTRACTS PRESENTATION

TITLE: THE HISTORIC LIGHTHOUSES OF THE ITALIAN COASTS
SESSION: UNDERWATER AND COASTAL CULTURAL HERITAGE
AUTHORS: FABRIZIO BENINCASA, MATTEO DE VINCENZI, GIANNI FASANO*
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<p>The tall tower building with an intense light source on the top, visible far away, called a lighthouse in English, takes its name in the Romance languages of <i>faro</i> (in Italian and Spanish), <i>phare</i> (in French), <i>farol</i> (in Portuguese). The term derives from the Greek <i>Pháros</i>, the name of a rocky islet near Alexandria in Egypt on which a famous structure of this type was built in the third century BC during the reign of Pharaoh Ptolemy II Philadelphus. The island was 2600 meters long and about 500 meters wide with a maximum elevation of 12 meters; as Strabo attested, the area was extremely treacherous for navigation due to the presence of shallows and reefs and the coast was harbourless; the lighthouse construction was necessary to solve these problems. The Pharos (or lighthouse) of Alexandria, one of the seven wonders of the ancient world, was about 110 m high; it was damaged and renovated several times until the earthquakes of 1302 and 1323 destroyed it definitively. Precursors of actual lighthouses were the beacons lit on the tops of the hills, which various Greek authors such as Homer and Herodotus spoke about in their works.</p> <p>The fuels used to produce lighting have progressively adapted to the times: bundles of dry wood, olive oil, wax candles, sperm whale fat, paraffin oil, acetylene, arriving to electricity between the end of the nineteenth century and the beginning of the twentieth century.</p> <p>The lighthouses didn't only have positive aspects; in fact, they not only facilitated bearings during night navigation, but also indicated to the pirates the coastal towns to plunder, along routes still unknown to them. This gave rise to a kind of "land piracy" since "prankster" characters lit "fake beacons" on reefs, shoals, rocks, and shallow waters where ships stranded and were therefore more easily plundered.</p> <p>The second part of the work, is focused on the current number of lighthouses in the world, giving</p>



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greater emphasis to the Italian *historic lighthouses*, which, by definition, are those that meet at least three of the following characteristics established by the International Association of Lighthouse Authorities (IALA-AISM):

- the station has been designed to be manned,
- the range of the light should be greater than 15 nautical miles and the height of the tower should be greater than 10 m above the ground,
- Historic Architectural interest (design, use of material, etc.),
- the station is over 100 years old,
- the station is protected by the local Cultural Heritage Authority,
- Archaeological importance.

As in other European nations, also in Italy the lighthouse lantern was often placed on the top of the bell towers of the churches along the coastline. The oldest Italian lighthouses, for which there is some documentation, are: on the Tyrrhenian coast the lighthouse of the Port of Rome, depicted in the mosaic of the *Thermae* of Ostia Antica; on the Adriatic coast the lighthouse of the Port of Ravenna, which remained incorporated into the Church of *Sant'Apollinare in Classe*.

Obviously in the paper we will only mention the lighthouses, which in our opinion are the most important and given the historicity of these we will only deal with the "bright" lighthouses, outlining the historical-geographical context within which they were built. We will not face, in this dissertation, the *mare magnum* of radio beacons or radar systems, or GPS, or satellite phones, which have little in common with the "classic" lighthouse that in many cases is still currently operative, especially in a small sea like the Mediterranean Sea.

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KEY WORDS (MAX 4)

Ancient lighthouses Navigation; Ancient Meteorology; Sailing techniques;



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FORM FOR ABSTRACTS PRESENTATION

TITLE: Beyond regional MCH boundaries: the Italian MSP process
SESSION: PATRIMONIO CULTURALE COSTIERO E SUBACQUEO
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <p><i>Maritime cultural heritage (MCH) is increasingly under pressure by ever-growing anthropogenic uses of the seas, such as port developments, pipelines, or submarine cables, tourism pressure, and trawling activities. In the Mediterranean Basin, the cultural heritage is a defining feature for local populations, and the risk of losing or overlooking it is especially detrimental.</i></p> <p><i>Maritime spatial planning (MSP), within its directive (89/2014 EC), recognizes the cultural heritage, coastal and underwater (UCH), tangible and intangible, as a relevant asset that must be considered, preserved, and promoted in the national management plans of the sea.</i></p> <p><i>The MSP directive created, for the coastal Member States, a unique opportunity to integrate and gather different individual existing projects focusing on the identification and classification of MCH and UCH, such as historical harbors, sea battles areas, age-submerged settlement sites, shipyards, shipwrecks, etc., into a cross-sectorial dynamic plan.</i></p> <p><i>Italian waters, from the Tyrrhenian Sea to the northern Adriatic Sea via the Ionian Sea, are areas of incredible ecological and cultural value, embedded in their cultural and archaeological heritage. In this context, the Maritime Spatial Plan assumes relevance for the national cultural heritage for two main reasons: (i) it allows for comprehensive consolidation of the cognitive status of cultural relics into a single and harmonized pool; (ii) it establishes a more integrated reading about further anthropogenic activities, assessing their potential impacts and promoting management measures that mitigate their interactions.</i></p> <p><i>The objective of the paper is to bring out the real opportunities offered by Italian msp plans, showing how the national process facilitated dialogue and harmonized the individual activities on underwater and coastal cultural heritage conducted by the national and regional superintendencies.</i></p> <p><i>The Italian process, still ongoing, formally began with the transposition of the MSP Directive into Italian legislation (Legislative Decree 201/2016 and the DPCM of December 2018), which established the guidelines, designated the Ministry of Infrastructure and Transport as a Competent Authority, and defined a new multi-scalar governance model. The preparation of an interdisciplinary plan and the active involvement of ministerial and regional actors was ensured by two factors: by extending the regional terrestrial boundaries by 12 nautical miles towards the sea (fragmentation of the sea into sub-areas) and by establishing a scientific team of 25 researchers (composed of IUAV,</i></p>



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CORILA and CNR-ISMAR) to provide operational support to the process and to act as mediator and harmonizer of the various inputs transmitted by the administrations.

The paper analyzes the Italian MSP process from the methodology and approach adopted, focusing on the outcome of the planning units and related management measures proposed for the protection and enhancement of submerged and coastal cultural heritage.

Among the main findings, the paper highlights, in particular, the involvement process of the interested parties, through the organization of more than 30 trilateral meetings (Ministry of Culture, Regional Superintendence, and Scientific Team) in which, in addition to the recognition of the state-of-art, planning units are identified for numerous coastal sub-areas (INM buffer) where cultural heritage and coastal-maritime tourism were recognized as priorities and proposing related measures to mitigate potential pressure and conflict by promoting actions in periods of high seasonality.

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**KEY WORDS (MAX 4) UNDERWATER CULTURAL HERITAGE; INTEGRATED APPROACH;
MARITIME SPATIAL PLANNING; CONFLICT MANAGEMENT**



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FORM FOR ABSTRACTS PRESENTATION

When geology becomes cultural wealth: Praia a Mare, town of caves

Underwater and Coastal Cultural Heritage

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ABSTRACT:

The geological conformation of an anthropized place decides the fate of the women and men who live in that portion of territory. Praia a mare, called the city of the island due to the presence of the imposing island of Dino, is actually characterized by the presence of many caves both on the mainland and on the island.

The area considered, limited to the north by the structural high of the Serra di Castrocucco and to the south by the Scalea promontory, includes a small stretch of the coast of Basilicata (Castrocucco-fraction of Maratea) and a larger sector of the Calabrian coast, falling in the municipalities of Tortora, Praia a Mare and S. Nicola Arcella. Dominated by the extensive alluvial plain of the Noce river, the area is characterized by the presence of reliefs that show good morphological maturity; numerous surfaces of subaerial origin and marine terraces interrupt the profile of the coastal slopes. The marine terraces are found starting from higher altitudes (about 180 m above sea level) and are characterized by a significant width.

During the lower and middle Pleistocene, the geodynamic evolution of this Apennine sector and the variations in the base level connected to the climatic variations connected to the glacial and interglacial periods resulted in variations in the sea level, determining transgressive episodes that led to the invasion of the riverbed of the paleo-Noce. Traces of which are found along the slopes consisting of erosional and depositional terraces and, at lower altitudes, in shoreline furrows. The Island of Dino is characterized by a sub-flat morphology, connecting to the mainland with a similar terraced surface in a forest area shaped by the erosive action of the sea and its Pleistocene oscillations. In accordance with this system of morphological traces, the karst system to which the caves in the area are linked has also undergone oscillations in the base level over time.

The 21 main karst caves present in the analyzed sector have been considered and can be schematically grouped into four homogeneous groups from the point of view of the base altitude, the Grotta della Madonna group with altitudes between 45 and 50 m above sea level, the caves of the Grotta delle Ciaole group with an altitude of around 20 metres, the Scoppellito caves with an altitude of around 10 meters and finally the group of caves on the island of Dino with an altitude



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around sea level. This altimetric distribution is closely correlated with the phases of geomorphological evolution of the coastal sector.

The life of men has taken place in these caves since the Paleolithic age: in its largest cave there are the geological signs of the sea that reached it but also the drawings of the Paleolithic men who settled this cave. And in this same cave there is the Sanctuary of the Madonna della Grotta, patron saint of Praia a Mare. And Greek monks settled in the nearby caves since the early Middle Ages, founding monasteries and places of spirituality. But Greek monasticism has also left signs of its passage on the island, as is also clear from the name of one of the caves, called the Monk's cave. And again in a cave on the island, the body of Vitigno was found, the hero of Praia who defended the city from an assault by the Turks led by Amurat Rayt who, in 1639, attacked the island of Dino with six vessels. It is probable that the first settlement of Praia took place between the 15th and 16th centuries by Schiavoni, who occupied the caves on the mainland, forming the first residential area of the town and giving it the name of Plaja Scavorum.

In this contribution, a census was carried out of the caves present in the Praia area so that they can become part of a redevelopment project, through the cleaning of some covered by debris, the protection of the sea caves from motor boats and all of them can become a tourist route that includes land and sea caves.



Cartolina anni'80 del XX secolo

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PRAIA A MARE, ISOLA DI DINO, CAVES, HISTORY



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: THE BUILDING MATERIALS OF THE LORENESE FORTS OF THE TUSCAN COAST
SESSION: UNDERWATER AND COASTAL CULTURAL HERITAGE
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ABSTRACT: <p>The system of fortifications on the Tuscan coast, whose genesis stretches from the Middle Ages to the 19th century, consists of 160 fortified centres, individual fortresses (or redoubts and batteries), watchtowers and huts for the residence of soldiers and cavalry guards. This set of structures remained largely intact until the unification of Italy. The European wars of Succession and the Seven Years' War that also affected Tuscany under the Habsburg-Lorraine dynasty (1737-1800 and 1814-59) led to a new phase of recovery and strengthening of the coastal fortifications, thanks also to the foundation in 1739 of the military genius under Colonel Odoardo Warren, with the task of restoring, rearming and thickening the defensive and sighting structures and carrying out a cartographic census of them. Between the mid-18th century and the Congress of Vienna, the coastal military organisation was given special attention, as evidenced by no less than 50 structures built during that period, many of which were destroyed or dismantled over the years. In particular, Pietro Leopoldo, in order to ensure the protection of Tuscany from the threat of the barbarians and the latest plagues, as well as to combat the scourge of smuggling, between 1786 and 1793, had six forts built on the coastline. All of the forts are of the same type, with a quadrangular body and an adjoining semi-circular platform on the sea front: Cinquale nuovo, Forte dei Marmi, Bibbona, Castagneto, Marze and San Rocco, the last two to the watch over the Castiglione-Grosseto coastal stretch, which until then had no towers. These forts, with the exception of the one at Cinquale Nuovo destroyed during the Second World War, have all been preserved and put to new use by both private individuals and public administrations [1-3].</p> <p>This work examines the construction techniques and the natural and artificial stone materials (mortars and bricks) used in the construction of this particular type of fortification. The aim is to verify the possible relationship between the materials used and the stone resources and raw materials (clays for bricks and limestone for the production of lime) of the individual territories, or to ascertain a standardised use of materials, with origin from a single production centre. Furthermore, the state of conservation of these fortifications in relation to decay phenomena will be examined, trying to highlight the influence of environmental factors and the characteristics of the stone materials. The study of the materials will make use of the classic techniques of mineralogical-petrographic investigation, which in the case of natural stone materials allow for their correct classification and also make it possible to recognise the intrinsic factors of the material itself that determine its resistance to the agents of decay. Regarding the mortars, there are many characteristics to investigate, such as the amount and type of binder, the grain size and composition of the aggregate, the type of lime lumps. This makes it possible to differentiate them, to confirm different construction phases and to identify new ones. Concerning the binder, the study of lumps gives information about the kind of carbonate stone that was burnt to produce the lime. As for the bricks, it is possible to recognize the amount and kinds of framework (use of a lean or fat earth). Moreover, the mineralogical analysis through x ray diffraction will give information about the possible use of a marly clay (presence of calcium silicates) and will give an estimation of the firing temperature.</p>
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KEY WORDS: LORENESE FORTS, TUSCANY, PIETRO LEOPOLDO, BUILDING MATERIALS



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Livorno (Italy), 11th -13th June 2024

TITLE: CULTURAL HERITAGE OF AMALFI COAST

SESSION: UNDERWATER AND COASTAL CULTURE HERITAGE

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The geo-historical system of the Amalfi Coast extends from the furthest point of Punta Campanella (Sorrento) to Vietri sul Mare: beyond the Colli di San Pietro in the municipality of Piano di Sorrento, where the *historic Amalfi State Road 163* begins, the landscape shows the southern rocky slope of the Monti Lattari system, characterised by a topography sloping down towards the sea. This territory condenses historical values and meanings that make this place a particular *cultural landscape*, defined by UNESCO as a 'combined works of nature and of man' in 1992: the inclusion of the 'Amalfi Coast' in the World Heritage List in 1997 as a landscape of exceptional cultural value - according to criteria (ii), (iv) and (v) - is due to its natural and topographical peculiarities, but also to the particular fusion of eastern and western cultural influences, that are reflected in its tangible and intangible heritage.

In addition to its naturalistic and environmental characteristics related to its geological conformation, biodiversity and agronomic practices, the Amalfi Coast is distinguished by the concentration of rituals, traditions, customs and crafts in singular connection with the 'spirit of the places' and its peculiar landscape, in a harmonious relationship between its architecture, with its typical extradosed vaults, and the peculiarity of its colours and natural scenery.

The archaeological heritage (from prehistory to the classical age), urban centres and monuments, rural settlements with their characteristic architecture, geological features, the coastline with its inlets and rocky sites define the cultural content, in the inseparable relationship between tangible and intangible assets.

The result of the studies carried out as part of the "*Progetto ArCCa_DiA-Digitalizzazione e Automazione*", *POR CAMPANIA FESR 2014-2020*, promoted by Scabec SpA, for which was studied the thematic context 'Amalfi Coast, an open-air landscape and cultural ecosystem', with the scientific coordination by prof. arch. Bianca Gioia Marino, with the collaboration of arch. Edoardo Schettino for the filing activity, envisaged a 'dematerialisation' of works, structures, assets and environments subject to intervention, through a careful process of historical, landscape and cultural analysis of the Amalfi Coast, aiming a scrupulous selection of materials and environments, representing the cultural heritage intended for the production of digital assets, like documents and images, to develop and generate datasets and digital resources on the study theme.

The purpose was to implement the *monitoring* process of the Amalfi Coast area, according to an innovative scientific criterion, based on the interception of assets, both tangible and intangible, related to physical elements existing on the coastal territory, on the basis of the most updated international Recommendations and Charters concerning cultural heritage and its fruition (such as the *Québec Declaration on the preservation of the spirit of place*, or the *ICOMOS charter on Cultural Routes and charter on Interpretation and Presentation*, adopted in Québec, Canada, on 4th October 2008, concerning the value of the spirit of places and the intangible dimensions of heritage).

Adopting that scientific principle as the basis of the research carried out, intended as a reiterable experimentation for future interdisciplinary approaches aimed at conveying and deepening the aspects linked to the heritage network of the Amalfi Coast area, it proposes to outline the methodology, encouraging the research of solutions that effectively implement the process of cataloguing and *dematerialisation* of heritage assets, describing the work done, analysing significant cases and identifying possibilities for further study of the case.



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KEY WORDS (MAX 4) *AMALFI COAST; HERITAGE; CULTURAL LANDSCAPE; TANGIBLE AND INTANGIBLE ASSETS.*

SESSION

**MORPHOLOGY AND EVOLUTION
OF COASTLINES AND SEABEDS**

ORAL PRESENTATIONS



**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: WAVE INFLUENCE IN SHORT- TO LONG-TERM RIVER DELTA MORPHODYNAMICS: A MEDITERRANEAN AND BLACK SEA PERSPECTIVE

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Waves play an important role in the construction, shaping and destruction of river deltas¹. The Mediterranean arc (including the Black Sea) provides abundant examples of river deltas that evolve in an environment strongly influenced by waves under weak tide-range conditions. The variety of plan-view delta shapes that characterize this area provides an opportunity for gauging the role of waves, and morphological feedback, in delta development. Delta shapes are identified from remote sensing sources and delta morphodynamics analysed on the basis of conceptual advances in delta studies supported by examples based on a numerical modelling approach using the open-source Delft3D model². Two important relationships are highlighted by these approaches: the balance between the river outflow and wave energy and the importance of alongshore sediment transport and bypass at the river mouth. These two relationships have an overarching role in determining a range of conditions: (1) the extent to which sand supplied to deltas is sequestered within deltas or lost by deltas through the agency of waves and longshore transport, (2) the degree of delta protrusion, (3) overall delta shape, which may include cusped, lobate, skewed, asymmetric or asymmetric, and to which waves and longshore currents may also adjust in the long term, (4)



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the orientation of the mouth relative to the dominant wave approach angle, (5) shoreline type and shoreline mobility over time involving tightly- or loosely-packed beach ridges, interspersed beach deposits within wetland environments, the presence or absence of spits, (6) conditioning of processes such as channel development, connectivity, avulsion and channel switching, (7) in fine, the balance between retreat, progradation or aggradation, and (8) the eventual survival of deltas in the face of sea-level rise. In addition to fluvial sand supply, delta build-up in the Mediterranean may also involve sand derived from abandoned lobes as well as older relict nearshore deposits that may undergo active wave reworking. Bars are commonly formed from bedload supply at the delta mouth(s), and are an important agent in the morphodynamic outcome of the interaction between the river discharge and waves. Longshore currents can redistribute wave-reworked mouth bar deposits. Transport may be divergent from the mouth or may be regionally unidirectional but wherein the symmetry of some deltas, probably rare, may be maintained by a strong river blocking effect on transport from the updrift flank. Finer-scale morphodynamic outcomes that are generally not reproducible at this stage by numerical modelling include transport reversal (counter-drift) at the delta-mouth margins in response to local wave refraction/diffraction effects. Where two or more distributary mouths occur, multiple drift cells ensue, assuring bedload retention within the delta.

The important decreases in fluvial sediment supply and water discharge affecting most Mediterranean deltas^{3,4} as a result of catchment management (sediment mining, damming, reforestation, flood control) and sea-level rise enhance the capacity of waves to rework deltas, endangering not only human endeavour and ecosystems but the very existence, in the future, of especially small deltas. The challenges posed by the preservation of these valuable coastal regions call for informed and innovative management strategies based on a better knowledge of the processes involved in wave-river interaction.



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KEY WORDS: MEDITERRANEAN DELTAS, WAVE-RIVER INTERACTION.



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: An *in situ* wind/coastal-going platform network for monitoring the sea-beach interactions under different climate conditions

Session: MORFOLOGIA ED EVOLUZIONE DELLE COSTE E DEI FONDALI

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Sicily is the largest island in the Mediterranean Sea with a coastal development of about 1,631 km, whose 705 km of beaches (while 814 are interested by rocky coasts and 112 km by artificial ones). Beaches can be divided between pocket beaches e few kilometers long stretches, made up from sand to cobbles, of carbonate, metamorphic and volcanic materials.

These beaches have a huge tourist value, added to both architectonic and cultural trails (7 UNESCO World Heritage Sites) and to the many inland, coastal and submerged archaeological areas.

The beaches, from more than 50 years, are threatened by erosion, prevalently due to the urbanization of the shoreline, with the disappearance of dunes as a consequence of the building of roads, promenades, and other urbanization processes. To this are added the effects of Climate Change which although they are not yet appreciable in terms of Sea Level Rise, they manifest themselves with a meteorological climate characterized by more energetic and concentrated events over time, sometimes coming from slightly different angles from those of the past.

These observations are the result of ex-post analysis which record cause and effect reactions rather than prodromal signals.

In a preventive and predictive logic, there is therefore a strong need at a scientific and stakeholder level to create a continuous monitoring system of the most dynamic part of the coast: the beaches.

In this ambit with international cooperation projects BESS e NEWS, funded by European Union within Interreg Program Italy - Malta, has been realized a first monitoring network with an *in situ* platforms (both wind survey and coastal-going) for observing sea-beach interactions under different climate conditions (MUSUMECI et al., 2023, RANDAZZO et al. 2021 a e b).

Each platform alimented with sun energy is equipped with one anemometer ad 2 or 3 (depending on the beach size) of cameras, both connected wi-fi with a control station which gets a wind data per second and an image every 3 hours from 6 in the morning to 8 in the evening (depending on the season).

The monitoring network developed in the framework of these projects allows us to gather images of



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several iconic beaches in Sicily and the Maltese islands. To obtain quantitative information on the trend of the erosion/deposition process; furthermore, with the REMACO project within the same framework, an orthogonalization algorithm of the images captured by the installed cameras was developed. The algorithm also allows the evaluation of the emerged beach evolution within a single storm and will help the model transition to a predictive tool.

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KEY WORDS: COASTAL AREAS, SHORELINE EVOLUTION, BEACH MONITORING, BEACH MANAGEMENT



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: Monitoring beach erosion along the Central Adriatic coast: the case study of Molise Region.
SESSION MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS
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ABSTRACT: Coastal areas are among the most dynamic environments, subject to deep and rapid changes over time that can significantly modify the entire morphological context in which are located. They are also subject to increasing anthropization linked to both the steadily growing tourist pressure and the presence of increasingly larger inhabited centers. In an attempt to deepen the understanding of the current state and potential future development of a coastal area, the reconstruction of its long to short-term geomorphological and anthropogenic evolution together with the assessment of possible future trends, assume a crucial importance. For this purpose, the coastal stretch of the Molise Region coast located south of the Termoli promontory, i.e. the southern Molise coast, was examined (Fig. 1), as it represents a typical example of a low-lying sedimentary coast, which is furthermore characterized by an important anthropogenic pressure mostly related to tourism activities. The southern Molise coast has experienced intense erosion since the early 1900s that first caused the complete erosion of the Biferno River delta then a more extensive shoreline retreat, and a consistent loss of beach in the last 65 years (Fig. 1). Shoreline retreat mainly affected the coastal areas around the Biferno River mouth that registered average annual long-term rates of nearly -3 m/year, but did not spare several other coastal portions in different periods (Rosskopf et al., 2018). To counteract the retreat, hard defense structures, mainly adherent and detached breakwaters, and groins, have been built over time. Nevertheless, erosion has partly further accelerated its pace over the last twenty years, with peak rates recorded between 2012 and 2019, and the increasing involvement of coastal stretches located south of the Biferno River mouth (Di Paola et al., 2023). The acquired data have allowed for first evaluations of a possible scenario of permanent flooding along the southern Molise coast for the year 2050 using the sea-level projection SSP5-8.5 (IPCC, 2021). This evaluation has shown that the current sandy beaches and low-lying areas behind the dune systems and near the Biferno mouth could be affected by permanent flooding in the near future. In detail, the results highlight that the study coast will be affected by permanent flooding for approximately 1.32 km ² , equal to 5% of the entire investigated territory (Di Paola et al., 2023).



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The considerations made so far highlight the elevated fragility now and in the near future of this coastal sector. For this reason, several monitoring campaigns were carried out between 2016 and 2023, particularly beach sediments were sampled in the backshore and foreshore zones and a series of topographic profiles, appropriately positioned along the coast, and connected to an equal number of bathymetric profiles extending up to the closing depth were acquired. These surveys have clearly shown the very recent morphological and sedimentary evolution of the study coast. In order to expedite these investigations, some drone survey campaigns were also carried out at strategic points in the studied area. In detail, the surveys conducted between 2019 and 2021 (Di Paola et al., 2022) allowed for the rapid creation of beach profiles at approximately 20 m intervals, starting from the elevation models obtained through the photointerpretation of data collected. The set of performed surveys, along with the campaigns planned for the near future, represent the monitoring plan outlined for the investigated coastal area and the entire Molise coast for defining future action strategies aimed at mitigating the effects of ongoing climate changes and supporting the sustainable development of the coast.



Fig. 1: Location of the study coast area and evolution of the coastline between 1954 and 2019

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KEY WORDS

Shoreline changes, natural and anthropogenic controls, coastal monitoring techniques, climate change.



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

MULTIPLE INSIGHTS INTO COASTAL PROCESSES OBTAINED FROM A YEAR OF FLUX MEASUREMENTS IN THE EASTERN LEVANTINE BASIN

SESSION:

MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The magnitude and composition of sediment fluxes in coastal water depend on the combination of multiple chemical, physical, and biological processes on land and in the sea. The objective of this study was to examine the processes that govern coastal sediment fluxes, their annual dynamics, and the sources of the sediments. In this one-year study, we used scuba divers to deploy maintain, and replace sediment traps that monthly measured sediment fluxes, 10 m above a 26 m deep seafloor, two kilometers offshore the Israeli coastline in the eastern Levantine Basin of the Mediterranean Sea. Sediments from the sediment traps and potential point sources at the seafloor (collected by push cores) and on land were analyzed for a series of physio-chemical characteristics including light (C and N) and heavier elements, grain size distribution and stable isotopes in carbonates and organic matter. These were accompanied by time series measurements of ambient currents, waves, and temperatures at the study site obtained from an acoustic Doppler current profiler and records of precipitation and of a nearby river flow. These data revealed intense resuspension and unidirectional (northwards) transport of sand and finer sediments during storms and the relationship between wave heights and grain size distribution in the traps. Our results have shown huge differences in sediment fluxes between months, ranging from $1.8 \text{ g m}^{-2} \text{ d}^{-1}$ in the autumn to $83 \text{ g m}^{-2} \text{ d}^{-1}$ in mid-winter. These fluxes were shown to be strongly correlated ($R^2=0.97$) with time-integrated, >1.5 m wave heights (H_s) during the sampling periods relating much of the flux to resuspension and transport processes. Isotope and chemical analysis of the sediments linked seasonal shifts in environmental conditions to shifts in the relative contribution of terrestrial and marine sources to the sediment fluxes. Moreover, it enabled us to relate coastal processes e.g. erosion of the coastal-escarpment during winter storms to later changes in the composition of the sediment fluxes in the water column, ~ 2 kilometers offshore. Ultimately, this study provided the first quantification of the flux of inorganically precipitated aragonite in the water column and explained its mechanism. This phenomenon that we observed in the warm, aragonite saturated ($\Omega_{Ar} \geq 4$), stratified coastal water may account for $15 \pm 3\%$ of the previously reported CO_2 efflux from the sea surface to the atmosphere in the southeastern Mediterranean. Considering the warming, and stratification of ocean areas wherein $\Omega_{Ar} \geq 4$, these findings may have global potential implications for the marine carbon cycle and CO_2 exchange with the atmosphere. Working year-round in coastal waters is often a physically and technically challenging endeavor. These findings however demonstrate both the wealth of information and the importance of combined time-series measurements of sediment fluxes and environmental parameters in coastal areas. They also demonstrate the benefits of combining a wide range of sample analyses for obtaining a wider scope understanding of coastal processes.

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<https://doi.org/10.1016/j.margeo.2018.09.004>

KEY WORDS (MAX 4)

SEDIMENT, FLUXES, TIME-SERIES, SOURCES



Tenth International Symposium

MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: *Uncrewed aerial vehicles: an investigation of the parameter influences for coastal monitoring*

SESSION:
MORFOLOGIA ED EVOLUZIONE DELLE COSTE E DEI FONDALI

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Data and information obtained from low-cost uncrewed aerial vehicles (UAVs), commonly referred to as ‘drones’, can be used to support coastal monitoring on erosion study. The Structure from Motion (SfM) techniques allow to reconstruct a high-resolution Digital Elevation Model (DEM) useful to assess shoreline and dune mass, starting from the images acquired by UAVs. Flight procedures, acquisition methods and ground references are important parameters to be carefully managed to achieve the necessary accuracy. However, the size of the areas to be monitored and the frequency of measurements require demanding resources which can limit studies when they are not sufficient. This work aims to investigate the best flight and processing settings for the application of SfM for coastal monitoring. The parameters investigated are for example the drone type, flight height, ground control points (GCPs) position and post-processing parameters. The results of these evaluations and the proposed procedure are shown.



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Livorno (Italy), 11th -13th June 2024

REFERENCES: (MAX 4)

KEY WORDS (MAX 4)

COASTAL MONITORING, PHOTOGRAMMETRY, DIGITAL ELEVATION MODEL, DRONES



**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: COASTAL PROCESSES AND COASTLINE EVOLUTION ON THE VRGADA ISLAND (CROATIA) - GETTING THE WHOLE PICTURE

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABED

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The Croatian part of the eastern Adriatic coast is generally known as a high rocky carbonate coast, where typical coastal forms such as cliffs and beaches and their related processes are largely absent. Steep carbonate coastal cliffs are mostly of tectonic origin, while carbonate gravel beaches dominate (Pikelj & Juračić, 2013). Only in a few places where soft rocks emerge in contact with the sea have reveal cliffs and sandy beaches developed. One of these places is the north-eastern side of the island of Vrgada.

The ~15 m high coastal cliff on the island of Vrgada consists of erodible aeolian-alluvial Pleistocene sediment succession (Banak et al., 2021). It is exposed to continuous coastal erosion, especially its eastern steeper (90°) side. In contrast, its northern side is less erodible, probably due to the milder slope and vegetation. As a result of erosion, an L-shaped sandy beach has formed at the foot of the cliff (Pikelj & Furčić, 2020).

The main idea of this research was to study the main coastal processes occurring along the cliff and the beach in order to explain the main mechanisms of coastal evolution.

The first step was to monitor cliff erosion between October 2022 and November 2023. During this period analysis of 3D models created using digital photogrammetry showed that most mass wasting events were rockfalls. These episodic events were mostly triggered by intense or frequent rainfall. Most of the eroded material has accumulated on the beach, right at the base of the cliffs. Eventually, this material is further distributed by the waves.

The second part of this work relates to the longshore-drift. Once eroded, accumulated material is reworked by the waves and carried away. It was assumed that the most common winds *Bora* and *Jugo (Sirocco)* cause dominant waves, both approaching from the east. The expected reduction in the grain size of the beach sediment towards the west was not clear, probably due to the continuous erosion of the cliffs and the input



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of new beach sediment. Therefore, it was assumed that longshore-drift of the sediment should be reflected in the composition of the marine subtidal sediments.

In general, the marine sediment along the carbonate Croatian coast consists mainly of biogenic marine carbonate. However, a strong local terrigenous input from cliff erosion was suspected. As expected, differences in the composition of the marine sediment in front of each cliff sides were evident. The marine sediment off the less erodible cliff contained fewer carbonates and more terrigenous minerals (mainly quartz), and generally had a smaller grain size. In contrast, the marine sediment off the main cliff erosion zone contained more biogenic carbonate grains, a higher carbonate content and extended to shallower depths. It was therefore concluded that the fine-grained material from the cliff erosion drifts westward and eventually ended up on the seafloor.

To support the assumption of the westward coastal drift, the third step was carried out: analysis of heavy minerals in beach sediment. Sediment samples collected on the east side of the beach contained approximately 24% of the heavy mineral fraction, while sediment samples on the west side contained approximately 6%. In particular, rutile, chromite and zircon (density $> 4.5 \text{ g/cm}^3$) showed decreasing trend towards the west. Such results reflect the transport of heavy minerals, which directly depends on their density: the higher the density, the more difficult it becomes to transport them and they remain behind in places of initial cliff erosion.

This study of the coastal cliffs on the island of Vrgada has shown that the erosion of the cliffs is mainly episodic caused by intense rainfall, while the main processes on the beach are due to longshore drift and sediment loss at depth. It is assumed that further or even faster erosion and cliff retreat may occur in the future due sea-level rise and increased storms associated with current climate change.

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KEY WORDS: CLIFF, BEACH, EROSION, LONGSHORE DRIFT



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: ASSESSING BEACHES' ATTENDANCE AND PRACTICES IN A LARGE COASTAL CITY. A CASE STUDY IN MARSEILLE (FRANCE)

SESSION: MORPHOLOGY AND EVOLUTION OF COASTS AND SEEDS

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

In large coastal cities, beaches are rarely studied as recreational areas of major concern for inhabitants and places with great management challenges for local authorities (Cabioc'h et Robert, 2022). This is rather surprising since beaches are often the largest public open spaces within these cities and they host lots of activities and visitors all year round. Except in a few studies where the interactions between users and the quality of the beach environment is investigated, beach attendance and uses are generally neglected or poorly considered. Furthermore, only a very small number of large cities really monitor and know the attendance and practices of users on their beaches.

In this context, this communication proposal deals with an initiative developed in Marseille (France), within the frame of an interdisciplinary scientific observatory dedicated to the study of the French Mediterranean coasts ruled by the French CNRS¹. From 2016 to 2020, an integrated study was conducted every summer to 1) assess the attendance of different urban beaches, 2) survey users' practices, habits and preferences, and 3) get key data from beach managers (municipal authorities in charge of cleaning and beach maintenance for the seaside season), through interviews. The study consisted in collecting data on the beach from 8 am to 8 pm on several summer days, following two time frames (a full week, and the same weekday in July each year). In total, we operated in three different beaches, one of which was studied every year. Attendance was assessed from hourly photographs taken from a unique view point, from which we assessed manually the number of people, and the counting of users entering and leaving the beach where this was possible according to the beach settings. Practices were evaluated through questionnaires were administered face to face with users on the field. Some years, the study was tied with others operations conducted with other scientists sampling bathing water (for microbiological and geochemical analyzes), with the aim to investigate on the relationship between the number and the practices of users on the one hand and the quality of bathing water on the other (Labille et al., 2020; Toubiana et al., 2021).

¹ Human-Environment Observatory « Mediterranean Coasts » (OHM Littoral méditerranéen) : <http://www.ohm-littoral-mediterraneen.fr/>



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In addition, these operations were complemented by the collection and analysis of meteorological data, and the exploitation of official data for the monitoring of coastal water carried out by health authorities. The results obtained present interesting findings on several aspects. They make it possible to assess the hourly and inter-daily variability of the beach attendance, as well as this variability from one beach to the other, in relation to the hydro-meteorological conditions of the day, the users' appreciation of the quality of the beach as well as its management. They also help to better understand the beach as a system within the city at various time scale and throughout different geographical locations (who comes?, from where?, by what means?, for what duration?, for what activities?, etc.). Initiated in 2016, the study also allows for an empirical assessment of the impact of the removal of parking places on the coastal road to develop a cycle lane in 2019, as well as the return to the beach after the first Covid-19 lockdown in spring 2020 (Robert et al., 2022). Also, many reflections on the perceptions of the environment and the wishes for the future of different categories of users are another interesting outcome, since Marseille has been engaged for several years in a strategy of requalification and renewal of its coastline.

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KEY WORDS (MAX 4)

BEACH ATTENDANCE; BEACH PRACTICES; ASSESSMENT; LARGE CITY



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: Morphodynamics of the shallow seabed during the course of a storm: high-resolution direct observations

SESSION: Morphology and Evolution of Coastlines and Seabeds

AUTHORS: Noga Rozen^{1,2}, Timor Katz³, Nadav Lensky^{1,2}, Onn Crouvi¹, Oded Katz¹, Amit Mushkin¹, Amotz Agnon²

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Studying sediment morphodynamics of seabeds (the interaction between small-scale sediment transport and morphology) during storm cycles is of interest to both Earth scientists and geo-engineers; it plays a crucial part in sustainable management of coastal areas. While changes in sediment morphology before and after a storm have been previously analyzed, intra-storm morphodynamics and sediment transport haven't been thoroughly examined due to challenges in direct observations under the harsh environment during storms. Here we present direct observations of sediment dynamics and shallow seafloor morphology during a winter high-wave event along the Eastern Mediterranean Sea, off the Israeli shore.

Two adjacent observation stations with ~300 kg bases were deployed at ~6.5 m water depth, about 500 m offshore the Neurim beach stretch, central Israel. One station was equipped with a doppler current meter (Nortek Aquadopp, acquisition frequency of 1 minute at 1 Hz every hour) and a wave pressure meter (RBRwave, acquisition frequency of approximately 17 minutes at 16 Hz every hour). The second station held an underwater video camera that systematically captured 30-second long video clips of the seafloor at 20-minute intervals. The recorded storm occurred on 3-5 March 2023 and started from a significant wave height of 0.1 m, reaching 1.76 m at its peak with a current speed of 0.23 m/s.

We defined five seabed morphology categories based on observations from the recorded videos, listed from calm to most intense water and sediment motion:

- Bio – seafloor morphology preserving evidence of biological activity.
- Irregular Ripples – unorganized ripples on the seafloor.
- Parallel Ripples – parallel rows of ripples.
- Flattened Ripples – parallel rows of smoother, flatter ripples.
- Smoothing – a lack of any discernible pattern on the seafloor.



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We used four categories to describe the movement (dynamics) of individual sand grains: stagnation, creep, saltation, and suspension (or a combination thereof).

Observations demonstrated a transitional sequence in seabed morphologies during the storm progression from initiation to peak significant wave height. As the storm intensified, seabed morphology transformed from Bio (biological control) to Irregular Ripples, to Parallel Ripples. Those later transformed to Flattened Ripples, until smoothing of the seabed occurred before the storm's peak. Sediment dynamics started at stagnation and showed a shift from creep movement to both creep and saltation, and eventually creep, saltation, and suspension movements combined before peak storm.

After the storm's peak, as significant wave height dropped, seabed morphology shifted back from Smoothing to Flattened Ripples. Then it alternated between Irregular Ripples, Parallel Ripples, and Flattened Ripples until it transitioned solely to Parallel Ripples. Eventually, Irregular Ripples re-formed, with no return to Bio state when the storm stopped. Sediment dynamics displayed relative stability, maintaining a combination of creep, saltation, and suspension until the significant wave height dropped substantially, after which the movement consisted only of creep and saltation. As the wave height declined sediment dynamics switched to creep motion, until stagnation was achieved at the storm's end.

Turbidity values inclined fast as the storm rose and included a peak at the exact time of maximal significant wave height. The decline in turbidity took longer and exhibited fluctuations between higher and lower values, until the return to its initial values right before the storm ended.

Our analysis displays dependence between seafloor morphodynamics and a storm's progression. It shows that changes in seafloor morphology and sediment movement as the storm rises are faster than the return to their original state, thus suggesting that this relationship can be described by a hysteresis curve. While high waves interrupt observations, storm peak traits can be assumed similar in stronger storms.

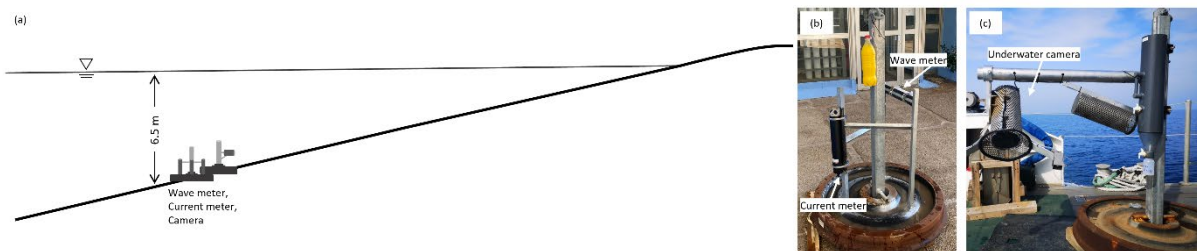


Fig. 1: Methods. (a) Observation stations setup, (b) underwater array equipped with current and wave meters, (c) underwater video camera.



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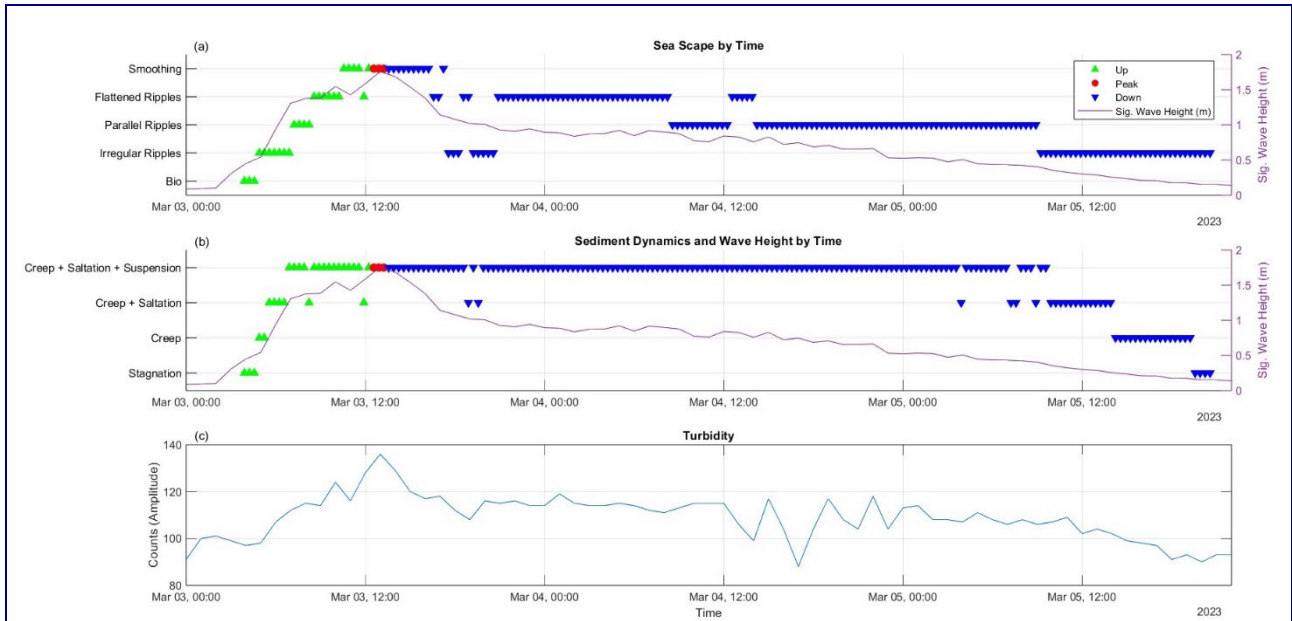


Fig 2: (a) seafloor morphology and significant wave height during the storm, (b) sediment dynamics and significant wave height during the storm, (c) turbidity values during the storm.

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
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KEY WORDS (MAX 4)

Seabed morphodynamics, waves, currents, high-resolution-time-lapse-videos



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: SHORELINE DETECTION BY APPLYING SEMIAUTOMATIC ALGORITHMS FOR HYPERSPECTRAL AND MULTISPECTRAL SATELLITE IMAGERY ON THE BEACHES OF THE GULF OF ORISTANO (SARDINIA, ITALY)

SESSION:
MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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Coastal areas are dynamic systems often exposed to multiple oceanographic and anthropogenic modifications. Their development is affected by mid- to long-term processes, and this variability makes remote sensing systems suitable and valuable tools for observing morphological variations at different time scales. Coastal information has been available through satellite imagery for nearly 30 years, and Satellite-Derived Shorelines (SDS) are now widely used to have an indirect approach to coastline behaviour and evolution. This could represent an advantage for scientists to automate the monitoring of coastal changes. However, considering the limitations related to the resolution of publicly available images, an accuracy assessment should be performed using *in situ* surveys to determine the quality of the detection.

The aim of the present work is to evaluate the evolution of the shoreline position on three different beaches of the Gulf of Oristano (Sardinia, Italy) by applying semi-automatic available algorithms for multispectral (Vos *et al.*, 2019; Palomar-Vázquez *et al.*, 2023) and hyperspectral images. The study was carried out in Arborea, Mare Morto and San Giovanni di Sinis beaches, for a 3-years study period. These three areas have different types of exposure due to their positions in the Gulf of Oristano, as well as various morphologies controlled by the presence or absence of banquettes of *Posidonia oceanica*. The studied beaches are not subjected to seagrass removal operations and tourism and human activities overall have a limited influence on these systems. For this reason, the morphological changes are mainly based on natural factors.

To compare the accuracy of SDS and the morphological changes of the beaches, available satellite algorithms for multispectral images (SAET and CoastSat) and for hyperspectral images (Souto-Ceccon *et al.*, 2023) are applied. The performance of the algorithms in the study area was tested by applying them on hyperspectral PRISMA imagery (satellite launched by The Italian Space Agency on 22 March 2019), with 5m resolution in the panchromatic band, and public optical imagery of Landsat 8, Landsat 9, and Sentinel-2, with respectively 15m and 10m of spatial resolution. In order to minimise errors and shifts between the SDSs extracted by different images, a preliminary orthorectification of the satellite images is done through ENVI software.

The SDS of September 2022, May and October 2023 were validated against RTK-GNSS surveys, acquired during fieldwork activities of the ASI OVERSEE project.

The variability of the beaches analysed in the Gulf of Oristano, the different dominant wave exposure due to the geographical beach location and the different morphologies, allowed a wide range testing of the . Furthermore, the presence of *Posidonia oceanica* debris on some of the analysed beaches is an important factor that could affect the accuracy of SDSs, with different results according to the algorithm used and the resolution of the images.

The results obtained from this work represent a useful methodological approach to monitor the shorelines in real time and the related morphological changes, by applying multispectral satellite imagery with relatively short revisit time and a large range of images availability. On the other hand, the use of hyperspectral imagery shows a promising future of applications. Additionally, the use of several algorithms allows the accuracy of the analysis and highlights the different limits detected by each methodologies. Finally, the degree of the automatism represents a way to accelerate the shoreline detections and to minimise the subjectivity due to human intervention.

This work is a contribution to the OVERSEE Project, financed by ASI under contract 2022-14-U.0.

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KEY WORDS (MAX 4) COASTAL DYNAMICS; PRISMA; COASTSAT; SAET

POSTER PRESENTATIONS



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: TOPOGRAPHIC AND BATHYMETRIC INTEGRATION WITH UAVS AND UNDERWATER PHOTOGRAMMETRY

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS: ALI ALAKBAR KARAKI* , ANGELO ODETTI**, MASSIMO CACCIA**, ROBERTA FERRETTI**, ILARIA FERRANDO*, DOMENICO SGUERSO*

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The interdisciplinary approach in coastal areas refers to a method of study and problem-solving that involves integrating knowledge and expertise from multiple fields of science. Coastal areas are dynamic and vulnerable regions where land meets the sea, and they face a wide range of interconnected issues, including environmental, economic, and social factors. Adopting an interdisciplinary approach is essential to understanding, managing, and sustainably developing these areas. One of the key issues to support coastal areas studies starts from collecting reliable geospatial data. This abstract introduces an innovative methodology that integrates topographic and underwater photogrammetry with SBES (Single Beam echosounder) using UAV (Unmanned Aerial Vehicle) and a snorkeling or ROV (Remote Operative Vehicle) on the sea surface. The primary goal is to join topographical and underwater data acquisition in a unified framework for coastal areas. The motivation lies in establishing a photogrammetric link between the snorkeler/ROV, who carries a marker during underwater data collection, and the UAV performing the topographic survey. The snorkeler/ROV effectively becomes a dynamic GCP (Ground Control Point) on the water surface with respect to the UAV. The connection between topographic and bathymetric data will rely on computing the snorkeler/ROV position. The basis to understanding the current position of a moving snorkeler/ROV on instant time will be based on orthophotos, the orthophotos will be the alternative tool rather than using GNSS (Global navigation satellite system) to compute the snorkeler's /ROV position. Crucially, this approach enables the identification of the underwater camera's center and echosounder position, inferred from the marker's placement on the snorkeler/ROV. This information facilitates understanding the spatial context of objects on the seabed within the captured images and acquired depth measurements. Central to this methodology is the precise determination of the marker's position on the snorkeler/ROV, aligned with the topographic photogrammetric survey reference system. Through Bundle Block Adjustment processes, measurements from positioned GCPs are leveraged to evaluate observation positioning accuracy. Images from UAV will be timely synchronized by underwater image and depth measurements to obtain the connection between emerged and submerged data. The culmination of these steps yields a georeferenced 3D model that spans from the underwater seabed to the terrestrial landscape, providing an RGB 3D representation of the coastal area. The model will not express only bathymetric and topographic data, but it will show the features on seabed and type on seabed. This will clearly express the reality of underwater environment which will contribute in understanding the occurring process. This methodology presents an affordable yet comprehensive solution for coastal monitoring,



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sediment transport analysis, shoreline detection, seabed classification and ecological habitat assessment. The implications extend to cost-effective coastal management and underscoring its potential impact.

REFERENCES: (MAX 4)

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KEY WORDS (MAX 4) PHOTOGRAMMETRY, TOP/BATHYMETRY MODEL, UAV, 3D MODEL



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Coastal Morphological Changes Using Video Monitoring System and Xbeach Model

SESSION:

MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS:

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coastal areas are highly dynamic environments, subject to morphological changes due to the action of waves, tides, and winds. Monitoring these changes is crucial for understanding coastal evolution and planning sustainable management strategies. The data collection method involves an HD IP video camera system implemented by the Apulian regional Basin Authority (AdBP) in collaboration with Polytechnic University of Bari located at two vulnerable sites Bruno et al. (2020), Torre Canne, Brindisi, Italy equipped with one thermal (TCth) and one visible (TCvs) camera, both face NNW, while Torre Lapillo in Porto Cesareo, Lecce, Italy (PC) has two visible cameras (PCvs1, PCvs2), directed NW and SE respectively. The video monitoring system captures images every 30 minutes and stores them to the local servers providing an automatic shoreline extraction from Timex images by the Shoreline Detection Model (SDM) Valentini et al. (2017), and then uploaded subsequently to a dedicated website (<http://93.51.158.173/>), allowing the users to show Timex (oblique and georectified), snap, and standard deviation (STD) images, as well as georectified shorelines in quasi-real time. The resulting shoreline data from the SDM offers invaluable insights into the temporal dynamics of beach morphology and shoreline positioning. This paper focuses on the validation of a model framework for predicting beach evolution on embayed sandy beaches by Xbeach Roelvink et al. (2009), which is designed to simulate coastal morphological changes. To validate the model, the measurements from a video-monitoring station, gathered during two storm events in 2016 will be used. Combining multibeam and d-RTK surveys with Unmanned Aerial Vehicle (UAV) imagery provides a high-resolution depth grid, particularly essential in shallow waters where wave hydrodynamics strongly interact with the bottom. This study centers on the coastal regions of Torre Lapillo, Lecce, Italy which has low-lying shores with sandy and calcarenite rocky beaches and generally experiences a moderate to low wave climate, with the primary wave directions being SSE and SW. The aim is to analyze shoreline changes, sediment accumulation patterns, and crucial beach parameters such as width, foreshore, and swash zone slopes. It introduces innovative and standardized methodologies for investigating shallow water hydrodynamics and morphodynamics, including Run-up and shoreline temporal evolution.



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The integration of various data sources, including wave characteristics, wind patterns, tide information, bathymetric/topographic data, and video data, enables precise simulations of beach behavior and morphological changes over time. By evaluating the Xbeach model's accuracy in replicating observed coastal dynamics, the validation of its performance is sought to enhance confidence in its predictive capabilities. This validation process ensures the model's efficacy in supporting future coastal management and hazard mitigation efforts. To further enhance the study's impact, the potential for using remote sensing technologies like LiDAR and satellite imagery in conjunction with the existing data sources will be explored. This multi approach promises a more comprehensive understanding of coastal dynamics and strengthens the foundation for informed decision-making in coastal management and risk mitigation.

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KEYWORDS: (MAX 4)

Coastal monitoring, Video system, Coastal morphodynamics, Xbeach



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: Human activity and recent changes in Baia Flaminia beach, northern Marche region (Central Italy).

SESSION: MORFOLOGIA ED EVOLUZIONE DELLE COSTE E DEI FONDALI

AUTHORS: DAVIDE BAIONI¹, OLIVIA NESCI² & VITTORIA VANDELLI¹

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ABSTRACT

Shoreline change is one of the most common natural processes that prevail upon coastal areas. The most important aspect of managing coastal areas is identifying the location and evolution over time. The location of the shoreline and its historical rate of change can provide important information for the design of coastal protection and plans for coastal development.

This paper describes the preliminary results of a research about the recent changes in shoreline positions and beach morphology of along the northern coast of Pesaro, focusing on the very recent variation recorded in the Baia Flaminia beach.

Pesaro is a coastal town located in the northern Marche region (Central Italy) which developed near the mouth of the Foglia River in a very favourable position that improved its urban spreading. The morphology of the Pesaro coastal plain area is due mainly to the tectonic structure, as well as the configuration of the lower plain of the Foglia upstream of Pesaro, which is characterized by an extremely low slope. The relief anticline has partially hindered the outflow of the Foglia River towards the sea, favouring the formation of large fluvial bends and the accumulation of predominantly silty-sandy alluvial sediment.

The Baia Flaminia beach is a narrow and elongated strip of low coast of about 800 m, represented by a sandy beach, located between the San Bartolo hill to the north and the mouth of the Foglia river to the south. Offshore, about 150 m from the shoreline, submerged reefs parallel to the coast were built in the early 1990 and have been modified in 2007.



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The human impact on this part of the coastal area, even if it has been particularly active recently only, is going to influence evidently the geomorphological processes. The very recent development of human activity and its modification of the coast seem to be strictly related with the changes of the morphology of the Baia Flaminia beach.

The shoreline position changes and morphology of Baia Flaminia beach are investigated for the period from 2003 (Fig.1a) to 2023 (Fig.1b) using satellite HD images and aerial photos.

Comparative analyses images integrated with field activity highlight that the main shoreline variation and changes in beach length and area, can be observed after the construction and modification of coastal structures, due to human activity, placed in 2007. In particular, our investigation indicates that the greatest changes of Baia Flaminia beach occurred both in the southern and northern area where the results of deep erosion can be well observed (Fig.1b), .

The study carried out highlight a close correlation in time between the modifications of the submerged bars and of the mouth of the adjacent Foglia river and those of the morphology of the beach and the coastline, which appear to follow the anthropic modification.

Therefore, our study suggests that the changes observed in recent times in the Baia Flaminia beach seems to be related mostly to human activity, specifically to the modifications on the territory related to economic development and population growth, rather than to meteorologic and/or other natural factors.

KEY WORDS: SHORELINE CHANGES; HUMAN ACTIVITY; BEACH EVOLUTION.



Figure 1: a) image of Baia Flaminia beach taken in 2003; b) image of Baia Flaminia beach taken in 2023. Images HD taken by the website google Earth (www.googleearth.com).



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: CLIMATE CHANGE, POLLUTION AND EROSION OF THE COASTAL STRIP
SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <p>The studies we have carried out in the coastal strips along the Italian coasts have shown, in recent years, often mutable changes. Having carried out multi-year research, in the same marine areas, is the only certainty of the scientific recording of past and ongoing changes.</p> <p>In many beaches along the entire coast of the provinces of Livorno and Grosseto (Tuscany), we have recorded a notable retreat, even by many meters, of the beaches used for tourism which has often led to a forced reduction in their use for tourist purposes and, consequently, great economic damage to campsites and tourist residences.</p> <p>But why has there been a noticeable decline in the areas we studied?</p> <p>In our research we combine the sampling of all the animal and plant species that inhabit the area under study together with the chemical analyses of the substrate whose samples are taken to the CNR ICCOM of Pisa.</p> <p>But why has this notable continuous retreat of the beaches occurred in the coastal strips we investigated?</p> <p>The first investigation, when obvious change in the size of sandy coasts is noticed, is to check whether there are nearby wastewater discharges into the sea. Year after year we have noticed a retreat towards the sea of the <i>Posidonia oceanica</i> (L.) Delile, 1813, which, being a marine phanerogam with stem, roots and leaves with which is well anchored to the seabed, defends the coast significantly, reducing the strength erosive shock of waves during strong storm surges (fig. 1).</p> <p>Our research has highlighted that to carry out nourishment of coastlines eroded by large storm surges it is first necessary to find tools to reduce the impact force of the incoming waves.</p> <p>The presence of beach rocks imitates the beach defense function of <i>Posidonia</i> meadows. That the beach-rocks are an obstacle before the waves arrive on the coast to save the beach is demonstrated, very simply, by the aerial photos of the coasts studied. The foaming of the wave makes us understand that it hit the rock, which is lower than the wave on the surface as well as the meadow greatly reducing the impact force.</p> <p>The aerial photos of the beach rocks make us see, and understand, that in the fractures between rocks, even a few meters, the wave penetrates with all its force and erodes the part of the beach in</p>



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front (fig. 2).

Our proposal to our Tuscan region was to close the gaps between the rocks with stones and only subsequently carry out the nourishment with sand of the eroded parts of the coast.

Coastal erosion is closely linked to human activities in the areas in front of the coasts and this can also be demonstrated with the relative changes in the biocenoses related to them over time. The rise in temperature throughout the Mediterranean Sea has led to the arrival of alien species from all over the seas, both animal and vegetal.

In our studies on the coastal strips, we have often measured the distance from the shore line reached by the waves which, in some cases, have reached and exceeded 80 m in length. This great impact force makes us understand why the defense made between the beach and the dunes have always been destroyed by the waves of strong storms on the beaches we studied.

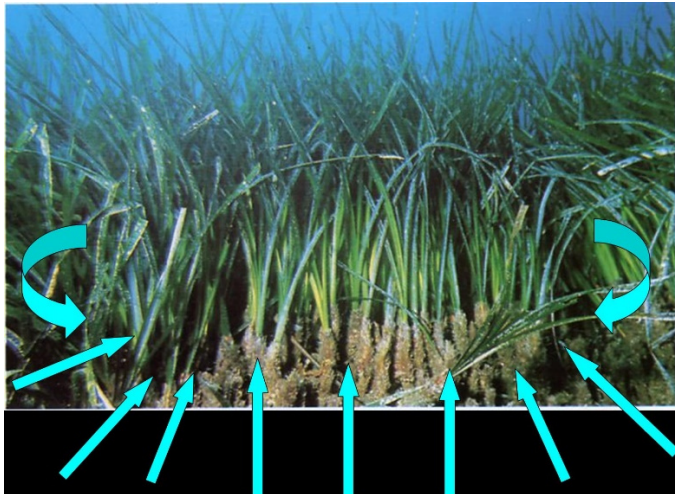


Fig. 1: Posidonia meadow that reduce the strength of the waves



Fig. 2: fracture between the beach rocks



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REFERENCES: (MAX 4)

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KEY WORDS (MAX 4) **POLLUTION, EROSION, BEACH ROCKS, WAVES**



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: POLLUTION PAR LES MICROPLASTIQUES DU LITTORAL DE ANNABA EXTRÊME NORD-EST ALGÉRIEN : ABONDANCE , DISTRIBUTION , COMPOSITION ET RISQUE

1. Session: MORPHOLOGY AND EVOLUTION OF COASTS AND SEEDS

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Résumé :

Les microplastiques sont des particules de plastique de moins de 5 mm ; qui s'accumulent dans l'environnement marin. Ils peuvent être ingérés par les organismes marins et ainsi entrer dans la chaîne alimentaire. L'objectif est d'établir un état de la contamination par les microplastiques des trois matrices eaux de surface, sédiment et biote (*Perna perna*). Nos investigations se sont focalisées sur la contamination par les microplastiques du littoral d'Annaba, un système côtier où l'activité anthropique est importante. Des microplastiques ont été prélevés sur trois stations différentes représentant différentes activités. Les microplastiques dans les sédiments ont été extraits par la méthode de séparation par densité à partir des échantillons prélevés selon la méthode (Crawford and Quinn, 2017). Les eaux de surface selon la méthode (Kukulka et al., 2012 ; Viršek et al., 2016) et du biote selon le protocole (Dehaut et al., 2016). La reconnaissance des fibres synthétiques est établie grâce aux critères suivants (Hidalgo-Ruz et al. 2012). Les résultats obtenus témoignent de la contamination de différentes matrices par les microplastiques. L'eau de surface et le sédiment sont contaminés avec des concentrations de (10 à 48000) P/Km², et de (3000 à 14000) items/Kg respectivement pour l'eau et sédiment. Le biote montre des concentrations plus faibles allant de 3 à 34 P/ Individu. La prédominance de fibre comparativement à d'autres microplastiques semble caractériser les sources de contamination. Cette tendance est aussi retrouvée dans les autres matrices. Les autres formes de particules seraient moins concentrées dans les milieux récepteurs. L'analyse des microplastiques par spectroscopie infrarouge à transformée de Fourier à réflectance totale atténuée (ATR-FTIR) a montré que les principaux polymères présents dans les microplastiques étaient le polyéthylène, le polypropylène, le polystyrène, le butyl branham, l'éthylène-propylène et le tri-acétate de cellulose.



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MICROPLASTIQUES , EAUX , SÉDIMENT , BIOTE , FIBRE , LITTORAL DE ANNABA.



Tenth International Symposium

**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: ONE-YEAR EVOLUTION OF A MEDITERRANEAN SANDY BEACH WITH *POSIDONIA OCEANICA* BANQUETTES (ARBOREA, SARDINIA, ITALY)

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The morphology of sandy beaches is controlled by several factors (i.e. tidal changes, current or wave exposure, etc.), which are highly site-specific. Typically, the morphology of a beach changes according to a wide range of temporal scales, ranging from interannual, seasonal or short-term changes driven by coastal storms. The storm period is generally characterised by higher waves that can impact and generate erosion and flooding, which change the morphology of the beach and even affect the dunes if present. The morphological response of a sandy beach depends not only on hydrodynamic impact but also on the presence of unique elements on the beach itself that can mitigate wave action on human infrastructures or natural features.

A natural characteristic that can change the behaviour of the beach morphology is the presence of banquettes of *Posidonia oceanica*. *Posidonia* is a seagrass species from the Mediterranean Sea, which can be present on sandy and rocky substrates from Turkey to Spain, covering at least 25% of the Mediterranean coastline (Pérez-Lloréns et al., 2014; Telesca et al., 2015).

This seagrass species often accumulates debris on the beach face, forming a natural structure commonly called banquette. Due to the economic importance of these areas, mainly related to touristic activities, *Posidonia oceanica* banquettes are often removed to improve the aesthetic appearance to tourist's eyes. The presence of seagrass litter reduces the attractiveness of the beach, and therefore, its removal is often practised. Nevertheless, removing seagrass eliminates not only its protective advantages like wave and current attenuation and sediment trapping but also the part of the beach sediment that is removed with the *Posidonia*, which depletes the sediment budget of the beach (Simeone and De Falco, 2013).

The present study aims to analyse the morphological evolution of Arborea Beach during one year and the conditions under which the *Posidonia* banquette was developed. To achieve the objectives, the study focused on the beach changes associated with coastal storms and seasonal variations.

Arborea Beach, located in the southern part of the Gulf of Oristano (Sardinia, Italy), is a natural sandy beach characterised by the presence of banquettes of *Posidonia*. The presence of the seagrass, together with the low anthropogenic influence in the area, were two factors that made Arborea chosen for this study. Five surveys were performed during a period of one year, where data from UAV aerial surveys, GPS profiles and alongshore measurements (i.e. instant shoreline and upper limit of the banquettes) were collected. The fieldwork includes a post-winter survey, two post-summer surveys and a pre and post-storm survey. Changes in the beach morphology are often associated with wave impact; therefore, the wave climate was analysed, and extreme events were identified during the study period. The dataset gathered from an extreme wave event allowed us to understand the dynamics of *Posidonia* deposition and the beach morphological changes before and after the event, showing the formation of a banquette on the beach face. Concerning the seasonal changes, the beach morphology presented variations in the banquette deposition. In the post-winter profiles, *Posidonia oceanica* banquettes were visible. This can be related to the regime of waves being higher during the winter period and also due to the higher number of extreme events. The lower wave action in the summer does not transport the debris to the beach face, resulting in a lower presence of banquettes.

The results from both seasonality and the extreme events demonstrate that the formation of *Posidonia* banquettes is highly related to the wave impact on the beach. This information regarding the formation of banquettes during a coastal storm and in winter can be crucial for the local authorities to manage the area.



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PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

This is a contribution to the OVERSEE Project, financed by ASI under contract 2022-14-U.0.

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KEY WORDS (MAX 4)

**POSIDONIA OCEANICA;
BANQUETTES;
BEACH MORPHOLOGY;
COASTAL STORMS.**



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: *RICCIONE'S STUDY CASE: EXPERIMENTATION OF INNOVATIVE ARTIFICIAL REEF FOR COASTAL DEFENCE AND INCREASE MARINE BIODIVERSITY*

SESSION: MORPHOLOGY AND EVOLUTION OF COASTS AND SEEDS

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Abstract (min 3000 max 4000 characters):

General frameworks: Riccione's study case about experimentation of innovative artificial reef for coastal defence and increase marine biodiversity.

Objectives: present results demonstrating the positive impact of underwater artificial barriers on water quality (oxygenation) and increase marine biodiversity (rocky and sandy seabed) in the marine area of Riccione (RN).

Main findings, results, and indications of the proposed work:

Blennius is an association of volunteers committed to the dissemination, research and awareness of the marine wealth of the North Adriatic, with particular reference to the area of Riccione.

Riccione is a town on the Romagna coast (near Rimini) with a small port and with the problem of coastal erosion that, reducing the width of the beaches, can create great problems for tourist activities and buildings in case of adverse weather events (so frequent today).

Since eighties of the twentieth century, underwater artificial barriers have been placed for coastal defence from waves and storms on the natural sandy seabed of this area..

This was a new, because it was usual to place emerged barriers (also today in several situations), and this choice had, and has, several advantages: the contrast to erosion (still under study), the maintenance of water oxygenation (the water does not stagnate and the oxygenation remains good) and increased biodiversity, thanks to the combination of sandy and rocky environments.

Initially they were "sandbags"- bags of synthetic material filled with sand - arranged parallel to the coast, about 200 meters from the shore, at a depth of about 2/3 meters.

In the last ten years, other experiments were done, with positioning of other types of barriers (innovative barriers as "reef balls" and "w-mesh") always parallel to the coastline and close to shore.

Now, attention and experimentation are focalized on w-mesh (see photo of the last positioning).

Our monitoring, in these years, focused on technical stability of these structures and on their biodiversity impact and its increase and evolution.

The results about the action of contrast to coastal erosion are still under evaluation and work in progress (the experimentation and the monitoring continue).

The results about the biodiversity monitoring demonstrated great enrichment of environmental biodiversity: several species of rocky environment colonized these reefs, increasing environmental reachness.



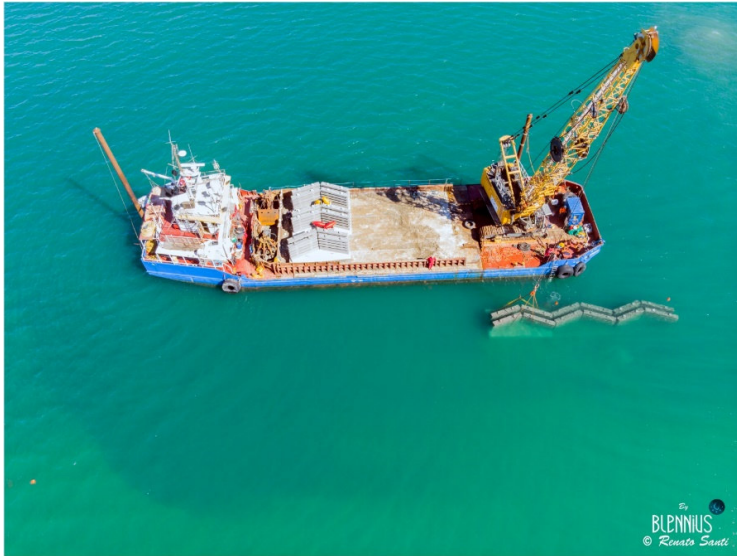
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Making these results known to the general public (with specific dissemination events) made it possible to carry out an important awareness-raising action for the protection of the environment itself.

*In these years, we have also provided data for the study of the presence/ absence of target species with the protocol Reef Check Great Adriatic Barrier and have participated to collections of samples of *Anemonia viridis* for the study conducted by Dr. Giorgia Palladino et al, 2022 (UNIBO and Fano Marine Center), concluded with the scientific article "Plasticity of the *Anemonia viridis* microbiota in response to different levels of combined anthropogenic and environmental stresses", published in the scientific journal "Frontiers in Marine Science".*

The monitoring action on biodiversity continues to verify its evolution on/of these artificial structures and the impact of ongoing climate changes in addition to the aspect of combating marine erosion.



REFERENCES: (MAX 4)

1. Monitoring of coastal ecosystems
2. Biodiversity
3. Underwater barriers
- 4.

KEY WORDS (MAX 4)



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FORM FOR ABSTRACTS PRESENTATION

TITLE: Identifying cliffs morphodynamics: a 3D GIS approach for a better hazard management. Examples in Croatia
SESSION: Morphology and evolution of coastlines and seabed
AUTHORS: Olivier COHEN ¹ , Kristina PIKELJ ² , Emmanuel BLAISE ¹
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): Coastal cliffs around the world are less studied and less known to the scientific community than low-lying sedimentary coastlines (Naylor <i>et al.</i> , 2010). However, these coastlines can highly be at risk when human infrastructure is built close to eroding areas (e.g. Blaise <i>et al.</i> , 2022). Scientific studies focus on mapping coastal evolution to quantify and predict shoreline retreat or on identifying the geological, marine and meteorological factors involved in the cliff morphologies and movements (e.g. Pikelj <i>et al.</i> , 2018). Quantitative analysis of cliffs morphodynamics is less frequently addressed (e.g. Roulland <i>et al.</i> , 2022) perhaps because of the difficulty of making in the field measurements in an environment with a steep and more restrictive topography than that of a beach or a dune. Over the last 25 years, airborne Lidar and photogrammetry have encountered an increasing success in the scientific community of Earth sciences specialists. It helps to collect a large amount of precise data as well to a transition from 2D to 3D cartography and terrain modelling. Such successive topographical surveys are very valuable for assessing the morphodynamics of the cliffs, for example by detecting changes not only in the horizontal displacement of the coastline, but also the profile characteristics and the volume of the cliffs and their evolution. In this paper, we depict a simple method to elaborate and map a multivariate index for coastal cliffs. The final map aims to classify zones at low, medium and high hazards related to morphodynamics. This classification is a synthetic description that has to be later explained with geological, marine and meteorological features.



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The data are gathered and the index is computed at regularly spaced and close locations along the shoreline. The index uses two sets of data. (1) 2D data: shoreline evolution, determined for example from a diachronic analysis of aerial photographs with measurements along transects. (2) 3D topographical data extracted from a Digital Elevation Model (DEM) and its derivatives: height of the cliff, slope). Each of these evolutionary and morphological parameters has a meaning in terms of hazard identification. The more rapid the shoreline retreat is, the more human infrastructures are threatened. The highest the cliff is, the bigger is the kinetic energy of a falling block (and the height of fall for an unfortunate pedestrian too). The steepest the slope is, the more rapid a mass movement might be as well as the risk of a person of slipping increases. So, a low cliff with a slow evolution rate, a mild slope should be less “dangerous” than a high and steep one rapidly eroding.

For each measurement points along the shoreline, three parameters are available. In the analysis depicted here, they are considered to have a similar role in the cliff morphodynamics and therefore will not be weighted in the statistical analysis. A hierarchical cluster analysis will be performed to identify groups of points with similar level of “hazard potential”. These levels are then mapped into a GIS using different colours.

The sites selected for this study are located in Croatia. The first is the coastal cliff of Duilovo in the urban area of Split, which was formed in Eocene Flysch. The lithology of this rather steep (up to 90°) coastal segment comprises mostly easily weathered marls with occasional outcrops of more resistant sandstones. Erosional processes along the studied cliff include rockfalls and rotational landslides assisted by water, while weathered marl particles are moved downslope by gravity during dry periods (Pikelj et al., 2018). The second coastal cliff is located on the island of Vrgada. Its lithology comprises Pleistocene aeolian-alluvial clastites. Massive episodic rockfalls usually occur at this 90° steep cliff. At both locations wave action is not the key process in the formation of the cliffs, however, it carries away debris cones and other forms of material accumulated downslope. Morphodynamic analysis on both sites will be tested and presented for the first time.

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Key words (MAX 4): Cliffs, hazards, Geographical Information System, Croatia



Tenth International Symposium

**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

**SEASONAL CHANGES IN GRAIN SIZE OF SEDIMENTS ALONG
CLIFF-DOMINATED BEACHES, ISRAEL'S MEDITERRANEAN
COAST**

SESSION:

MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS:

Onn Crouvi, Ran Shemesh, Oded Katz, Amit Mushkin, Navot Morag, and Nadav Lensky

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E-MAIL ADDRESS:

ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Today, many coastal regions are considered as high-risk areas due to predicted sea-level rise and increase in human pressure on these resources. This recognition led to the development of increasingly complex coastal evolution models that can predict how the coast and adjacent cliff (if exists) will be affected due to different climatic scenarios. However, although substantial progress in the research of the coastal region has been made in recent years, we still lack a basic theoretical framework of how coastal processes interact with each other and influence the changes and responses to interventions at different stages of development. One of these knowledge gaps is the sedimentological dynamics of beach and coastal cliff sediments (and the interactions between them); this gap is the focus of this current study. Beach morphodynamics are largely controlled by the interaction of wave climate with beach sediments. Local changes in sediment grain size, shape or density can lead to distinct morphological changes of beach systems subjected to similar energetic inputs. Whereas the spatial variation of grain size along beach profiles has been well studied, the temporal variation in beach grain size has received less attention. Moreover, the fate of cliff-eroded sediments along sandy coasts, with limited tidal effect, was rarely studied as most studies focused on shingle beaches (rocky/pebble rich) especially in coastal environments where tide plays an important role.

Here we use grain size data to explore the temporal dynamics of beach sediments in cliff-dominated beaches along Israel's Mediterranean coast and their relationship to cliff erosion as well as sand



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abrasion/attrition. Our approach is based on repetitive seasonal-scale sampling of surficial sediments along cross shore transects over 3 years. We hypothesize that for a given location along the cross-shore transect: 1) Coarsening of the particle size distribution (PSD) with time is related to the addition of sediments from the cliff, and 2) Fining of the PSD with time is related to physical weathering (abrasion by waves and wind, depends on the location along the beach).

We found that most samples exhibit unimodal PSD, with a mode either at the fine sand fraction (180-220 μm) composed of quartz, or at the coarse sand to very coarse sand fraction (900-1,200 μm), composed of eolianite rock chips. The coarse fraction dominates the PSD mostly during winter times, whereas at summer times it is usually absent. In addition, this coarse fraction decreases with time that passed since waves reached the cliff base during sea storms. Our results suggest that: 1) The addition of the coarse fraction during winter is related to high-energy wave storms that mobilize and transport cliff-derived materials (taluses) along the beach, and 2) The disappearance of the coarse fraction towards summer is most likely related to sand abrasion by wave and/or by wind action, i.e. breakage of the ~ 1 mm eolianite rock chips into ~ 200 μm quartz grains. Our findings emphasize the importance of cliff erosion and sand abrasion in controlling the temporal variation in PSD along cliff-dominated beaches.

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4)

PARTICLE SIZE DISTRIBUTION, BEACH, COAST, CLIFF EROSION



Tenth International Symposium

MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: "MACHINE LEARNING FOR SUSTAINABLE LAND MANAGEMENT: A GLOBAL SOIL SALINIZATION STUDY"

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS: MATTEO DALLE VAGLIE

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Introduction

On a global scale the accumulation of excessive soluble salts in soils is a serious threat to coastal areas, environmental sustainability, and agricultural productivity. Effective measures and predictions of soil salinity is necessary to estimate the negative effects of this phenomenon on food markets, sustainable production, and ecosystem balance. Modern machine learning techniques have become effective tools for deciphering intricate data patterns and making precise predictions. (Wang, 2009) (Hassani, 2021) In order to create an efficient forecasting model, this study focuses on cutting-edge machine learning techniques to redefine the state of the art in this sector.

Objectives

The main goal of this study is to develop an accurate forecasting model to assess the impacts on consumption, production, and ecosystem services of soil salinity in degraded agricultural land under climate change scenarios. This aspect is crucial for developing effective mitigation strategies and practices for a sustainable development. Furthermore, the economic consequences for agricultural-related firms and labour market dynamics necessitate careful examination. The predictive model's ability to forecast soil salinity levels can provide insights into yields reduction, decreased quality of harvested products, and increased production costs, all of which are critical considerations for sector businesses. To quantify the impacts on labour and food market we will use a combination of mixed effects model and geographical weighted regression. This rationale aims at disentangling the complex ensembles of factors that shape the market response and subsequent market outcomes in the face of this risk.

Methods

The proposed research will be conducted in multiple phases, focusing predominantly on mapping, and analysing soil salinity in coastal areas using advanced machine learning techniques. Initially, the study will involve collecting extensive datasets on soil conditions, climate patterns, and ecological parameters from various coastal regions. The data acquisition phase will prioritize gathering high-resolution satellite imagery, ground-based sensor readings, and historical soil composition records. Following data collection, the research will progress to the data preprocessing stage, where cleaning, normalization, and transformation of the datasets will be performed to ensure compatibility with machine learning algorithms. The core phase of the project will involve the application of advanced machine learning



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techniques to analyse and map soil salinity patterns. This stage will utilize a combination of supervised and unsupervised learning algorithms, including neural networks, decision trees, and clustering methods, to identify patterns and trends in soil salinity. The machine learning models will be trained and validated using a portion of the collected dataset, and their performance will be evaluated using metrics such as accuracy, precision, and recall. In parallel with the machine learning analysis, the research will also involve developing a dynamic mapping system. This system will integrate the findings from the machine learning models into interactive maps that provide visual representations of soil salinity levels across different coastal areas. These maps will be designed to be user-friendly and accessible to a broad range of stakeholders, including researchers, policymakers, and agricultural professionals. Throughout the project, regular progress meetings and reviews will be conducted to ensure that the research stays on track and adheres to the highest scientific standards. The research team will also engage in continuous learning and adaptation, incorporating new techniques and methodologies as they become available in the field of machine learning and environmental analysis.

Conclusion

In conclusion, this research aims to significantly advance the understanding of soil salinity in coastal areas through the application of cutting-edge machine learning techniques. By accurately mapping and analysing soil salinity patterns, the study will contribute valuable insights into environmental sustainability and agricultural productivity in these regions. The development of a dynamic mapping system will further enhance the practical utility of the research findings, providing a powerful tool for decision-making and policy formulation. Ultimately, this research will pave the way for more effective and targeted interventions to mitigate the adverse effects of soil salinity on coastal ecosystems and agricultural lands.

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KEY WORDS: SOIL SALINIZATION, MACHINE LEARNING, FOOD SECURITY, SUSTAINABLE DEVELOPMENT



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Impacts of harbour works on the Italian coasts: a methodological approach to measure areas affected by sea-land changes.

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS: FILIPPO D'ASCOLA, MARIA LUISA CASSESE, PAOLA LA VALLE, DANIELA PAGANELLI, RAFFAELE PROIETTI

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The coastal zone, representing the land-sea boundary area, constitutes one of the most critical areas, subject to environmental degradation, not only because of the fragility typical of the transitional environment, but also because of the conflicting interests generated by the numerous economic activities. Anthropogenic activities as urbanization, industrialization and tourism have accelerated, in many cases strongly changed, the natural evolution of Italy's coasts, especially since the 1950s. This transformation, which has affected both the emerged and submerged coastal strip, is mainly associated with the construction of defense works and ports. In particular, the historical evolution of the function of harbors has resulted in their significant increase in number and size, with impacts that are related to production, commercial and tourism activities. In contrast, the lack of an updated legislation, of an adequate project development and of environmental monitoring of impacts on harbor infrastructures cannot yet be considered complete and homogeneous at the national level. The coastline study plays a key role in the monitoring activities aimed at analyzing changes on coastal environments induced by harbor infrastructures.

The Italian National Centre for Coastal Defence (CN COS) of ISPRA has carried out the characterization and the monitoring of the coast and coastal dynamics studies at national level. As of today, the CN COS has gathered a range of information on the coastal strip from the backshore to the shoreline over a period of approximately 20 years (2000-2020). This activity allowed to develop a Geodatabase containing the linear information on the characterization of natural and artificial elements shaping the coast, derived from photointerpretation of aerial and satellite images. The purpose of this paper is to assess the impact induced by the realization of harbor works (infrastructures and basins) on the coastal zone at national level analyzing the coastline variation and defining areas impacted by the structures.

The methodological approach used provided a specific analysis using the information layers of



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three different periods 1950, 2000, 2006 realized by ISPRA for the characterization of the coastline, together with documents and historical cartographies to cover the entire Italian territory.

This approach allowed to recreate the "ante-harbor" line, that defines a representative line of the coastal asset before the construction of the harbor, thus representing the reference baseline. This line was compared with the 2006 harbor line (HL_2006), that has been created using orthophotos from flight IT2006 provided by Ministry of the Environment.

The comparison of the two lines (ante-harbor line and 2006-harbour line) allowed to quantify not only coastline changes, but also areas impacted by the structures, with specific reference to 3 types of coastal impacts: Sealing, Submerged Alteration Zone and Excavation Areas.

The direct and comprehensive measurement of the three types of impacts, including the large historic harbors and the smaller structures distributed on the coast, can be a useful base in order to study the historical evolution and impact of harbor works on the Italian coastal territory, in agreement with a sustainable coastal management.

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4) COASTLINE CHANGES, ENVIRONMENTAL IMPACTS, HARBOR INFRASTRUCTURES



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: ENVIRONMENTAL AND DENSITY-DEPENDENT EFFECTS ON MEGABENTHIC BIVALVES DIVERSITY IN THE SUBTIDAL AREA OF THE GULF OF CADIZ

SESSION: MORPHOLOGY AND EVOLUTION OF COASTS AND SEEDS

AUTHORS: DELGADO, M., ROMÁN, S., SILVA, L., RODRÍGUEZ-RÚA, A., LLORENS, S.

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General framework

The Gulf of Cádiz (GoC) constitutes one of the most complex systems in the global ocean, due to the exchange of water masses connecting the North Atlantic Ocean and the Mediterranean Sea through the Strait of Gibraltar (Sánchez et al., 2017) and the presence of several river outflows. These characteristics promote high biological productivity, making it one of the most important fishing grounds in the Iberian Peninsula. Furthermore, the sedimentary seabeds of its coastline favor high biodiversity and the settlement of marine bivalves of molluscs (Gofas et al., 2011; Biton, 2010). Despite its ecological importance, community or diversity studies are scarce in the subtidal area of the Huelva coast (GoC) including the maritime front of the Doñana National Park (Site of Community Importance).

Objectives

The objective of the present work was to investigate the effects of environmental (water column and sedimentary bottom floor characteristics) and density-dependent factors on diversity indices.

Main findings, results, and indications of the proposed work

Material and Methods

The study area is located in the SW Iberian Peninsula (GoC) and covers the subtidal area from the mouth of the Guadalquivir River to the mouth of Guadiana River (Huelva coast) (Figure 1). Sampling strategy and data collection are described in Delgado et al. (2023). At each station, richness, Shannon and evenness diversity indices were calculated. The effects of environmental and density-dependent factors were investigated, and the total bivalve density and diversity indices were modeled using generalized additive models (GAM). The environmental explanatory variables considered in the models were: depth, distance to the nearest river mouth and wastewater treatment plants, chlorophyll-*a* concentration, sea bottom salinity, sea bottom temperature, sea bottom turbidity, mean sediment grain size and sediment organic matter. The population density of *Chamelea gallina* has been incorporated as a density-dependent covariate.

Results

Figure 2 shows the best GAM for each response variable. In general, the most frequent explanatory variable for



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models was *C. gallina* density. The high level of collinearity of *C. gallina* density with total bivalve density also informed about the dominance of this species in this ecosystem (linear model, $p < 0.001$). *C. gallina* density established a positive relationship with specific richness but an indirect relationship with Shannon and evenness indices. *C. gallina* is not a reef-building species like mussels or oysters, but an increase in their presence could positively influence the abundance of other species as a product of a common benefit. However, the decrease in Shannon and evenness indices reflect that an increase in *C. gallina* abundance, within certain limits, is not accompanied by a proportional increase in the density of other species or a higher level of heterogeneity in the community. Depth and sea bottom temperature also determined diversity indices and total bivalve density. The organic content of sediment (OM), sea bottom temperature and distance to the nearest river mouth and wastewater treatment plants explained in lesser extent some diversity indices and bivalve density, respectively. Bottom turbidity, sediment grain size and chlorophyll a concentration were not significant explanatory covariates in the best GAMs.

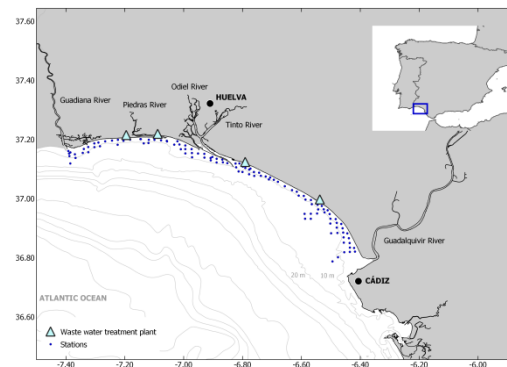


Figure 1. Iberian Peninsula and the SW Spanish coast of the Gulf of Cádiz (blue box). Sampling stations during ACUVEN-3 survey (blue points).

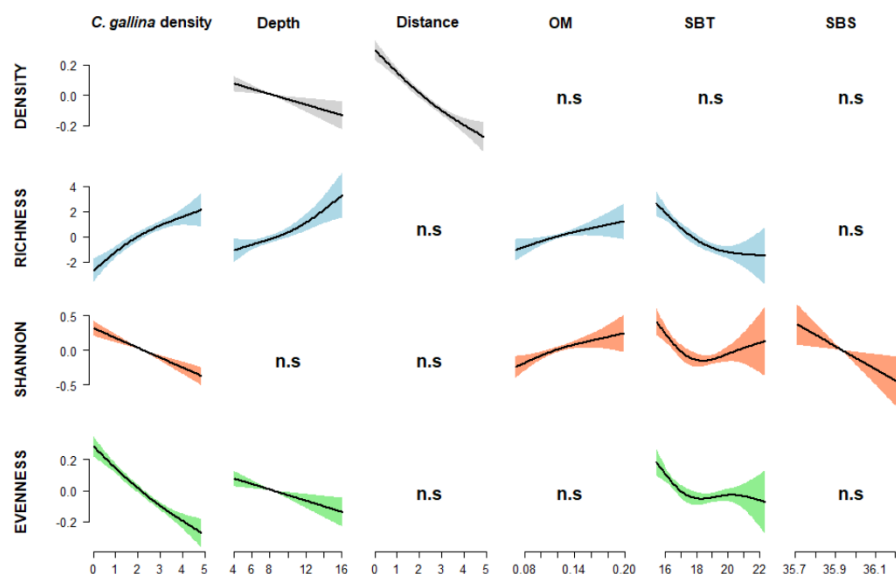


Figure 2. Effects of *C. gallina* density and environmental variables [depth (m), distance (km), organic matter in sediment (OM, %), sea bottom temperature (SBT, °C) and sea bottom salinity (SBS, psu)] with a statistical significance on bivalve density and ecological indices.



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Acknowledgements

The present study was developed within the framework of the project VENUS (Estudio integral de los bancos naturales de moluscos bivalvos en el Golfo de Cádiz para su gestión sostenible y la conservación de sus hábitats asociados) (0139_VENUS_5_E) cofinanced by the European Regional Development Fund (FEDER, Interreg V-A España Portugal (POCTEP) 2014-2020 program) and the project IN-BENTO (Desarrollo de bioindicadores para el seguimiento de los ecosistemas intermareal y submareal sometidos a explotación marisquera en el litoral de Huelva) (Plan Complementario de I+D+i, Plan de Recuperación, Transformación y Resiliencia, área de Biodiversidad, Junta de Andalucía; NextGenerationEU).

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KEY WORDS (MAX 4): *CHAMELEA GALLINA*, DIVERSITY INDICES, ENVIRONMENTAL VARIABLES, DENSITY-DEPENDENT EFFECTS



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FORM FOR ABSTRACTS PRESENTATION

TITLE: Multi-technical approach for coastal changes reconstruction in an urbanized context
SESSION: Morphology and evolution of coastlines and seabeds
AUTHORS: Giovanni Fasciglione ¹ , Guido Benassai ¹ , Gaia Mattei ¹ , Gerardo Pappone ¹ , Francesco Peluso ¹ , Pietro P.C. Aucelli ¹
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ABSTRACT: <p>Nowadays Google Earth™ and other open-source programs such as Copernicus etc., are revolutionizing the approach to coastal geomorphological studies allowing advanced spatial analyses in the framework of mapping and risk prediction studies related to both anthropic and natural forcing. Their use typically needs to be combined with field measurements, more sophisticated geographic information system (GIS) analyses and related tools. In this context it is well-known that the construction of barriers strongly modifies coastal morpho-dynamics, therefore the effective management of these areas implies a full understanding of their impact on both coastal assets and sediment circulation.</p> <p>In this research, we coupled the spatial analysis of global open access dataset (meteo-marine data provided by the Central Tyrrhenian Sea Port Authority, aerial and satellite photos dating from 1994 to 2021) and high-resolution data (morpho-acoustic data carried out before the construction of the breakwaters and in May 2023) collected by using innovative technologies for marine surveys in order to assess the main coastal changes due to the restoration of two breakwaters protecting a significant urban beach along the coast of Naples city (southern Italy). This “tombolo” has formed due to sand accumulation behind the breakwater fronting Diaz Square, built in the early XIX century.</p> <p>Firstly, the integrated GIS analysis of historical maps from Google Earth and data coming from a GPS onsite survey resulted in the evaluation, through the DSAS spatial analysis tool, of net-shoreline movements and relative rates that occurred in the last 30 years. Secondly, the calculation of seabed DTMs before and after the breakwater restoration allowed the quantification of loss and accumulation volumes of sediments and the identification of respective areas. It was observed that, in the last decade, the progradation rate has more than tripled towards the east, compared to the one of the previous time span, reaching 3,5m/y; DTMs showed that the area of sedimentary accumulation is concentrated close to the shoreline, causing advancement of the emerged beach of about 35 – 39 m in 10 years. This is due to the underwater sedimentary circulation: sand accumulates in the bathymetric sector between -4 and -5 m during the winter and is redistributed up to the shoreline during the summer.</p> <p>Lastly, thanks to the Copernicus data elaboration, a ground uplift trend of 0.24 mm/y was observed since 2006;</p>



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while, according to IPCC reports, a relative sea-level rise (RSLR) rate of 4.2 mm/y was measured, amounting to a total of 7-8 cm of rising over the last 15 years (2007-2022) for the Mediterranean area.

In this study, we obtained a twofold result. On one hand, we evaluated the positive effect of the breakwater restoration that induced a widening of the usable beach by about 1700 m²; on the other hand, we demonstrated the effectiveness of an integrated approach that takes into account environmental data from global repositories and those from a high-resolution onsite investigation by innovative technologies, whose spatial analysis allowed us to reconstruct not only the historical shoreline evolution but also the coastal effects of the breakwater modification. In conclusion, the integration of different technologies such as open-source software, field surveys and analytical calculations provided fundamental information for planning prevention and adaptation strategies paying particular attention to low-lying coastal sectors in urbanized contexts prone to flooding due to the ongoing climate changes.

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3. <https://climate.copernicus.eu/climate-indicators/sea-level>
4. <https://www.ipcc.ch/report/ar6/syr/>

KEYWORDS:

Coastal areas erosion;
Factors and processes of coastal instability;
Evolution and morphodynamics of coastal zone and surface;
Sediment transport and redistribution.



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FORM FOR ABSTRACTS PRESENTATION

TITLE: EVALUATING THE IMPACT OF SAND FENCES ON FOREDUNE RECOVERY IN SANT PERE PESCADOR BEACH (COSTA BRAVA, SPAIN).

SESSION: Morphology and evolution of coastlines and seabed

AUTHORS: CARLA GARCIA-LOZANO¹, MARTA TONDA¹, FRANCESC XAVIER ROIG-MUNAR¹, JOSEP PINTÓ¹, CAROLINA MARTÍ-LLAMBRICH¹.

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

In recent decades, coastal dune systems have been significantly diminished and altered due to erosion from environmental and human factors [1]. Nature-based solutions, particularly the use of sand fences, have become important for restoring these ecosystems. These fences help accumulate sediment, rebuild beach-dune profiles, and reduce erosion, especially during storms, enhancing the resilience of these vital coastal areas. Sand fences are a key artificial measure that influence the morphology and vegetation of sandy coastlines [2].

Our study assesses the efficacy of sand fences in sediment accumulation at Sant Pere Pescador beach, located in the Gulf of Roses, Catalonia, Spain. The beach, characterized by sediment transport from the NNE, is surrounded by campsites.

We focus on two zones that covers 2 kilometers of beach: the northern area, in front of Las Dunas campsite, where nature-based solutions have been applied for three years, and the southern area near La Ballena Alegre campsite, where management ceased in 2021. The study, begun in winter 2020, involved installing sand fences, each 10-15 meters long, 85cm high, with 60% porosity, oriented NNW. Management continued in the north but stopped in the south in 2021.

Data were gathered using drones and high-resolution (10 cm) digital elevation models, pre and post sand fence installation in 2019 and 2023. Sand fences, acting as wind barriers, prevent significant erosion by trapping sand during winter storms.

The effectiveness of sand fences has led to significant sand retention and accumulation over time. Specifically, these fences have contributed to a foredune increase of approximately 0.5 meters in the south and 1.25 meters in the north, as detailed in Table 1. The average height in the southern



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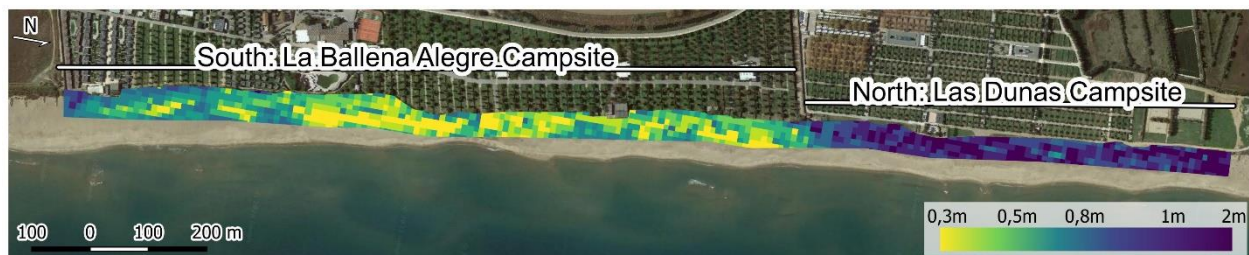
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region rose from 1.9 meters to 2.4 meters, marking a 26% increase, while the northern area saw a more dramatic rise from 1.4 meters to 2.6 meters, equivalent to a 96% increase. These percentages are calculated based on the comparison of initial heights in 2019 and final heights in 2023. Figure 1 effectively illustrates the dynamic changes in the topography of Sant Pere Pescador beach across the years, highlighting the substantial role of sand fences in sediment accumulation, with increases ranging from 0.5 meters in the south to 1 to 2 meters in the north.

Table 1. Height of the foredune in the north and the south zones before (2019) and after (2023) the implementation of the management measures.

	Height \bar{x} 2019	Height \bar{x} 2023	Height \bar{x} increment	Height % increment
South	1,9m	2,4m	0,5m	26%
North	1,4m	2,6m	1,25m	96%

Figure 1. Increase in the average height of the foredune within 10-square-meter polygons before (2019) and after (2023) the implementation of management measures.



The southern foredune, adjacent to the Ballena Alegre campsite, has shown the smallest increase in sand accumulation. This limited growth is attributed to the scarce or absent implementation of management measures, such as sand traps or roped demarcation. In contrast, the northern section, near the Las Dunas campsite, has experienced significant foredune recovery following the installation of sand traps in 2020. As a result, the northern area demonstrates greater resilience and adaptability to climate change, while the southern region, with its lesser protective measures, faces a heightened risk of flooding and coastal erosion, particularly during sea storms. These results are well aligned with studies that highlighted the importance of protective measures like fences in reducing human impact and dune vulnerability in Spain [3].

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DUNE RESTORATION, BEACH MANAGEMENT, SAND FENCES, CAMPSITES.



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

The ESA Ulysses project and the exploitation in the Mediterranean area of Soil Sealing products and indicators

SESSION:

MORPHOLOGY AND EVOLUTION OF COASTS AND SEEDS

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Soil sealing – also called imperviousness – is defined as a change in the nature of the soil leading to its impermeability. Soil sealing has several impacts on the environment, especially in urban areas and local climate, influencing heat exchange and soil permeability; soil sealing monitoring is crucial for the Mediterranean coastal areas, where soil degradation combined with drought and fires contributes to desertification.

Some artificial features like buildings, paved roads, paved parking lots, and other artifacts can be considered to have a long duration. In general, these land cover types are referred to as permanent soil sealing because the probability of coming back to natural use is low. Other land cover features included in the definition of soil sealing can be considered reversible. For them, the probability of coming back to natural use is higher. The land cover classes that are included in the reversible soil sealing have been defined with the users of the project, and include solar panels, construction site in early stage, mines and quarries, long-term plastic-covered soil in agricultural areas (e.g., non-paved greenhouses).

The project Mediterranean Soil Sealing, promoted by the European Space Agency (ESA) in the frame of the EO Science for Society – Mediterranean Regional Initiative, aims to provide specific products related to soil sealing, its degree and reversible soil sealing over the Mediterranean coastal areas by exploiting EO data with an innovative methodology capable to optimize and scale-up their use with other non-EO data. Such products have to be designed to allow – concerning current practices and existing services – a better characterization, quantification and monitoring within time of soil sealing over the Mediterranean basin, supporting users and stakeholders involved in monitoring and preventing land degradation. The project started in March 2021 and the final products are available in 2024. The project team is led by Planetek Italia, and composed by ISPRA and CLS.

Planetek Italia is in charge of the development of the infrastructure, the engineering of the algorithms and the communication activities. CLS is in charge of the soil sealing mask and of the experimental reversible soil sealing processing algorithms, ISPRA of the soil sealing degree processing algorithms. The interaction with the users is led by ISPRA, institutionally involved in the land degradation theme into international and regional organizations and the national body responsible for the theme in Italy.

The targeted products are high-resolution maps of the degree of soil sealing and the reversible soil sealing over the Mediterranean coastal areas (within 20km from the coast) for the 2018-2022, at yearly temporal resolution with a targeted spatial resolution of 10m.

The involvement of stakeholders and end-users is an essential element of the project, as stated by ESA in the call for proposals. Since from the early stage of the proposal, efforts have been made to reach a diversity of users and stakeholders; the presence of ISPRA in the consortium is a plus for the project in this sense.

Users are grouped into classes: municipalities; sub-national agencies or local governmental institution; national institutions and research centers; regional institutions (EEA) and international (UN). Users are kept updated and focused on project activities by providing them concrete elements on which to ask for direct feedback. The users are also involved in the definition of a new way to serve them the project results. Instead of delivering just a set of maps, the team develops an extensive collection of indicators and analytics integrated into an interactive dashboard that allow the users to access quickly and easily the information they need.

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PROBLEMS AND MEASUREMENT TECHNIQUES**

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KEY WORDS (MAX 4)

SEALING, IMPERVIOUSNESS, COASTAL AREAS, MEDITERRANEAN



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FORM FOR ABSTRACTS PRESENTATION

Title: Mass movements in cliff-dominated beaches in the eastern Mediterranean; Insights from the storm, seasonal and annual-scale coastal sediment budget

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Mass movement along coasts is a complex process that reflects interactions of coastal sediments and hydrodynamics. The state of coastal environments is commonly examined through their sediment budget, which can be estimated in terms of volumes of sediment supplied (influx) and sediment removed (outflux) along a particular coast sector over a specific period. Beach sediment budgets can display a net gain (accretion), a net loss (erosion), or be in equilibrium. To capture the essentials of this process in the eastern Mediterranean coasts, the sediment budget of cliff-dominated beaches was quantified using repeat ground-based LiDAR scans and time-lapse photography at storm to seasonal time-scales over 3 years.

The beach stretches examined are located along the Israeli Mediterranean shoreline, which is part of the Nile's littoral cell (NLC). Since the middle Pleistocene, the main supplier of sand to the NLC has been the Nile River and its delta. Another primary sand supplier into the NLC during the Holocene is the actively retreating sea cliff that spread along ~40 km of Israel's coastline.

Two beach stretches, Gaash and Neurim, were analyzed as typical endmembers for cliff-dominated beaches. Both are located away from artificial marine structures that may influence the natural sediment supply. The Neurim site is ~190 m long segment and characterized by a 20 – 30 m wide sandy shore and a cliff that reaches up to 23 m above sea level. The average slope of the cliff face at the studied section is 53°. The Neurim beach platform consist of up to ~1 m thick loose sand overlaying eolianite beds. It has a flat topography most of the year with some exposed eolianite remnants near the cliff base and waterline. The Gaash beach stretch is ~170 m long and is characterized by a relatively narrow, 5 – 15 m wide beach and a ~40 m high cliff. Most of the beach is covered by coarse, reworked eolianite pebbles and a <1 m layer of sand. The average measured slope of this cliff section is 55°.

We compared before and after LiDAR based high-resolution topography grids and calculated the total sediment budget at storm (i.e. significant wave height >1.5 m), seasonal and multi-annual intervals at both studied beach stretches. In addition to better-understand the effect of the stormy wave conditions on coastal morphology and to quantify the minimal significant wave height needed for beach and cliff erosion, we gathered data from time laps cameras deployed in Neurim site during six winter storms. Studying the sediment budget and wave conditions in the two cliff dominated beach stretches, we found the following: (a) Individual winter storms can result in either beach erosion or accretion; (b) The



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previously proposed seasonal pattern of winter beach erosion and summer beach accretion appears to be only partly applicable to cliff-dominated beaches. This is likely associated with the temporally variable contribution of talus and cliff material to the beach; (c) The 3-year sediment budget at the two studied sites was slightly positive ($\sim 10^2$ - 10^3 m³). However, as these volumes are comparable to the observed erosion/accretion volumes at the storm and seasonal time scales, we suggest that these beaches appear to be in a dynamic equilibrium; (d) At the 3-year scale, cliff and talus sand contribution was comparable to the observed net beach accretion. Thus, cliff erosion and retreat is a major contributing component to the coastal sediment budget; (e) Wave height threshold values for mobilizing sediment along the beach is <1 m for Gaash and 2.3 m for Neurim. The threshold value for initiating talus/cliff erosion is 3.5 m at Neurim beach.

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4): Coast, Coastal cliff, Mass balance, Nile Littoral Cell



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FORM FOR ABSTRACTS PRESENTATION

TITLE: ASSESSMENT OF COASTAL AREA VARIATION IN SOUTH LEBANON
SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS
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ABSTRACT: <p><i>Coastal areas concentrate most of the economic activities and urbanization around the world. 37% of the world population was living in a band of one-hundred-kilometer width along the coast in 1997 [1]. The aim of this study is to assess the variation of the coastal area of Tyre coast nature reserve, and identify the underlying causes, determining whether these variations are natural or artificial. The reserve comprises three zones: touristic, archaeological, and agricultural, with the study concentrated on the touristic zone. Historical analysis reveals two distinct periods, before and after the Lebanese Civil War (1975–1990). During the war, the absence of governmental surveillance resulted in illegal activities such as soil suction and dredging, while post 1990 witnessed a turn off in illegal activities but saw artificial alterations for tourism. To conduct a comprehensive analysis, data spanning from 1938 to 2021 were collected from topographic surveys, satellite images (1963, 1994, 2005, 2007, 2013), and aerial photos (1975), utilizing GNSS receivers for accurate measurements. The shorelines referred to 1938 was measured during the topographic maps production, while the shorelines referred to 2018, and 2021, were measured by GNSS receivers. To have an accurate measurement it was required to start from a trusted geodetic point that is utilized from the public services in Tyre in the topographic and cadastral works. The second source of data are produced very high-resolution satellite images for the creation of the shorelines over several years and generated from different satellite missions. After the data collection, the next step is to produce and generate the shorelines in accurate and precise mode, to prepare them for the comparison and analysis process. The topographic data are managed in CAD software to produce the shorelines and to check their geographic location. In the other hand, satellite images and aerial photo, are imported to Geographic Information System (GIS) software to generate the shorelines, first all the images are referred to the same reference coordinate system, then the shorelines are created by digitizing the images. The generated shorelines are imported to a GIS software for data managing and the comparison between the years done by the using the geoprocessing tools (Union), that this tool function can illustrate clearly to indicate the type of variation (erosion or accretion) occurred between the years, and to understand and identify if the variation is due to artificial or natural activity based on the correlation between the geometric data, and the historical knowledge of the study area. Also, the usage of Digital Shoreline Analysis System (DSAS) for illustrating the shoreline movement if it is forward or backward</i></p>



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the with respect to the shore. The results shows that the coastal area loses about 35% of its area over 83 years. In the other hand the DSAS results shows that the shoreline movement was toward the shore in a maximum record about 70 meters. As a conclusion the coastal erosion in the Tyre coast natural deserve is due to artificial activities.

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KEY WORDS:

COASTAL EROSION, SHORELINE MOVEMENT, DIGITAL SHORELINE ANALYSIS SYSTEM (DSAS)



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FORM FOR ABSTRACTS PRESENTATION

<p>Title: Assessment for selected stressors to harmonize the ecological and environmental requirements to argue Ecosystem-Based Management</p>
<p>Session: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABED'S</p>
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<p>ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): Coastal and marine environments face challenges in effectively managing the sustainability of their resources and protecting their marine environments. Human activities have a footprint in time and space on both coastal and marine ecosystems. Assessing the allocation and power of human activities and their effects on coastal-marine biodiversity is necessary for adequate conservation with sustainable development. In fact, sediment analysis can reflect the current quality of the system and the pollution history of a certain area. Alexandria is the second largest city in the Middle East with regards to industrial activities, about 40% of the nation's industry surrounds the city. The Alexandria coastal region, characterized by its unique ecological and environmental dynamics, faces an array of stressors that challenge the sustainability of its ecosystems. This study undertakes a comprehensive assessment of selected stressors, aiming to harmonize ecological and environmental requirements in support of Ecosystem-Based Management (EBM). Through a systematic analysis of stressors impacting the Alexandria coastal region, ranging from anthropogenic activities to natural phenomena, this research seeks to identify key factors contributing to ecosystem disruption. It is grounded in the specific context of the Alexandria coastal region, taking into account the complexities of its ecosystems and the diverse challenges posed by human activities. Specific attention is given to the</p>



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identification of stressors relevant to this coastal stretch, acknowledging the potential influence of industrial activities, urbanization, shipping, and other human-related factors. Additionally, natural stressors such as climate variability, sea level rise, and geological features are considered within the context of the Alexandria coastal region.

The area of study covers the coastal strip along Alexandria city from El-Agami headland in the west to Abu Qir headland in the east. This study presents an approach to evaluate the ecological risks in marine ecosystems that are exposed to heavy human impacts and pollution in five areas of the Alexandria coastal region that are affected by different environmental stressors. The evaluation helps to identify the ecological risks that have increased or decreased due to human activities and enables the calculation of the allowable probability of anthropogenic impact in these three areas. The results indicated that two of the five studied areas had a low-risk probability Al-Agami is characterized by sandy beaches and dunes, contributing to its natural beauty. The area is a mix of urban and natural influences, potentially serving as a transition zone, which suggests a favourable environment. This interdisciplinary approach offers a way to align ecological and environmental requirements, promoting the requirements of the management of marine ecosystems. Correspondingly, the present study revealed that there is a decrease in the levels of total organic matter and total phosphorus. This decrease could be attributed to the prevention of the discharge of untreated sewage into the coastal area of Alexandria for a period.

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Key words (MAX 4): Ecological Risk, Eastern Harbour, Abu Qir, marine ecosystem management



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Modeling of wave height, currents and sediment transport at Locos beach (Torrevieja, Spain) before and after nourishment

SESSION:

MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS:

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ABSTRACT:

The dumping of sand on beaches to combat coastal erosion is a common process [1]. In recent years, due to the lack of natural material (fine sand), nourishment has been performed with coarse sand from quarries. Modifications to the characteristics of a beach or coast, such as the dumping of material different from the existing one, can lead to a destabilization of the coastal dynamics of the area [2]. Therefore, it is important to investigate the modifications that the wave heights, currents and sediment transport of an area will undergo due to beach nourishment. The objective of this work is to model the wave heights, currents and sediment transport before and after the nourishment of a beach with material coarser than the original.

Los Locos beach (Torrevieja, Spain) was a fine sand beach with a median sediment size of 0.194 mm that was nourished in January 2020 with quarry sand with a median sediment size of 1.2 mm. Since the bathymetry before and after the nourishment (2022) were available, the modeling of wave heights, currents and sediment transport produced by the mean regime swell was performed for each indecent direction on the beach. In addition, the profile evolution was also modeled against a usual storm situation. The modeling was performed using the SMC 2.5 software (Coastal Modeling System, <http://www.smc.unican.es>) of the Environmental Hydraulics Institute of the University of Cantabria. The swell data for the area were obtained from the SIMAR Node 2077096 of the Puertos del Estado website (<https://www.puertos.es>). This database provides information from 1958 to the present with hourly wave height, period and direction of the swell. The data were analyzed to obtain the medium regime of each direction and the corresponding storms. Storms are defined as those situations in which the wave height is greater than the 95th percentile for at least 6 consecutive hours. [3].

The waves analysis determined that the most frequent swell in the area are those coming from the E with 52.3% of occurrence and a wave height $H_{s,12}$ of 3.37 m, while the least frequent are those coming from the SE with a wave height $H_{s,12}$ of 1.86 m and an occurrence of 6.18%. In addition, the mean swell flow has a wave height of 2.35 m and a direction of 102.6° with respect to the north, that is, it comes from the ESE. Regarding storms, it should be noted that the wave height to be exceeded to be considered a storm is 1.45 m. Considering this value, an average of 13 storms occur per year with an average duration of 32.6 h, and an average wave height of 1.79 m. The maximum storm in the area occurred in 2020 with an average wave height of 2.74 m, a maximum of 7.51 m and a duration of 108 hours.

The 2D modeling of wave height and currents in the area shows that there is hardly any variation before and after nourishment, because the modification in the bathymetry is very small and hardly influences the coastal dynamics of the area. However, when sediment transport before and after nourishment is analysed a significant reduction in sediment transport is observed (Figure 1). The most important transport in the area occurs in the southern part of the beach near the head of the breakwater. The overall reduction is 65%, with the most important reduction occurring in



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the ENE direction from 43.1 m³/s before nourishment to 14.3 m³/s after nourishment. This change is mainly due to the increase in the median sediment size, as the sediment increases tenfold in size during nourishment.

Finally, with respect to the profile modeling, the influence of the change in sediment size can be observed. Faced with an average storm of 32 h, the pre-nourishment profile suffers an erosion of 8.4 m, while the profile after nourishment only regresses 4.7 m. Therefore, it can be concluded that the nourishment performed presents an important benefit for the protection of the beach.

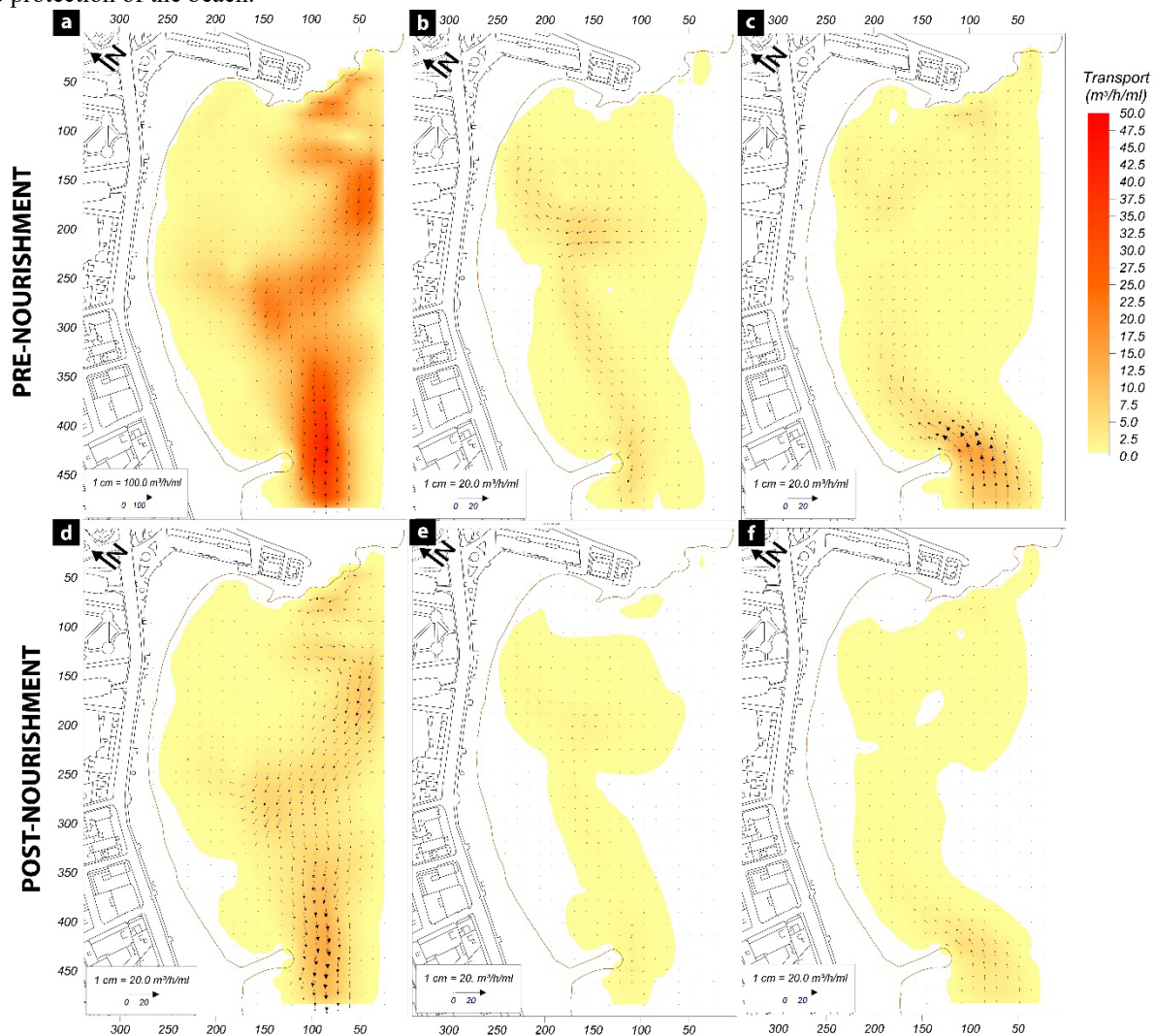


Figure 1. Sediment transport for swell coming from: a) ENE; b) ESE; c) SSE; e) ENE; f) ESE; g) SSE.

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KEY WORDS: SEDIMENT TRANSPORT, MORPHODYNAMICS OF COASTAL ZONE, EROSION, BEACH NOURISHMENT



**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: REMOTE SENSING FOR RECONSTRUCTION OF OMBRONE RIVER DELTA BEACH RIDGES
Session: Morfologia ed evoluzione delle coste e dei fondali
AUTHORS: IRENE MAMMÌ – LORENZO ROSSI
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <i>The study area is the Ombrone River delta (South of Tuscany, Italy), a wave dominated delta, that is associated to variation in wave and longshore transport conditions and formed during the last 2500 years.</i> <i>The delta morphology has been continuously reshaped by marine and fluvial processes assuming a characteristic asymmetric delta shape during periods of progradation and a configuration with a straighter coast during phases of erosion.</i> <i>Beach ridges, a characteristic depositional landform of wave dominated delta, cross the entire coastal plain.</i> <i>They are associated with ancient shorelines and are found in various parts of the world, and their genesis is often different depending on the dominant forcing, which is why the term "beach ridges" is widely debated in the literature.</i> <i>The coastal deposits of beach ridges can be used for the study and understanding of the morphodynamic of the present and the past. They can provide information about the past wave direction, sediment availability at the source, and sea level oscillations.</i> <i>The spatial patterns they form reflect changes in sedimentation and wave motion propagation conditions, for example, truncated beach ridges are often indicative of changes in wave motion, longshore drift, and wind direction or decrease of sediment availability as during erosive phases in a wave dominated delta. Additionally, concave, convex, or curved beach ridges indicate the presence of shoals or promontories, influencing wave propagation, refraction, and sediment deposition or progradation phase of a river delta.</i> <i>However, these deposits relate to advancing coastlines regardless of whether they are primarily of aeolian or marine origin.</i> <i>From the analysis of literature data, extreme events, sediment availability at the river mouth, and its oscillations have controlled the development of these deposits in the Ombrone River delta.</i>



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The aim of this study is combining different remote sensing data to obtain a very detailed mapping of all the beach ridges present in the area. The map is a fundamental instrument to better understand the evolution of the delta. Satellite images and aerial photos were used to discriminate beach ridges; Unmanned Aerial Vehicle (UAV) photogrammetric survey and LiDAR (Light Detection and Ranging) data were applied also for a detailed 3D model reconstruction of the area. For this project the Ministry of the Environment and the Sea Lidar survey (2008) was used and a drone flight was carried out specifically for this study over the mouth of the delta to identify the smallest landforms.

A topographic survey was carried out as well to calibrate UAV imagery and to verify LiDAR data accuracy. A presence of a small step of about 20 cm between the LiDAR 1x1 m and 2x2 m grid spacing (Digital Terrain Model) DTMs, was found out and corrected.

A DTM produced from the UAV survey was processed with 10 cm grid spacing.

Successively all the DTMs were processed with ArcGIS 9.3 algorithms as Slope, Aspect and Topographic Position Index in order to highlight coastal morphologies and to perform morphometric and statistical analysis.

Thanks to this high resolution, and the capacity to efficiently delineate each individual morphology, was possible to enhance many small beach ridges close to the river mouth, modified by human activities and by river mouth dynamic.

This research showed how high resolution DTMs produced from Lidar and UAV, combined with other remote sensing data, could be a helpful tool for the reconstruction of ancient morphologies also in large areas like delta plains. A complete beach ridges mapping was produced to better understand the delta evolution also through the analysis of the different geometries of these morphologies.

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KEY WORDS (MAX 4)

BEACH RIDGES

OMBRONE RIVER DELTA

REMOTE SENSING

MAPPING



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: Near-shore sediment dynamics along Israel's eastern Mediterranean coastline quantified with repeat campaigns of bathymetric LiDAR

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The Nile littoral cell (NLC) extends 650 km along the eastern Mediterranean, from Abu Quir Bay near Alexandria, Egypt, to Haifa Bay in northern Israel. Wave-induced long-shore currents transport a flux of approximately 1,000,000 m³/yr of sand (Inman and Jenkins, 1984) from the Nile River delta northwards along the coast to the cell's final depositional sink at Haifa Bay, where Zviely et al. (2007) estimated an average deposition rate ~ 90,000 m³/yr since the Holocene. Previous studies have demonstrated that this dynamically sustained sediment equilibrium is maintained in part by sand influx from actively eroding on-shore coastal cliffs along the final 100 km stretch of the NLC south of Haifa Bay (Mushkin et al., 2016). However, sand dynamics and its flux within the near-shore shallow (< 30 m) environment of the NLC remain loosely constrained. To address this fundamental knowledge gap we employed repeat airborne LiDAR scans to measure near-shore intra-annual bathymetric changes along a 5-km-long cliff-dominated coastal stretch located approximately 60 km south of Haifa Bay. Cliff and on-shore sediment dynamics at this site were studied in detail using repeat ground-based LiDAR scans spanning a three-year period between 2015 and 2018 (Shemesh et al., 2021).

A Leica Chiroptera 4X LiDAR sensor flown at 470 m above sea level was used to map a 5 km² area (from the coastal cliff to a water depth of approximately 20 m) at an average scan density of 6 pts/m² during three separate campaigns carried out 11/2022, 6/2023 and 10/2023. All campaigns were carried out at relatively calm sea conditions with significant wave heights lower than 0.5 m and at least seven days after rain/flood events, which can increase sediment content in the water. An effective water penetration depth of 18 - 20 m was achieved for all three campaigns and accuracy bounds of ± 0.06 m in the vertical direction were constrained using independent bathymetric measurements carried out for each campaign. Accordingly, we estimated uncertainty bounds of ± 0.09 m for bathymetric/topographic difference maps produced between these dates using gridded data at 0.5 m/pixel resolution.

Bathymetric difference maps revealed that sand deposition/erosion manifested as bathymetric changes were limited to water depths shallower than 7 meters. Below this depth, bathymetric changes (if occurred) were under detection limits. The difference maps demonstrated clear deposition/erosion patterns of up to 1.5 m in places. The 2022-2023 winter period covered by the 11/2022 to 6/2023 campaigns was characterized by erosion at water depths of 0 to -2 m and -5 to -6 meters, while deposition was mostly distributed along water depths between -2 and -5 m. The volume of sand mobilized at these water depths along the 5-km stretch examined was on the order of approximately 600,000 m³. Processing of the 10/2023 data is still in progress. Completion of analysis for this unique bathymetric LiDAR



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data set spanning an entire year is expected to yield unprecedented quantification of sediment dynamics in the near-shore environment of the northern NLC.

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KEY WORDS (MAX 4): Coastal cliff, Sediment budget, Nile Littoral Cell, bathymetric LiDAR



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Mapping coastal vulnerability against erosion along the Alicante coastline, Spain.

SESSION:

MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS:

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ABSTRACT:

Coastal erosion is a worldwide problem affecting sandy coastlines, particularly affecting the Mediterranean region due to the agglomeration of residents, tourists, urban growth, infrastructure, and biodiversity in its coastal areas. In addition, the potentially significant impacts of climate change should be considered [1]. Coastal erosion can be influenced by a variety of factors, each with different underlying causes: natural factors like the morphology or the composition of the sediments, wave energy and littoral drift or anthropic actions such as ports or beach nourishments. Moreover, the disappearance of dune areas deserves special attention, as they constitute a natural reservoir of sand for beaches and are essential for creating and stabilising wetlands and the shoreline. The Coastal Vulnerability Index (CVI) is a comprehensive index that assesses coastal vulnerability through multiple variables widely used in recent years [2].

The main objective of this work is to map the coastal vulnerability of a 12 km stretch of the Costa Blanca, in the province of Alicante, Spain, from Cape Santa Pola to Alicante city. It is an area where natural spaces with wetlands and important dune ridges alternate with highly urbanized spots, with marked erosion of the beaches detected in some sections. A CVI adapted to the area will determine the vulnerability of coastal stretches based on existing data and a reliable approach, which is critical for developing appropriate coastal management strategies.

The method consists of assessing the vulnerability of three main indicators: geomorphology (geology, coastal slope, erosion rate, beach width and dune width), hydrodynamics (significant wave height, mean tide range and flood level indicator) and vegetation variables (state of seagrass meadows, depth and width of these meadows and backshore area covered by vegetation). A total of 11 variables were considered. All the required data have been downloaded from open and official sources and stored within a geographic information system. For this study, QGIS 3.28.12 Firenze were used. Thus, a geodatabase in GeoPackage format was created containing all the geospatial information collected (cartography, bathymetry, DTMs, orthoimages, etc.), and the ones generated during the research (analysis of coastal erosion from 1929 to 2023 using aerial images, calculations of the different variables of the CVI), as well as the results and their associated cartographic maps.

The coastal strip studied was divided into sections spaced 200 m apart, obtaining the CVI on each one from representative transverse profiles created perpendicular to the shoreline, from the baseline to the bathymetric – 20 m. The vulnerability of each variable was evaluated from 1 (very low) to 5 (very high) and the overall CVI was obtained as the square root of the product of the variables divided by the number of variables [3].

The results (Figure 1) show 45.4% "High", 30.3% "Moderate" and 24.3% "Low" vulnerability along the transects in the study area. The higher values of CVI were obtained on the beaches of Arenales del Sol and Urbanova. This is mainly due to its lower coastal slope, the higher erosion rate and the actual limited beach width, as well as the lack of dunes in these urbanized spots of the coast.



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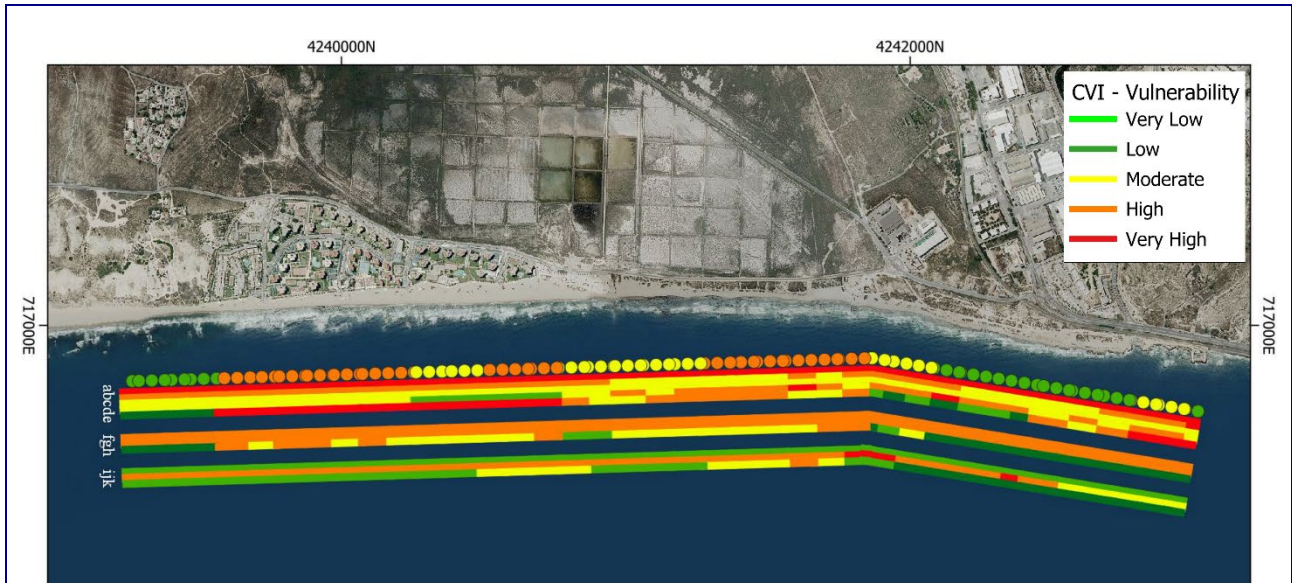


Figure 1. Overall vulnerability (circle symbol) and CVI for each variable: a) Geology, b) Coastal slope, c) Erosion rate, d) Beach width, e) Dune width, f) Significant wave height, g) Mean tide range, h) Flood level indicator, i) Biological state of seagrass meadows, j) upper limit of the meadow, k) backshore area covered by vegetation.

This study identifies vulnerable stretches of the coastal area. Dune ridges serve as barriers to flooding and reduce erosion. A sufficient beach width and slope are key to preventing flooding during extreme weather events. Mapping coastal vulnerability using a CVI helps prioritize investments and actions to increase coastal resilience.

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KEYWORDS: COASTAL EROSION, HAZARD AND COASTAL MANAGEMENT, COASTAL VULNERABILITY INDEX, SEDIMENTARY BUDGET.



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: REMOTE SENSING AND GIS FOR MONITORING EROSION AND EVOLUTION OF THE ALGERIAN COASTLINE

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS: KARIMA REMMACHE

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Shoreline change at various spatial and temporal scales on sandy beaches depends on the coastal morphology and dynamics. However, anthropogenic activity has changed the way in which coastal geomorphology influences beach erosive process trends. Coastal responses in the face of different influencing factors are important for decision makers to manage risks in a coastal zone sustainable development approach.

This study is situated in the context of image interpretation, whose objective is to extract information from remote sensing data, especially from very high spatial resolution images covering the Algerian coast. The present contribution is based on the combination of the coastline kinematic study and beach evolution using very high-resolution remote sensing data and GIS, as well as the hydrodynamic modelling at very high resolution using the SWAN model. Then, the coastline of the central Algerian region is subject to increasing anthropic pressure, notably through sedimentary contributions from the wadis and accretion following the installation of protection structures.

This study also looks at the analysis of the morpho-sedimentary aspects of the beach through the extrapolation of the granulometric indices. The granulometric study of the beach samples shows that the sediments collected along the coastline are generally coarse to medium sands; however, the sediments collected near the coastal dune are medium to fine sands. This is a sorting of sediments from west to east by the longshore drift currents, which mobilise the fine sands from the area near the coastline. Perpendicular currents induce a sedimentary transit from the coastline to the beach.

In order to achieve a territorial planification and a sustainable development of the Algerian coastal zone and in view of a necessity to prevent the coastal risks presented by erosion due to its constantly changing socio-economic and environmental impacts. We sought to identify from a geomorphological, sedimentological and hydrodynamic viewpoint the factors affecting the Algerian coastline's central zone by beach and to assess a development impact on their evolution and balance. For this purpose, an 18-year historical time series on the coastline is analyzed, in order to obtain recent evidence of erosion/accretion trends. We used mathematical morphology to transform very high spatial resolution RGB satellite images into shorelines. The results show that there is a wide variety of shoreline evolution trends in the study area. This study showed that there



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is a concordance between the wave energy distribution and the shoreline evolution. The results relating to granulometric indices and their distributions showed that the spatial distribution variability of sand grains highlights the combined effect of the hydrodynamics and sediment sources. The evidence of sediment dynamics and the geochemical study corroborate the results both qualitatively and quantitatively, making it possible to identify erodibility in this coastal zone and to understand coastal responses to the various influencing factors. This is of great importance to geoscientists. Remote sensing is suitable for collecting information on a large scale and at high frequency. Thus, GIS is a functional tool for managing various data. In this respect, it demonstrates its ability to display and interpret data immediately. The deep learning technique is an effective way to extract features from study areas, integrate multi-source data and determine change rates.

General frameworks

Objectives

Main findings, results, and indications of the proposed work

REFERENCES: (MAX 4)

- 1.
- 2.
- 3.
- 4.

KEY WORDS (MAX 4): Remote sensing, GIS, Shoreline, Hydrodynamics, Granulometry



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

A proposal of a multiscale procedure for the detailed analysis of the coastal morphological setting along susceptible areas

SESSION: MORPHOLOGY AND EVOLUTION OF COASTLINES AND SEABEDS

AUTHORS:

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Assessment of coastal vulnerability to physical and anthropogenic factors is a crucial step in coastal hazard management, especially in growing risk scenarios promoted by sea level rise, climate change, and increasing human pressure. The application of geomorphological susceptibility indices is a consolidated approach to estimate the proneness to erosion processes of low-relief coasts at a regional/wide scale. Such a method is largely based on the combination of physical variables such as shoreline changes, dune and beach geometry, vegetation, and coastal infrastructures, which were statistically or arbitrarily ranked to extract a vulnerability classification. Apart from a certain degree of uncertainty in assigning weights to variables, coastal indexes (CIs) are often estimated using raw data, topographic maps, or remote-sensed images with a coarse temporal and spatial resolution. Such a low availability of high-resolution data represents a strong limitation in the robust construction of CIs. Recent advances in the availability of UAS platforms with higher performance in terms of flight duration, sensor availability, and mapping resolution provide a unique opportunity to compare high-resolution DEMs with the results of the application of CIs. Such a comparison has been tested along a wide sector of the coastal areas of the Basilicata, southern Italy, where strong human impact and environmental factors have favoured the severe occurrence of shoreline retreat and coastal erosion.

The study area is a large coastal plain located along the Ionian coastal belt of the Basilicata region, southern Italy. It coincides with the southernmost and youngest outcropping sector of the Bradano Foredeep, which has undergone a progressive stage of emersion since the Middle Pleistocene induced by tectonics (Pescatore et al., 2009). The morpho-sedimentary evolution of the Metaponto plain is the result of the complex



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sedimentary processes induced by progressive and discontinuous sea-level rise occurring after the fast base-level fall and related incision processes of the LGM (Corrado et al., 2022). The youngest alluvial and coastal deposits of the study area are related to the main meander-type rivers of the study area and to the beach depositional systems. The present-day shore is featured by a low-gradient sandy beach that is limited landward by several diachronic dune ridges. Fine marshy deposits can be observed between these different generations of dunes.

The application of a coastal susceptibility index (Rizzo et al., 2018, Aucelli et al., 2018) has allowed the identification of erosion hot-spots (i.e., the areas that can be considered more susceptible to erosion) along the 60 km wide coastal belt. Short-term comparison (i.e., about ten years) of high-resolution LIDAR DEMs was performed. Two types of LiDAR-derived data were used: 1) raw point clouds obtained from a LiDAR survey from aircraft carried out in 2013 at the regional scale; 2) point clouds obtained from UAS surveys in 2022 with LiDAR sensor. The comparison of the two high-resolution surveys allowed us to observe and quantify both the 2-D and volumetric changes occurring in the hot-spot areas highlighted by the application of the coastal susceptibility index. Our data can be useful: 1) to verify the usefulness of the methodology for the precise and effective delineation of coastal areas at risk of erosion due to recent sea-level; 2) to provide valuable information regarding the degree of coastal susceptibility along the coasts and the impact of recent extreme events on the study area.

This study shows how susceptibility indices are very useful for the qualitative identification of areas subjected to main changes in beach systems but they need to be integrated by high-resolution and repeated monitoring campaigns over large areas, which can represent effective data to both a finer reconstruction of the geomorphological evolution of wide sectors of vulnerable coasts.

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KEY WORDS: Coastal erosion, susceptibility index, Monitoring techniques, Ionian coast,



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Reconstructing recent coastal changes of a protected area through a multi-technique approach

SESSION:

Morphology and evolution of coastlines and seabeds

AUTHORS:

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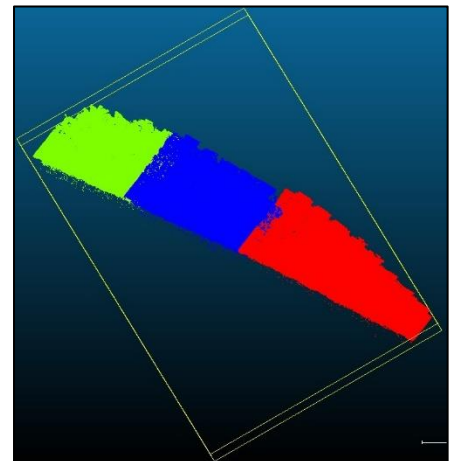
ABSTRACT:

Coastal environments are characterized by complex dynamics, involving the constant interaction among geological, oceanographic, climatic, and anthropic processes; the consequence of such interaction is the continuous modifications of coastal landforms, sometimes even over short periods.

In the last centuries, human activity has begun to deeply alter the coastal dynamic balance, sometimes

overwhelming the natural evolution trend. Therefore, coastal evolution studies assume an increasingly important role in planning prevention, preservation, and remediation strategies, especially in areas with a relevant role in biodiversity conservation.

The aim of this research is the evaluation of recent morphological and environmental changes that occurred along the sandy stretch belonging to the Site of Community Importance (SCI) "Spiaggia del Mingardo e Scoglio di Cala del Cefalo" in the Campania region (Southern Italy), southeastward respect the Mingardo River. Through an integrated GIS analysis of topographic maps, aerial and satellite photos (1), and high-resolution data (a photogrammetric survey carried out with an aerial drone in April 2023), a retreating trend of both the shoreline and the dune system was observed. In particular, a decrease in the retreating trend of the shoreline has been detected since 2004, while the mean erosion rate is equal to -0.354 m/y for the period between 2011 and 2016, approximately 12 cm more than the previous timespan. On the other hand, the retreat of the dune system over the whole period amounted to 40 m, 35 m, and 27 m in the northern, middle,





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and southern areas respectively, while the highest retreat has been detected for the period between 2012-2016. This coincides with the results obtained for the shoreline between 2011 and 2016. Since one of the strongest storm surges occurred in 2014, this result demonstrates the great influence of storm surges on the state of conservation of the coast, as testified by detected wash-over fans and strong degradation of the vegetation cover. Therefore, the resulting forcing factors acting in the area are the winter wave regime, which can cause flooding and consequent dragging of sediment offshore, and the draining of the Mingardo River. Another relevant aspect is the intense anthropization of the area, especially during the summer season.

To conclude, this work provides evidence of the high impact of storm surges on beach and dune environments, showing the importance of an integrated approach for the analysis of coastal dynamics in a fast-evolving world, where human presence could strongly interfere with natural processes. This information is crucial for the assessment of the potential erosion risk, providing an essential basis for local governments in the decision process of good practice for the sustainable management of the coast, also taking into account the expected increase in storm surge frequency and magnitude strictly related to climate change.

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1. <https://www.google.com/intl/it/earth/about/>

KEYWORDS

Coastal change, GIS analysis, multi-technique approach, dune system evolution

SESSION

**COASTAL AND OFFSHORE ENGINEERING:
ENERGY PRODUCTION AND TRANSPORT,
PORT AND OFFSHORE STRUCTURES,
WATER QUALITY, MEASUREMENTS AND
MONITORING, DATA PROCESSING AND
SERVICES, DIGITAL TWINS, ECONOMIC-
ENVIRONMENTAL ASSESSMENT,
REGULATORY CONTEXT**

ORAL PRESENTATIONS



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: AI AND MACHINE LEARNING TO EXTEND METEO-MARINE STATION OBSERVATIONS INTO THE FUTURE.
SESSION: COASTAL AND OFFSHORE ENGINEERING
AUTHORS: JOEL AZZOPARDI CONTACT PERSON AND E-MAIL ADDRESS JOEL AZZOPARDI, JOEL.AZZOPARDI@UM.EDU.MT
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <i>General frameworks</i> <i>Objectives</i> <i>Main findings, results, and indications of the proposed work</i> <p>The real-time availability of data from coastal meteo-marine stations is increasingly important. This data is vital for stakeholders like port authorities, government agencies, researchers, and the public. Real-time (now-cast) data is essential, but short-term forecasts for upcoming hours would be extremely beneficial. AI and Machine Learning (ML) are key in generating these forecasts [2,3,4]. Recent technological advancements and cost reductions have led to a surge in such station installations. Notably, several stations have been installed in the Malta-Sicily channel under the i-waveNet project [1].</p> <p>This paper discusses our research into using ML to predict station observations data. Our main challenge is that most stations have been made operational in these last months, thus limiting the amount of data that is available for training. Literature favors deep learning, particularly LSTMs, for predictions, but these require huge training datasets whereby even a 3-year dataset of hourly observations would not be considered sufficient to train an LSM. We compare the performance of 3 ML architectures – Long Short-Term Memory Network (LSTM,) Random Forest (RF), and Multivariate Linear Regression (LR) – to predict the hourly values for air temperature, wind speed, atmospheric pressure, and humidity for the next 24 hours. We used Python with keras (LSTM) and sklearn (RF and LR). Hyper-parameter tuning (for LSTM and RF) is performed with the help of the Optuna package that performs a search for the best ML parameters.</p> <p>Input features include the hourly values of the last 48 hours of these four parameters, in addition to the hour and current day of the year. The hour and day are converted into a sinusoidal signal by multiplying the hour or day ratio to pi, and then the sine of the resulting value is taken. In this way 0000 hours would have a similar difference to 0100</p>



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as to 2300. Features are scaled using sklearn's Min-Max Scaler. We trained separate models for each target parameter.

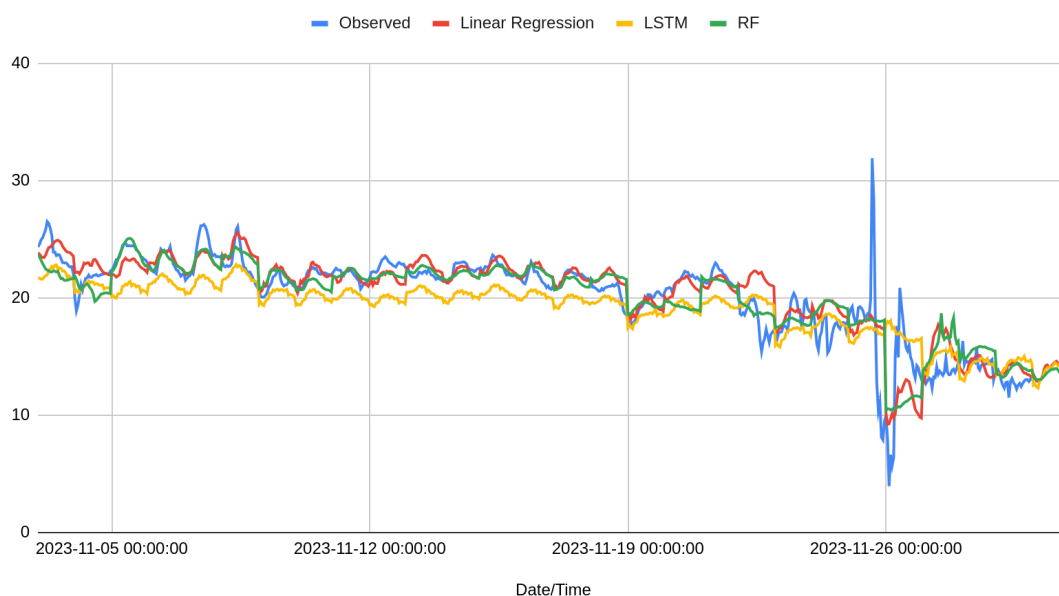
In an attempt to counteract the issue of limited available data, we experiment with different training sets. We utilise a 32-month dataset from the Cirkewwa station (Oct 2020 - May 2023), and evaluate how models trained with this dataset predict values for the Cirkewwa station and for 3 other stations (2 in Malta and 1 in southern Sicily) for November 2023. We also utilise a 1-month dataset from the Cirkewwa station (Oct 2023), and evaluate how models trained on it generate prediction for this station, and the 3 other stations. Finally, we train a model for each station using the October 2023 data for that, and use that model to predict the data for that station for November 2023. The rationale behind these different training datasets was to evaluate to what extent long datasets are required for ML predictions for the different parameters, and also investigate whether models are sufficiently generalisable to be applied across different stations. Outcomes would help identify potential solutions for scenarios with scarce or missing data.

Our results show that different parameters have differing characteristics and thus would require different treatment. The simplest model (linear regression) performed best when predicting air temperature, pressure and humidity. On the other hand, wind speed was best modeled using LSTM. Models trained on the longer dataset proved to be better when predicting all parameters except for pressure whereby models trained with data from the previous month proved to be more effective. Furthermore, models prove to be generalisable for all parameters across the different stations except for pressure.

The figures below illustrate the predictions of the various parameters using different ML architectures.

Finally, we are releasing the model training code, prediction tools, and the best-performing pre-trained models for each parameter to the public: <https://ocean.mt/research/stationDataPredictions.zip>

Predicted Air Temperature

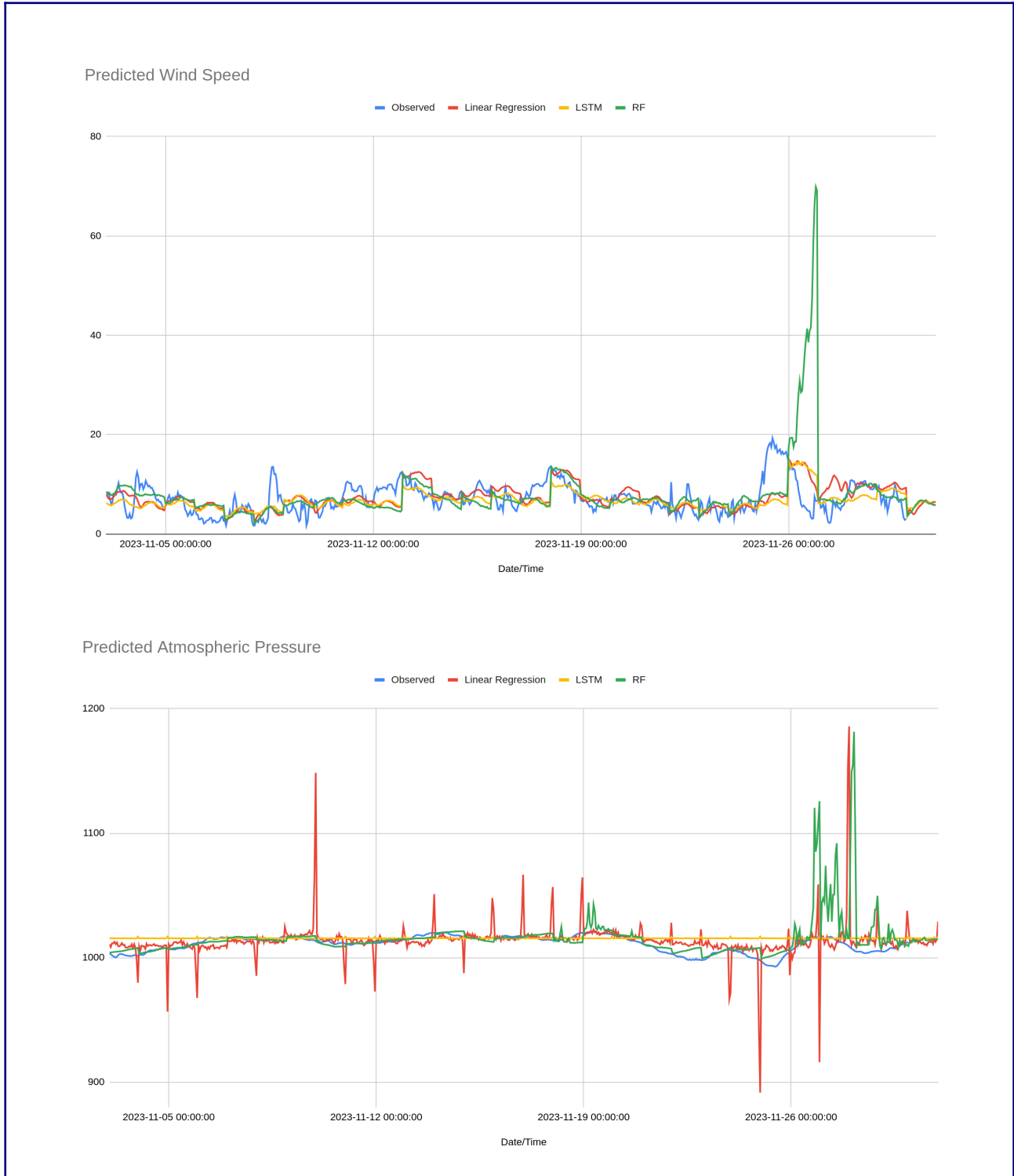




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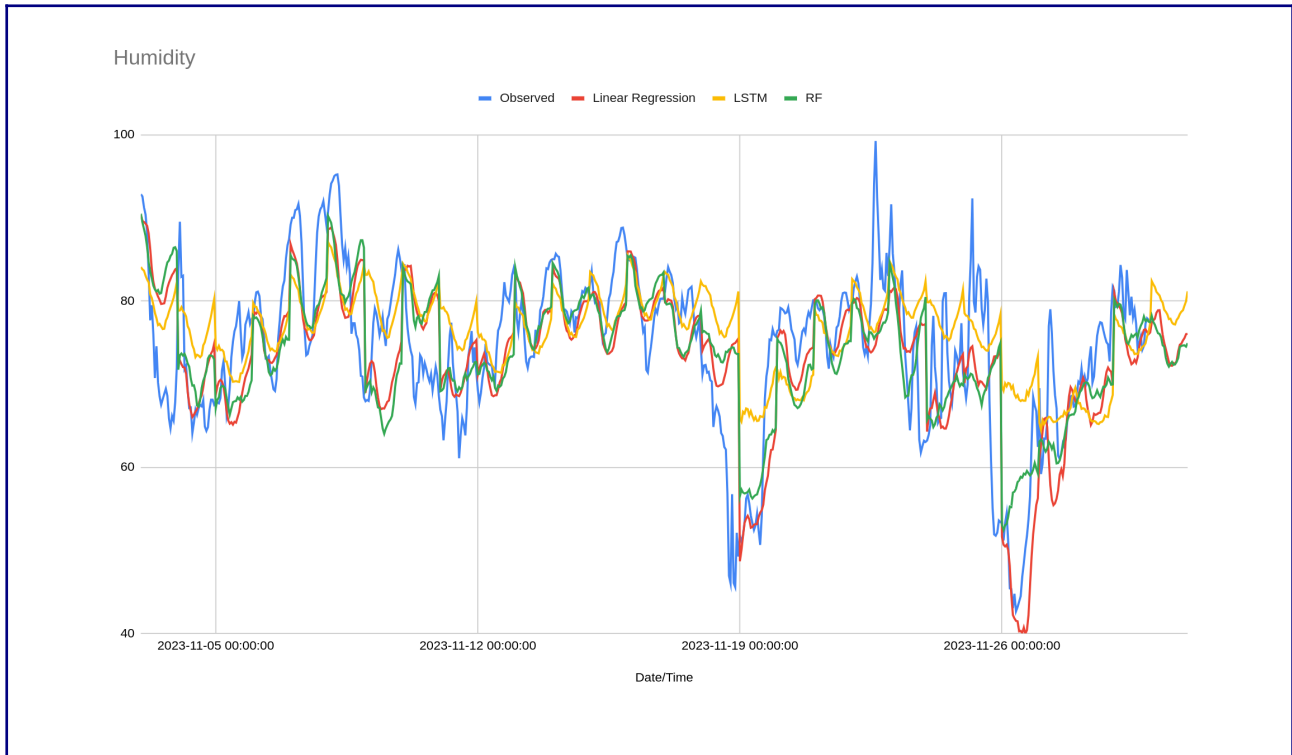
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KEY WORDS (MAX 4)

1. Machine Learning
2. Artificial Intelligence
3. Predictions
4. Observations



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: WAVE ENERGY ASSESSMENT IN THE ADRIATIC SEA USING SWAN MODEL
Session: Coastal and offshore engineering: energy production and transport, port and offshore structures, water quality, measurements and monitoring, data processing and services, digital twins, economic-environmental assessment, regulatory context
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ABSTRACT: Research activities carried out by the University of Camerino under the project named COASTENERGY Blue Energy in ports and coastal urban areas (https://programming14-20.italy-croatia.eu/web/coastenergy) aim to evaluate the wave energy potential sources at two different locations along the Italian central Adriatic coast (Ancona and San Benedetto del Tronto) to identify the pilot areas for the study and preliminary exploitation of the wave energy by three different wave energy converter technologies, which named wave clapper, wave roller, and Wavestar technologies. They predicted that the highest wave energy fluxes 620 MW per year and 583 MW per year is observed for Ancona and San Benedetto del Tronto by the wave clapper technology. The wave energy potentials were calculated by the measured wave buoy data of Ancona and Ortona from the RON (Rete Ondametrica Nazionale- ISPRA). In this study, they evaluated wave propagation from the offshore to nearshore using the model based on spectral inverse refraction (Abernety e Gilbert 1978), which allows an estimation and reproduction of the wave motion for the whole area (from offshore to nearshore) registered from the Buoy. This model does not account for the nonlinear wave interactions and physical process (wave breaking, white capping, shoaling etc..) of the wave propagation (Soleimani et al., 2015). The gap of this study is that it does not evaluate the accurate wave parameters in the nearshore zone to calculate the wave energy fluxes. Nowadays, more accurate models to estimate wave propagation by using numerical models like SWAN (Simulating WAVes Nearshore) ((Islek et al., 2021; Yuksel et al., 2021)), MIKE 21 SW (Spectral Wave) ((Yuksel et al., 2020)), and WAM (Wave modeling). To fill the gap, we introduce a new approach that will evaluate the wave parameters and wave energy fluxes from the offshore to the nearshore zone by using the SWAN modeling. In this study, we selected four locations in the Adriatic Sea, including Venezia, Monopoli, Ancona, and Ortana. The primary goal is to examine the wave patterns of the Adriatic coastline over the past two decades, from 2000 to 2020, utilizing the SWAN model. This evaluation aims to identify the most ideal locations for energy sources. Through these areas, we can specify the most appropriate Wave Energy Converters (WECs) to capture part of wave energy and simultaneously tackle the issue of coastal erosion. To obtain wave characteristics using the SWAN model, it is necessary to acquire bathymetry and wind data: therefore, we downloaded from the GEBCO and ERA5 websites the long-term wave characteristics data from the ISPRA RON website for buoy measurements at four distinct locations: Venezia, Monopoli, Ancona, and Ortana. First of all, we run the SWAN simulation for 20 years by giving the inputs of wind and bathymetry fields for those locations to get the wave characteristics Then we validated the SWAN outputs for those locations to observe the accuracy of the modeled data results against measured data. Afterwards, we calculated the wave power at each area to identify and spot the most optimal locations of the energy sources. Finally, we specified the suitable wave energy converter technology to extract wave power.

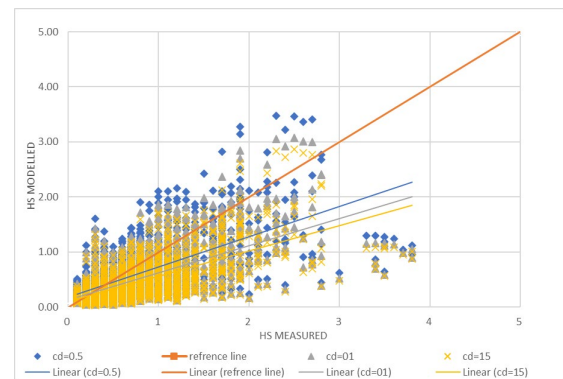
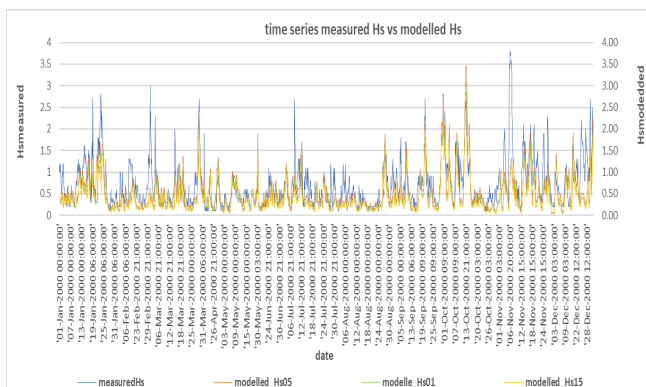


MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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The expected results of the study are:

- A long-term wave modeling of the four different offshore locations to evaluate the wave characteristics on the coast will help to understand the wave climate patterns.
- The time series and scatter plot for both measured and modeled wave height (Hs) and wave period (Tm) are to observe the reliability and accuracy of the modeled data against measured data.
- The final aim is to analyze the long-term wave characteristic analysis to reduce the negative impact of ocean waves on the stability of coastal regions while simultaneously harnessing wave energy through the suitable selection of the nearshore WECs.
- This project studies the wave climate and energy fluxes on the monthly, seasonal, and annual analysis to specify the most optimal location for the energy extraction.
- The optimal locations are crucial for the most suitable selection of WEC devices for wave energy extraction.
- We showed only the results related to one location (Ancona) for the period of 20 years.
- Ancona buoy's mean wave height is 0.76 meters with a wave period of 6.1 s and a power of 2.19 kW/m.
- The graph1 described that wave data from the buoy measurements plot against swan modelling outputs by considering the three different whitecapping parameters $cd=0.5, 1, 1.5$. The model results tend to be almost similar to the measured data.
- The graph2 scalar plot described that the model underestimation. Our model is working quite well for the future predictions of the wave climate.



Graph1) time series plot for measured vs modelled Hs Graph2) scatter plot for measured vs modelled Hs

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KEY WORDS:

SWAN, WAVE ENERGY SOURCES, WAVE POWER, WAVE ENERGY CONVERTER



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: MODELING THE HIGH-IMPACT LOW-PROBABILITY OIL SPILLS IN THE MEDITERRANEAN

SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Large oil spills can be considered the High Impact Low Probability (HILP) events that confront scientists and decision-makers with new challenges. In both environmental and economic terms, the costs of these spills are considerable. Marine biota can be seriously affected due to direct toxic effects and physical smothering. Loss of natural habitat or shelter might lead to the elimination of vulnerable species. Fishery and mariculture resources can be severely damaged due to toxic effects on stock and disruption of business activities. In addition to the costs incurred in cleaning up oil spills, serious financial losses are experienced by economic sectors that rely on clean seawater and clean coastal areas: commercial fisheries, tourism, salt production, shipping, sea water desalination, and power plants.

The severity of impact depends on the spill quantity, exposure time and type of oil, the environmental conditions and the sensitivity of the organisms, their habitats, and local economy to the oil.

In the framework of the NECCTON (New Copernicus Capability for Trophic Ocean Networks) project, new operational tools and products are implementing to strengthen the Copernicus Marine Service capability of modeling marine pollution and assessment of integrated pressures.

A Lagrangian oil spill model MEDSLIK-II (De Dominicis et al., 2013) is used as a powerful and robust tool that predicts oil spill transport and transformation at sea. Oil drift is forced by currents, waves, and wind. Oil weathering is simulated by means of the bulk formulae for the thick and thin slick accounting for viscous-gravity spreading, evaporation, and natural dispersion. An oil beaching algorithm includes the probability that oil may be washed back into the water.

In deterministic mode, the model was recently validated on several oil spill cases (e.g., the Agia Zoni-II oil spill, 2017, the Ulysse-Virginia oil spill 2018, and the Baniyas oil spill 2021).

For NECCTON, MEDSLIK-II has been used to reconstruct the historical VLCC Haven oil spill (off the Port of Genoa, 1991). The Haven incident not only became one of the largest shipwrecks in the world, but also one of the worst oil pollution cases in the Mediterranean. The P. Oceanica meadows were heavily devastated in the Arenzano area. For the next decade, fisheries along the French and Italian coast suffered severe environmental damage from oil pollution.

The hindcast of oil drift and fate has been performed using the reanalyzes provided by the Copernicus Marine Service. The results have been validated with the overflight data held by METEO France.

In the framework of the project, stochastic oil spill modeling is performed to deliver the multi-year hazard maps over the Mediterranean. These maps reveal a conditional probability, which assumes the condition of the Haven



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catastrophe occurs in the Mediterranean. A simulated oil spill scenario assumes that 10 000 tons of crude oil were released for 50 hours. The initial spatial distribution of possible oil spill sources is randomly generated using PDF (probability density function) retrieved from the new satellite-based SAR (synthetic aperture radar) statistics 2014–2019 (Dong et al., 2022). Temporal randomization is also applied to the starting spill dates. For the first time, the whole Mediterranean will be covered by the statistically representative long-term MEDSLIK-II simulations. Hazard distributions at the sea surface and on the coastlines help to identify the basin-scale hot spots and clean areas guiding remote observations and ecotoxicological sampling (Zodiatis et al., 2021). Overlaying the hazard maps and seagrass habitats will allow estimation of potential threats of spilled oil to macrophytes. Such hazard assessment can serve as an important input to decision making by complementing other environmental stressors and can be used in the integrated pressure assessment. The NECCTON Project is supported by the Horizon Europe RIA programme (grant number 101081273).

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KEY WORDS: (MAX 4) *COASTAL CIRCULATION AND MIXING; COPERNICUS SERVICES; COASTAL ENVIRONMENTAL PHYSICS*



**MONITORING OF MEDITERRANEAN COASTAL AREAS:
PROBLEMS AND MEASUREMENT TECHNIQUES**

Livorno (Italy), 11th -13th June 2024

TITLE:

Renewable energy and Sardinian coastal areas: market and environmental issues

SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The global power production from renewables is expected to reach 13 % in 2035 by global energy planners. However renewable energy sources still have a potential to be developed as in various areas they are not easily accepted for their environmental issues. To this respect coastal areas of an island like Sardinia are characterized by a very high environmental value with economic and commercial implications. Nevertheless, they are endowed with significant renewable resources concerning the sun, the wind, and the waves.

The exploitation of these energy sources must confront technical and landscape constraints. Namely quantifying the wave power resource and designing a device for its exploitation is still a challenge while that is not the case of the wind with its turbines or the sun with its PV panels, both using technologies at commercial TRL. In addition, the challenge when using wind and sea for electricity supply is their unsteady electricity production rate, which is not easy to adapt to the varying electricity demand. Previous studies (e.g., IEA, 2023) confirm that a mix of flexibility resources is needed to manage variability across all timescales and seasons. Turbines and panels require seasonal flexibility services, which can be provided from Wave Energy Converter (WEC) (Figure 1, adapted from Vrana and Svendsen, 2021).



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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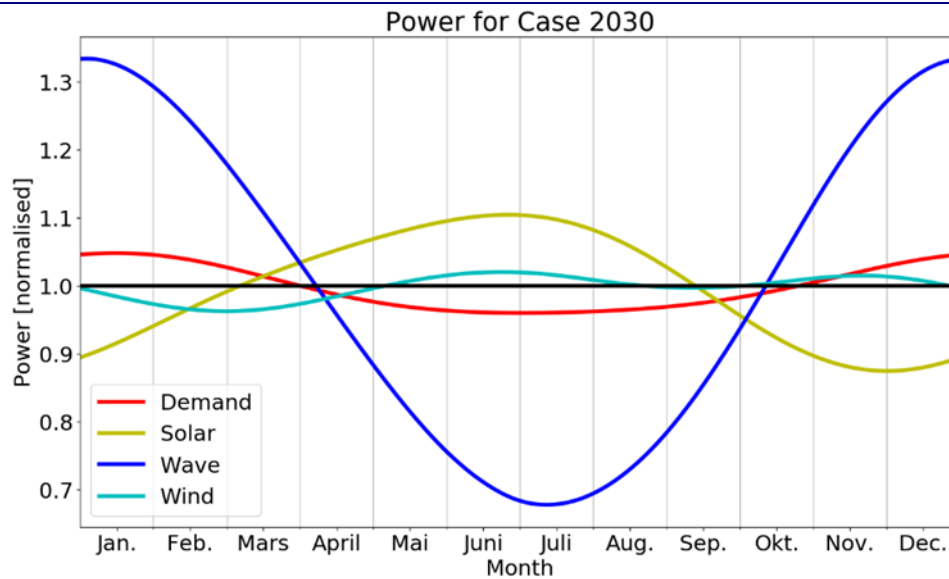


Figure 1. Seasonal power fluctuations

Wave energy is among the renewable technologies with the greatest potential to scale up. However, the integration of the Wave Energy Converter (WEC) into the landscape to yield the output just where it can be used is a very interesting issue. The essential features in which a WEC should excel in order to show long-term economic potential include the survivability (reliable mooring system and preferably a passive safety system that can effectively reduce extreme loads), reliability and maintainability (easy access and inspection of the most essential parts of the WEC), overall power performance (efficient wave energy absorbing technology and PTO), scalability (capable of further enlarging its dimensions to improve its Levelised Cost of Energy - LCoE) and high environmental benefit (expected to have a great environmental benefit and a minimal environmental footprint). Floating Wave Activating Bodies (WAB) in offshore and nearshore areas have had successful results in technology development level (e.g., AquaBuoy, IPS Buoy, FO3, PowerBuoy, WavePiston, Pelamis).

This paper presents preliminary results of numerical application to a WAB located in the nearshore area along the Western Sardinian coast. Modeling of a small size wind turbine for the same location is considered, focusing on configurations of wind turbines which have been intensively studied but are not widespread at present as Vertical Axis Wind Turbines. The performance of such systems has been investigated through computational modeling (Gazzano et al., 2010; Sulis et al., 2021) and can be used in proposing new installations. They can be profitably proposed in a combined wind and wave device into the coastal context due to their limited visual impact especially for small scale systems. The energy community which contributes to increasing public acceptance of renewable energy projects and make it easier to attract private investments in the clean energy transition, is in the background.

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KEY WORDS (MAX 4) WAVE ENERGY CONVERTER, WIND TURBINE, NEARSHORE AREAS, ENERGY COMMUNITY



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: μ -NAUTILUS, AN AUTONOMOUS LIGHTWEIGHT PROFILER WITH DEPTH CONTROL AND CONFIGURABLE SAMPLING TIME

SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Coastal lagoons, like Mar Menor, hold significant ecological importance but are highly vulnerable to environmental disruptions resulting from resource exploitation. Continuous monitoring is crucial for investigating the factors behind critical situations and evaluating the effectiveness of recovery efforts. However, manual sampling as used in the Mar Menor [1] is costly and certainly provide limited results. Therefore, the scientific community and government administrations demand automatic methods that allow for increased data collection and reduced time-consuming operational tasks.

Previously, an autonomous submersible profiler, called s-Nautilus, was developed. s-Nautilus monitors the water column every six hours from the seabed to the surface and sends the recorded information to a server via IoT. However, the weight of this profiler is 21 kg, so it would be desirable to reduce its size and weight to facilitate its transport. Furthermore, this profiler measures the different water parameters during the ascent without depth or speed control, so the monitoring of the water column is not accurate. Therefore, the aim of this paper is to design a reduce-size autonomous submersible profiler, called μ -Nautilus, which builds upon the previous model. Additionally, this profiler must be able to stop at a given depth for a configurable period of time with an absolute depth error of less than 20 cm using ballast tanks as the only control action.

To achieve the first objective, it is important to note that the previous profiler includes external sensor supports and an internal structure housing various electromechanical components of the profiler such as power supplies, two ballast tanks which will allow the ascent and the descent of the profiler, an electronic board that controls the system and an antenna to provide communications. The structure of μ -Nautilus is half the size of its predecessor prototype, with a single 750 cm³ ballast tank to modify the depth of the profiler.

To achieve the control objective, only a ballast tank is used as the only actuator to modify the weight of the profiler. It was decided not to use actuators that have to be installed on the outside of the profiler structure [2] due to the fact that fouling is predominant in the Mar Menor and, therefore, this type of actuator needs to be serviced at high frequency. Satisfactory control is achieved by using simulation software such as Matlab, a tank in the laboratory in the Technical University of Cartagena which allows to check, in a simple way, the real behavior of the profiler, and by conducting tests in conditions similar to those in the Mar Menor, such as the “Real Club de Regatas” in Cartagena.



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On the one hand, the design outcome is a profiler which key physical attributes, including a weight of 11 kg, a minimum diameter of 50 mm and a maximum of 250 mm for the main body. Additionally, it has a maximum height of approximately 818.57 mm, which includes a lower structure functioning as a landing platform, elevating the bottom of the profiler by 88.57 mm. This design element serves to prevent equipment damage and minimizes impact with underwater flora.



Figure 1. μ -Nautilus prototype with integrated sensors.

On the other hand, satisfactory depth control is obtained through cascade control. The outer loop, controls the depth where the profiler is located and the inner loop controls the speed ascent. After carrying out tests in the “Real Club de Regatas”, it was concluded that this control allows a satisfactory control with an absolute error of 15 cm depth. Moreover, equipped with four 3200 mAh batteries, it can operate autonomously for over 30 days with cycles every 6 hours. This time is more than enough because it is advisable to clean the sensors every three weeks due to the prevalent fouling in the Mar Menor.

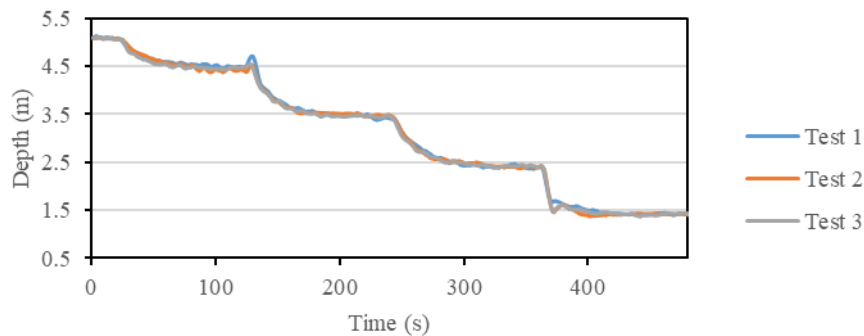


Figure 2. Depth evolution while remaining stable for 60 seconds at the 4.5, 3.5, 2.5, and 1.5-meter setpoints at the “Real Club de Regatas” in Cartagena.

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KEY WORDS (MAX 4)

PROFILER, SENSOR PLATFORM, WSN, DEPTH CONTROL



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FORM FOR ABSTRACTS PRESENTATION

TITLE: **EMODNET DATA INGESTION A KEY RESOURCE FOR THE MARINE SCIENCE COMMUNITY**

SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

A holistic approach to environmental sustainability requires addressing global challenges such as climate change and sustainable management of marine resources that rely on data analysis. In the world of marine scientific research, the need for large amounts of reliable and accessible data is critical. Marine data are collected from different sources using various tools and methodologies. There are several standards used for formatting marine data, and adopting them, by all organizations and stakeholders, takes time and effort. To overcome the technical difficulties involved in submitting data to shared platforms a group including more than 44 international organizations, is active in the European Marine Observation and Data Network (EMODNet) Data Ingestion project with the goal of simplifying the process of data acquisition and transformation so that they are made interoperable. The EMODnet Data Ingestion project simplifies the sharing of marine data and is an important tool toward more open, collaborative and advanced research. The project's portal helps collect, standardize and share a wide range of marine data related to European seas. Scientists, and anyone else interested, can contribute to the reuse of the data, in accordance with the principles of open data. The data thus collected flow into the European marine data infrastructure EMODnet (<https://www.emodnet-ingestion.eu/>), an initiative launched by the European Commission, DG MARE, as part of its Marine Knowledge 2020 strategy.

Scientific institutions, funding agencies and academic journals have promoted policies that encourage open data dissemination as a requirement for publication and funding. Scientists are encouraged to actively contribute to the sharing project by providing high-quality data and contributing to the interoperability process. Direct involvement of the scientific community is critical to the continued success of EMODnet Data Ingestion. In order to encourage overcoming particularism and a future-oriented perspective, it is possible to apply for a DOI (Digital Object Identifier) for one's data, which is a unique and permanent identification system that allows the data to be cited in a manner similar to the citation of a



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paper.

Access to reliable marine data, through European portals such as EMODnet, brings a number of significant benefits to the scientific community, institutions, industries and society as a whole. Through a single portal, access is provided to marine data from the following themes: bathymetry, geology, physics, chemistry, biology, seafloor habitats, and human activities.

Conclusions:

EMODnet promotes international collaboration by allowing scientists to access data from different Mediterranean countries. This synergy fosters a more comprehensive and integrated understanding of marine ecosystems, overcoming challenges related to geographic boundaries. EMODnet also represents an indispensable ally for the scientific community involved in the study of the Mediterranean Sea. Thanks to its ability to provide accurate, standardized and accessible data, scientists can analyze long-term data to understand temperature variations, the presence of marine species and the impacts of climate change, thus helping to formulate management and conservation strategies. EMODNet transforms marine data into innovative data products that represent not only a scientific challenge but also a commitment to a sustainable future.

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KEY WORDS (MAX 4) OPEN DATA, INTEROPERABILITY, MARINE KNOWLEDGE, DATA SERVICES



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Monitoring the phenomenon of seawater intrusion in the estuary area of the river Magra and in the alluvial plain of the lower Val di Magra (SP).

SESSION:

COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Marine intrusion is a topical issue as a direct consequence of climate change. The progression of the salt wedge inland compromises the quality and quantity of groundwater, seriously damaging agriculture and gradually desertifying the territory.

Marine intrusion is often enhanced by rivers. During the summer period, when the discharge is lower, tidal oscillations can favour the progression of the salt wedge along the riverbed, even for several km inland. This phenomenon is increased in rivers with estuarine morphology. Among these, the Magra River is one of the main examples in Italy. It flows between Toscana and Liguria. In its final part, after the confluence with the Vara River, Magra River flows through a wide alluvial plain known as lower Val di Magra. Here it feeds an important coastal aquifer currently exploited for drinking water purposes. In this area, the phenomenon of seawater intrusion through the R. Magra has progressively intensified in recent times due to the extraction of inert materials from the riverbed

This research aims to define the extent of the marine intrusion phenomenon through the R. Magra estuary and its spread within the floodplain. For this purpose, river waters were monitored (electrical conductivity) and sampled periodically for more than a year (from 2022 to 2024) in a series of stations located from the Magra-Vara confluence to the sea. The years of monitoring were all characterised by below-average rainfall and extremely hot summers (2022 one of the hottest recorded). The same type of periodic monitoring also involved a series of wells located along the Magra riverside and instrumented with CTD multi-parameter probes.

The monitoring data were collected in maps showing the variations of the surface water EC of the R. Magra during the year (FIG.1). The measurements performed confirm that a natural barrier, located between the towns of Romito and Sarzana, currently defines the limit of the R. Magra estuary.

The water samples were analysed using an IRMS to obtain Oxygen isotopic values. Oxygen is used as a



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natural tracer of the R. Magra waters. The correlation between EC and $\delta^{18}\text{O}$ effectively highlights seawater-freshwater mixing and validates the EC data (FIG.2)

The monitoring results show that the R. Magra, in the area under examination, can be chemically summarised as a 3-element system: Magra, Vara and sea. The contribution from other tributaries is irrelevant compared to the Magra's discharge. Starting from this conceptual chemical model, the Montecarlo method was used to simulate all possible EC-O values of the river waters and of the Magra-Vara and Magra-sea mixings. They were compared with data recorded in the wells along the riversides to identify feeding areas and mixing between the aquifer and the river water. The comparison revealed a fraction of seawater in the aquifer near Romito and a source area downstream of the monitored well (Sep. 2023).

A larger area was investigated through multivariate analysis of water macroconstituents obtained from literature and relating several wells located all over the floodplain. Through PCA analysis, the zone of influence of the R. Magra water and of the sea water was defined. These zones provide an estimation of the current extent of seawater intrusion in the floodplain and its possible future evolution.

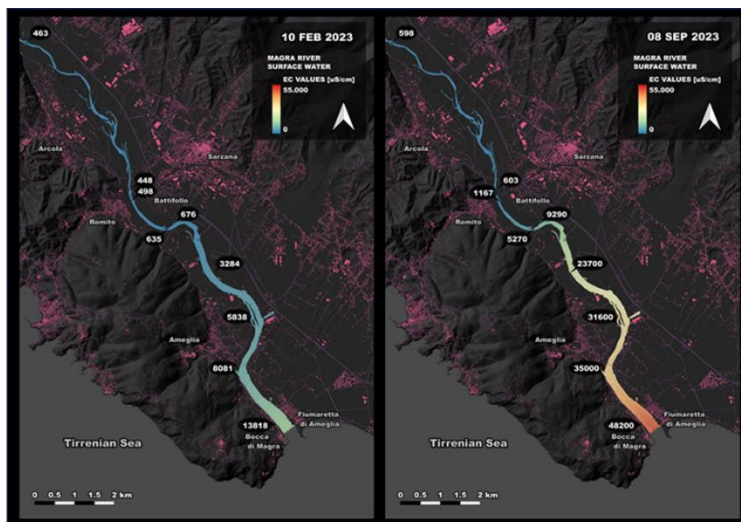


FIG. 1 Maps of surface water EC of the Magra River corresponding to the minimum and maximum marine intrusion recorded during the monitoring period.

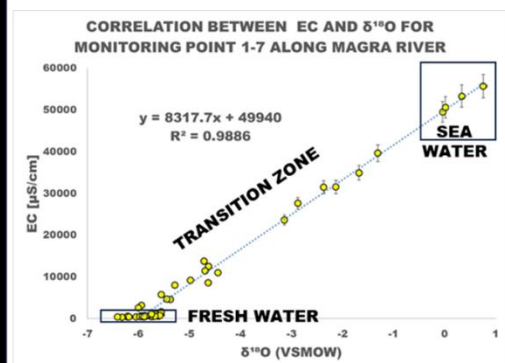


FIG. 2 Seawater-freshwater mixing along the Magra estuary, between Romito and the seacoast.

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KEY WORDS (MAX 4)

Seawater intrusions, Isotops, Magra, Monitoring



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FORM FOR ABSTRACTS PRESENTATION

TITLE: THE SEA LEVEL RISE OF THE NEXT HUNDRED YEARS. THE CASE STUDY OF MIAMI AS A PARADIGMATIC EXAMPLE FOR MEDITERRANEAN COASTS

SESSION: COASTAL AND OFFSHORE ENGINEERING; ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT:

The climate crisis is becoming increasingly urgent, demanding hypotheses that can halt, almost crystallize, our settlements in their current state, giving us the opportunity to continue living in the world we have known or, optimistically speaking, improve the condition of our cities and, consequently, our lives, making them potentially sustainable.

This challenge, in some areas experiencing faster and more abrupt climate changes, has driven research to identify emerging practical applications, allowing for more precise monitoring and analysis and enabling more detailed responses in the identified intervention measures. Let's talk about South Florida, specifically Miami-Dade County, where sea levels have risen by 30 cm since the early 1900s and over 10 cm since 1993, at a much faster pace than the rest of the planet. Flooding due to spring high tides, known as "king tides," has become four times more common than 15 years ago. Predictions for sea level rise by the end of the century suggest 1.5 to almost 2 meters for the eastern coast of the United States. If this scenario were to become a reality, nearly a third of the current population of Miami-Dade will have to relocate, as much of southern Florida will become uninhabitable due to being below sea level. The county has proposed a protection plan involving the elevation of road levels and the relocation of buildings away from coastal areas, creating open spaces to divert waters from high tides. The plan also includes increased residential density in areas farther from the coast, in neighborhoods where property values were much lower, and residents were mainly low-income families, many belonging to ethnic, religious, or linguistic minorities. This strategy could lead to "climate gentrification." The invasion of poorer neighborhoods, now the only possible refuge for the more affluent, would lead to the abandonment of territories by the existing population, unable to afford the prices imposed by the arrival of "new colonizers," and would be forced to leave the areas, permanently altering the urban identity of the neighborhood and causing significant demographic transformation.

Therefore, the University of Coral Gables, Miami, is developing an infrastructure project to prevent the climatic and social phenomenon that has already begun to impact the entire city. The project envisions a system capable of preventing floods not only by ensuring safety at the currently projected sea level rise but also, through its modular prismatic structure, growing in height, thus ensuring the same level of protection even with rising water levels and the need for an increasingly higher protection system if necessary in the future. The design of this protection system is closely tied not only to the aspects of dynamic and centrifugal forces present in wave motion but also to social aspects. It is increasingly essential to address the future considering the most vulnerable realities, overshadowed by the security measures of the wealthy who, as new colonizers, are once again taking away space, culture, and identity from places, territories, and people. Such phenomena, although still distant from the Mediterranean and particularly Italian imagination, are already part of the catastrophic scenario increasingly affecting our territories, profoundly marked by medicanes, Mediterranean hurricanes, causing increasing damage in our cities. The analysis conducted according to the IPCC and NOAA forecasts for the Miami case study is therefore replicable for our territory, providing data on plausible scenarios important for the design of a protection system dedicated to our coasts, intervening and preventing the social phenomenon that is already a reality in America.

It becomes crucial to bear in mind the social vocation that architecture has always had as a tool to build not only places but inhabited spaces, spaces dedicated to its inhabitants.

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KEY WORDS: MEDICANES, FLOODING, SEA LEVEL RISE, CLIMATE CHANGE



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Flooding Brickell, Miami, Chiara Simoncini, Artificial intelligence, Novembre 2023



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FORM FOR ABSTRACTS PRESENTATION

TITLE: TOWARDS A GUIDE FOR BUILDING DIGITAL TWINS OF PORT INFRASTRUCTURE
SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <p>Ports are critical infrastructure assets that play a pivotal role in functional and spatial activities associated with maritime transportation (de Langen et al., 2018). Delays or disruptions in port operations hinder supply chain, transport, energy, and tourism networks, thus having economic impacts on the societies that ports serve. In an era of intense pressures on the digitalization of every part of the economy such as the port systems, the upward trend in using state-of-the-art sensing and real-time data has attracted research interest in the civil engineering industry. Digital Twins (DT) of port systems are popping up in European marine networks. The primary functional scope of these real-time replicas involves the aspects of modeling, visualization, interaction, and synchronization of all different port elements to address the challenging issues of lifecycle management, changing requirements, and progressive improvement (Klerk et al. 2023). Therefore, twinning in port systems is a demanding task that firstly requires decentralized policies on managing targeted parts of port facilities and operations before proceeding with a systematic approach for port DT. Although, port twinning for optimizing operations related to logistics and shipping (e.g., for decarbonization purposes) has gained popularity, fostering the principles of DT in managing the lifetime performance of port infrastructure has not been yet integrated into current research. To this end, the present work conceptualizes a pilot guide for building DT of port infrastructure with the ultimate goal of retaining functionality, ensuring sustainability, and increasing resilience. In this guide, technologies (e.g., remote sensing with Unmanned Aerial Vehicles), tools (e.g., Geographic Information Systems, GIS), automation techniques (e.g., image processing of aerial imagery), and models (e.g., damage models of protection structures) previously investigated by the authors (Tsaimou et al., 2023 & 2024) are coupled together to assist in computer-aided DT applications. The key elements are:</p> <ol style="list-style-type: none">i. Identifying port structures and their special features (e.g., construction material, cross-sections, etc.).ii. Applying a Structural Health Monitoring (SHM) program with real-time data that relies upon a) building inspection schemes based on state-of-the-art techniques and b) assessing existing structural condition.iii. Investigating response to external stressors including wave forces, environmental conditions, natural hazards, etc.



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To validate the robustness of the port DT guide, the structural replica modeling was applied at the berthing facilities and the windward breakwater of the domestic ferry and cruise terminals of a Greek port. The results of the overall application included the following:

- Photogrammetry output generated by analyzing camera-based UAV imagery, i.e., Digital Elevation Models (DEMs) and orthophotos.
- Damage detection in the port concrete pavements of the berthing facilities and the rubble-mound structures of the protection works expressed in terms of cracking and armor layer displacement, respectively, assisted by (semi-)automated image-processing techniques and GIS tools.
- Pilot investigation on the damage progression of the examined port concrete pavements and rubble mound structure.

The main research implications are reflected in the effectiveness of the proposed guide on modeling a DT for the in-service structures of the Greek port. This real-time replica proved promising to search for targeted smart maintenance and upgrade interventions. Further research may include incorporating additional inspection techniques to achieve an integrated DT modeling, thus optimizing lifetime cycle, budget allocation, and port operation issues when treatments are required.

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KEY WORDS: PORT INFRASTRUCTURE, DIGITAL TWINS, STRUCTURAL HEALTH MONITORING (SHM), UNMANNED AERIAL VEHICLES (UAVS)

POSTER PRESENTATIONS



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE:

Numerical Wave Tanks for Wave Energy Converters Using High-Performance Computing

SESSION:

Coastal and offshore engineering: energy production and transport, port and offshore structures, water quality, measurements and monitoring, data processing and services, digital twins, economic-environmental assessment, regulatory context.

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Numerical Wave Tanks (NWTs) have transformed Coastal Engineering, providing a virtual environment for simulating, analyzing, and optimizing Wave Energy Converters (WEC). The integration of Computational Fluid Dynamics (CFD) and High-Performance Computing (HPC) within NWTs plays an important role in simulating and optimizing complex interactions between waves and WECs, offering cost-effective experimentation and a deeper understanding of fluid dynamics. Recent advancements in CFD-based NWTs (CNWTs) provide a more accurate representation of wave-structure interactions, significantly enhancing the efficiency and precision of WEC tests. Consequently, NWTs emerge as powerful tools for researchers and engineers, driving innovation in wave energy conversion for sustainable solutions. This study explores the complexity of assessing the reliability and accuracy of CFD-based numerical wave tanks, particularly in simulations utilizing High-Performance Computing (HPC). To achieve this, a comprehensive analysis of open-access computational fluid dynamics (CFD) tools suitable for HPC architectures has been conducted. A deeper understanding of wave hydrodynamics facilitates the optimization of structural design and performance, thereby enhancing the effectiveness of wave-energy converters and driving advancements in renewable energy derived from wave sources

Numerical simulations, conducted with OpenFOAM, involved the consideration of two-phase fluids assumed to be incompressible, maintained at a constant temperature, and incapable of mixing, utilizing the Volume-of-Fluid (VOF) method. Numerical simulations were conducted, considering the geometry of the physical 37-meter wave flume available at the Laboratory of Maritime Engineering at the University of Florence. The study specifically examined fluid motion resulting from a moving vertical wall, simulating a piston-type wavemaker. The structured rectangular hexahedral mesh was considered. As shown in Figure 1, the mesh was gradually refined free surface.

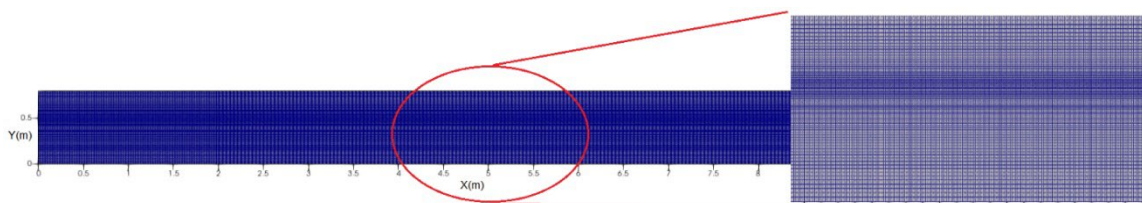


Figure 1. The general view of the grid and zoom of the grid in the vicinity of the water surface



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Consequently, incorporating HPC into NWT based on CFD is pivotal for improving the accuracy of simulations. NWT simulations present challenges, such as complexities in turbulence modeling, grid resolution, and sensitivity to boundary conditions, all of which impact the precision of results. HPC employs advanced methodologies to tackle these challenges, facilitating finer grid resolutions and reducing computational time, thereby enabling highly detailed simulations. Figure 2 shows a screenshot of the wave generation in a 37-meter channel using a piston-type wave maker. The visualization depicts a 15-meter segment at the midpoint.

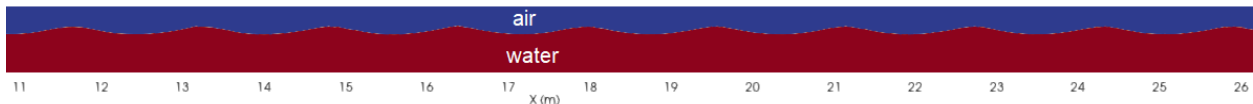


Figure 2. Generation of regular waves with a piston-type wave maker in a 37-meter flume, visualizing a 15-meter segment at the midpoint

In the context of high-performance computing (HPC), the analysis of wave energy converters (WECs) through numerical wave tanks is vital due to computational complexity. High-fidelity simulations require meticulous consideration of parameters, and HPC's parallelization capabilities efficiently handle vast datasets, enabling simulations with finer spatial and temporal resolutions and critical for resolving small-scale features and turbulent flows around WEC components. HPC accelerates numerical experiments, facilitating broader design space exploration and parametric studies to optimize WEC performance. The utilization of HPC resources allows researchers to address the computational demands of numerical wave tank simulations, making high-resolution analyses feasible for advancing efficient wave energy converter design and deployment. Considering assumptions and simplifications in the CNWT, the numerical model is an effective tool for evaluating WEC under diverse conditions, eliminating the need for expensive and time-consuming experimental tank tests.

ACKNOWLEDGMENTS

The authors acknowledge the contribution of the National Recovery and Resilience Plan, Mission 4 Component 2 - Investment 1.4 - NATIONAL CENTER FOR HPC, BIG DATA AND QUANTUM COMPUTING, funded by the EU - NextGenerationEU - (CUP B83C22002830001).

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KEYWORDS: NUMERICAL WAVE TANKS, CFD, WAVE ENERGY, HPC



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MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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FORM FOR ABSTRACTS PRESENTATION

TITLE:

CLIFF INSTABILITY AND DETECTION OF SURFACE CRACKS WITH DRONE
PHOTOGRAPHY AND VISUAL INSPECTION:
THE CASE FOR CLOSING A PUBLIC FACILITY ON THE HADERA SHORELINE, EASTERN
MEDITERRANEAN

SESSION:

COASTAL AND OFFSHORE ENGINEERING

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A 3D model of the Bet Hankin restaurant on the shoreline cliff at Hadera, Israel. The red-blue scale represents the slope (degrees) on the reference section marked. A colour-code for the slope is given on the right, together with a histogram (principal mode 85°).



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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The typically sandy and narrow shorelines of the southern Levant are mostly backed by sandstone cliffs that reach tens of meters in height. During the last decades the shore is undergoing accelerated development, posing considerable engineering challenges. Awareness of hazards related to cliff stability has been rising, along with the accumulation of casualties. Recent studies of the Levantine coastal cliff have used modern quantitative methods for monitoring and analyzing the overall process of cliff recession and disintegration [1,2]. Here we report a case study where a hazardous crack was identified by visual inspection coupled with modern survey techniques. The identification of the crack has induced a closure order for a restaurant, constructed as a residence over eight decades ago, long before the surge in modern development.

The site in question is located on the Hadera waterfront. Hadera is a medium-size urban center (over 100,000 residents), located about the midpoint between Tel-Aviv and Haifa, the two largest coastal cities in Israel. The town hosts a coal port, and is a likely site for the next commercial port to be constructed in the country. The city offers an attractive coast, bordering a stretch of nature reserve with archaeological sites. The coastal cliff near the restaurant exceeds 20 m in height. Our teams were commissioned by the authorities to assess the stability of the cliff. In addition to the general issues of the cliff, we focused on a particular building: It was planned in the late 1930's and was erected in the early 1940's. In recent years the building is used as a popular restaurant and a party hall. For field surveys we used data from a regional airborne LiDAR monitoring program (annual repetition) and localized drone photogrammetry; for stability analysis we used the FLAC software with available determinations of rock properties for the site.

During monitoring, a massive rockfall hit the cliff some 50 meters north of the restaurant. Based on annual airborne LiDAR surveys, over 200 cubic meters were involved in the rockfall. The cliff receded 12 meters due to the rockfall. We have surveyed the coastal cliff at the immediate vicinity of the restaurant with drone photography and generated geological sections. We used a light drone to capture a photogrammetric three-dimensional model and measured elevations and slopes. A modal slope of circa 84 degrees is measured adjacent to the restaurant. The situation is exacerbated by a waterfront dirt-road at the foot of the cliff. A retaining wall has been constructed at an adjacent section of the cliff.

A columnar geological section directly underneath the restaurant revealed a massive aeolinite-calcarenite lithology (locally dubbed "kurkar"). The sandstone, cross-bedded in places, features variable degrees of cementation and induration. A geological cross-section shows an adjacent lens of argillaceous silty sandstone (locally dubbed "hamra"), which supports thick vegetation at the sloping surface. The variability of induration expresses itself by distributed notches, with a conspicuous one underlying a four-meter thick massive layer at the top of the section, right underneath the restaurant. Debris of blocks that seem to have originated in that layer are scattered around the beach. Open cracks that traverse the top 4 meter layer of sandstone underneath the restaurant have been documented. Our preliminary stability analysis suggests that the cliff is marginally stable (factor of safety around unity). The cliff might lose stability in the event of a heavy rainstorm or a moderate earthquake.

This case study exemplifies the usefulness of a combination of methods for identifying coastal cliff hazards. Advanced monitoring and analysis, especially when combined with more traditional methods such as field geology, should be used to underscore rockfall hazard.

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KEY WORDS (MAX 4)

- (1) Protected Natural Areas. (2) Design and planning of coastal and port settlements. (3) Sustainable tourism and water sports. (4) Anthropogenic and natural landscapes.



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

Title: MODELING OF FLOW PATTERNS AND MICROBIOLOGICAL PARAMETERS FOR HAZARD ASSESSMENT OF BATHING WATERS AFFECTED BY COMBINED SEWER OVERFLOWS

SESSION: "INGEGNERIA COSTIERA E OFFSHORE: PRODUZIONE E TRASPORTO DI ENERGIA, STRUTTURE PORTUALI E OFFSHORE, QUALITÀ DELLE ACQUE, MISURE E MONITORAGGIO, ELABORAZIONE DATI E SERVIZI, DIGITAL TWIN, VALUTAZIONE ECONOMICO-AMBIENTALE, CONTESTO NORMATIVO"

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The present abstract introduces a numerical study conducted by ARPA Puglia to model the plume of the urban discharge of mixed origin (sewage and surface runoff). The sewage flows from the Matteotti spillway affecting the bathing area of "Pane e Pomodoro", among the most important and crowded urban beaches of Bari. The Matteotti spillway is an underground pipeline acting as an emergency weir of the main sewer system that prevents the flood level from being reached during or soon after intense rainfall events. Once the spillway is triggered, the sluice gates at the front open and the wastewater accumulated in the spillway, without any treatment for the reduction of the bacterial load, is thus discharged into the seawater forming a plume. Then, the municipality of Bari emits an urgent bathing prohibition measure at "Pane e Pomodoro" beach and promptly the Regional Environmental Protection Agency (ARPA Puglia) samples water specimens and measures their bacteriological content. The prohibition is removed once the laboratory analysis shows the bacterial content below the limits defined by Italian laws (Italian Legislative Decree n. 116/2008). The main outcome of this study was the numerical simulation of the bacterial concentration diffusion plume after the meteorological event occurred on July 2018: the simulation was gained using the DHI's Mike 3 suite enhanced with the ECOlab module, both organized as step-by-step processes.

Primarily, the hydrodynamic and diffusion model was set-up to reproduce the typical pattern flow of the coastal area and to describe the evolution of the closely related diffusive processes: this set-up required the characterization of the meteo-sea climate and hydrodynamic circulation of an area wider than the one potentially affected by the spill.

The bathymetry of the seabed was reproduced approximately over 12 km off the coast by means of a triangular mesh, while the meteo-sea climate conditions were reproduced using wind data time series collected with the inner control unit located on the roof of the ARPA Puglia directional building, very close to "Pane e Pomodoro" beach, whereas wave data time series were provided by the National Wave Network (RON network) collected with the buoy located offshore of Monopoli (about 30 km south-east of Bari). With reference to the summer season, wind roses and time series of the distribution and direction of the significant wave heights were calculated. Accordingly, the wave propagation in the study area was investigated using the MIKE 21 Spectral Waves wind-wave transformation model. It enables the determination of wave patterns in the proximity of the coast and, especially, the radiation stress helpful for later current model simulations to be performed using the MIKE 3 module. Concerning bathing water quality, the ECOlab predictive model enables the simulation of the Escherichia coli and Intestinal Enterococci concentrations (i.e. indicators of faecal contamination required by Italian Legislative Decree n. 116/2008), whose decay is achievable as a function of several parameters such as solar radiation, salinity, temperature and water transparency. The ECO Lab module, nested with the hydrodynamic model previously produced and validated, was finally applied to simulate the spreading of the marine microbiological contamination.

Output from the hydrodynamic model (temperature, salinity, density and wind forcing) and concentrations of microbiological parameters (E. coli and intestinal Enterococci) were assumed for the initial conditions, boundary conditions and pollution source (Matteotti spillway) of the EcoLab model. Finally, the validation of the ECO Lab



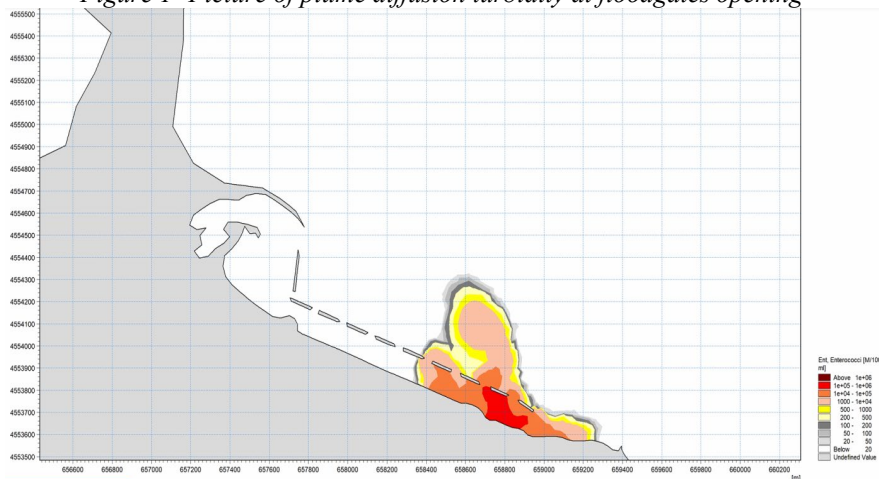
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model was performed by comparing the microbiological concentration values measured with the model and by ARPA Puglia during its monitoring activities.



Figure 1- Picture of plume diffusion turbidity at floodgates opening



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KEY WORDS (MAX 4)

OVERSPILL, BATHING WATERS, WATER QUALITY, FLOW PATTERN



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FORM FOR ABSTRACTS PRESENTATION

TITLE: PLASTIC POLLUTION ON TUSCAN COASTS: ENVIRONMENTAL MEASURES MUNICIPALITIES CAN PUT IN PLACE TO REDUCE IT

SESSION: Coastal and offshore engineering: energy production and transport, port and offshore structures, water quality, measurements and monitoring, data processing and services, digital twins, economic-environmental assessment, regulatory context

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Toxic pollution from plastic waste undermines human health, contributes to loss of ecosystem and cultural services, and generates large-scale and long-term harmful environmental changes, thus putting at risk the sustainability of marine and coastal ecosystems. To be addressed, it requires the adoption of regulatory measures at international, national and local scale. The identification of top litter items discarded in the environment is essential to prioritize environmental policies to prevent plastic leakage and promote a circular economy. In the framework of the Citizen Science project “Profili Antropici” financed by “8 per Mille Chiesa Valdese”, we quantified macrolitter items on three beaches with different environmental conditions and usage by citizens along the coast of Tuscany and identified possible regulatory measures that can be taken by the local administrators.

Macrolitter were collected at Bocca di Serchio (Marina di Vecchiano, PI), Cala del Leone (Livorno), and Lillatro (Rosignano, LI) during three sampling occasion on each beach between November 2022 and July 2023. A total of 11'237 litter items, of which 88,39% were plastics, were collected and categorized according to the EU Joint List of Litter items (1). Single-use plastic (SUP, defined in accordance of the EU Single-Single Use Plastics Directive (SUPD, 2019/904/EU) (2)) items correspond to 35.18% of total litter items (ranging from a minimum of 14.72% at Bocca di Serchio in June 2023 to a maximum of 72.61% in Lillatro during November 2022). The most abundant single-use plastic items are cigarette butts (22.69% of all litter items), plastic drink bottles ≤ 0.5 l (3.19 % of all litter items), plastic cups/lids drinks (2.89% of all litter items), plastic cotton bud sticks (2.79% of all litter items), and plastic drink bottles > 0.5 l (1.19% of all litter items). Cigarette butts were found at all sampling occasions, with the exception of Cala del Leone in April 2023. At Lillatro, the abundance of cigarette butts ranged from 1040 in November 2022 to 317 in



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the July 2023. The highest abundance (300 items) of plastic drinks bottles ≤ 0.5 l was at Cala del Leone in April 2023; the highest abundance of plastic cups/lids (124 items) was at Bocca del Serchio in March 2023, while highest occurrence of plastic cotton buds sticks (251 items) was at Bocca del Serchio in November 2022. For plastic drinks bottles > 0.5 l the highest occurrence (58 items) was at Cala del Leone during November 2022. Of the 20 most abundant litter items, 14 are in plastic and 6 are SUP items. The minimum litter abundance was 438 litter items/100 m survey items at Cala del Leone in November 2022 and the maximum was 2'354 litter items/100m survey in February 2023. These values are higher than European precautionary threshold value for marine litter (20 items/100m survey). Non-identifiable litter items summed up to 46.52% of all litter items. Plastic pieces < 50 cm were 27.35% of all litter items (minimum 6.87% at Cala Del Leone in June 2023; 66.78% at Lillatro in February 2023). Pieces of polystyrene represented 12.81% of all litter items.

Municipalities can significantly limit plastic pollution on their territory through the development of integrated strategies that include public procurement and exemplarity as well as territorial animation. We discuss the environmental policies that have been taken by other local administrations in Italy (3) and at the international level (4) and suggest how these policies can be put in place also in the three municipalities of this study. This work confirms the opportunity to use citizen science to gather relevant data on macrolitter items and to monitor the effectiveness of environmental regulations to reduce plastic pollution.

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KEY WORDS (MAX 4) PLASTIC POLLUTION, COASTAL ECOSYSTEMS, ENVIRONMENTAL REGULATIONS, ANTHROPOCENE



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: MONITORING OF MICROPLASTICS IN PORT SEDIMENTS.
EVALUATION OF DIFFERENT ANALYTICAL METHODS.

SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

General frameworks :

Pollution of the marine environment by microplastics is an emerging issue in the field of dredging. The development of monitoring of microplastics in the marine environment and in particular in sediments is recommended at national level, via the zero plastic waste at sea roadmap, at European level, via several measures of the Marine Strategy Framework Directive (MSFD), and at the international level via the various recommendations of the regional seas conventions.

The OSPAR convention is working in particular on the development of a microplastics indicator in sediments. In this context, a sampling and analysis protocol should be recommended by this agreement.

Cerema is in charge of the technical management of the national maritime port surveillance network (REPOM).

Objectives :

The purpose of this network is to monitor the quality of port sediments by relying on the services responsible for policing coastal waters.

In order to acquire data on the contamination of port sediments by microplastics, specific monitoring was initiated in 2021 at the ports of Brest and Douarnenez. In 2022, 15 additional ports, spread over several seaboard, were monitored.

Different analysis methods were tested in conjunction with Cedre, IFPEN and the Laboceja laboratory. The results of this test phase will make it possible to decide whether or not to generalize the monitoring of microplastics to all REPOM points.

Methods:

Sampling is carried out by the Water Police services of each department. The sampling plan for REPOM points should not change from year to year in order to maintain some continuity in the data series. The same is true for the analysis of microplastics, the concentrations of which can thus be compared with those of other contaminants, in particular phthalates.

Currently there is no standard for the analysis of microplastics in sediments. As part of the 2021 and 2022 test campaigns, several methods were tested in order to identify the method best suited to REPOM's needs:

- visual analysis
- Fourier Transform Infrared (FTIR)
- pyrolysis via IFPEN's Rock-Eval process
- pyrolysis coupled with gas chromatography and mass spectrometry (Pyr-GC/MS)

Results:

The first results received concern the FTIR analyses. There is a marked disparity in the results. The contents vary between 470 MP/kg and nearly 35,000 MP/kg.

An important variability is also observed within the same port depending on the sampled points. The median of the values is 8,300 MP/kg for a standard deviation of more than 10,000 MP/kg. The most frequently identified polymers are polyethylene (23%), polypropylene (20%) and finally the polyethylene-propylene copolymer (12%).

The particles are mainly of size less than 500 µm.

According to the first visual analyses, the microplastics found in the port sediments are mainly composed of fragments of hard plastic (45-80%) and synthetic fibers (15-60%).

Pyrolysis analyzes are in progress. Difficulties were encountered due to the high load of organic matter in the port sediments. Thus, the extraction method must be subject to adaptations.

Discussion:

Currently there is no standard for the analysis of microplastics in sediments.

As part of the 2021 and 2022 test campaigns, several analysis methods were tested in order to identify the most suitable method for generalizing this monitoring via the REPOM. Several criteria will thus be evaluated: results obtained, speed of analysis, and cost.

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3. Galgani Francois, Bruzard Stéphane, Duflos Guillaume, Fabre Pascale, Casdaldi Emmanuelle, Ghiglione Jeff, Grimaud Régis, George Matthieu, Huvet Arnaud, Lagarde Fabienne, Paul-Pont Ika, Ter Halle Alexandra, 2020. Pollution des océans par les plastiques et les microplastiques.

KEY WORDS (MAX 4) :

MEASUREMENT METHODS AND INSTRUMENTS. MARINE PLASTICS. REGULATORY CONTEXT. DATABASES AND TELECOMMUNICATIONS NETWORKS MANAGEMENT.



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

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FORM FOR ABSTRACTS PRESENTATION

TITLE: MAPPING THE IMPACTS OF MARINE LITTER IN COASTAL ECOSYSTEMS
SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <i>General frameworks</i> Marine litter, primarily plastic pollution, in coastal marine ecosystems is a rising problem that is unlikely to abate anytime soon. Recent estimates indicate the total amount of buoyant marine plastic litter is 3,000–3,400 kilotonnes, which is much higher than previous estimates, while the plastic input into the marine environment is 470–540 kilotonnes per year, slightly less than previous estimates (Kaandorp et al., 2023). Several international policies aim to address this issue such as the United Nation’s sustainable development goal 14 Life Below Water, where plastic pollution is one of the top five state of emergency actions that need to be addressed in addition to acidification, ocean warming and overfishing (UN-SDG, 2023). In this study, we review and analyze the major impacts of marine litter on coastal ecosystems around the world that have been observed historically during the previous half-century. <i>Objectives</i> The main objective of this study is to (i) provide a synthesis of the current impacts of plastic marine litter on coastal ecosystems, and (ii) perform a methodological review of previous research highlighting the important insights from studies. <i>Main findings, results, and indications of the proposed work</i> A literature review was carried out to identify the impact of marine plastic pollution affecting coastal ecosystems globally. Various search combinations in SCOPUS considering ‘impacts’, ‘effects’, ‘marine litter’, ‘marine debris’ and ‘coastal’ were performed, for a total of 855 studies after duplicates were removed. Studies considered were published from 1974 to 2023, with an exponential increase over the last decade. Preliminary results provided by a network analysis indicated the most common keywords were microplastics, marine litter and plastic pollution. From here, the primary impacts discussed within the studies in the literature search include direct impacts, such as environmental damage, disrupting the functioning and equilibrium of these areas and harmful effects on coastal biodiversity. Many studies



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provided physical evidence, such as entanglement and ingestion of these items, which can have a variety of toxicological consequences, including irreparable harm and even death. Additionally, there are also several economic impacts that range from clean-up costs marine litter removal to the destruction of fishing gear or ship endangerment by causing navigational harm. This has a variety of social consequences, including a negative public perception by reducing visual attractiveness, which may deter tourists, creating indirect economic costs to local communities. Overall, this study discusses an extensive list of impacts reported from scientific literature, highlighting there is a global need to coordinate efforts at the local, national, and international levels. Identifying the principal consequences will allow essential preventative and removal efforts to be targeted to assist in maintaining healthy coastal ecosystems.

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KEY WORDS (MAX 4)

PLASTIC POLLUTION, COASTLINES, SOCIO-ECONOMICS



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FORM FOR ABSTRACTS PRESENTATION

TITLE: Citizen Science and Machine Learning forecasting *Ostreopsis cf. ovata* blooms

SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT

Benthic Harmful Algal Blooms (HABs) are detrimental to humans, marine organisms and the environment. *Ostreopsis ovata* (Fukuyo, 1981) belonging to the genus *Ostreopsis* Schmidt is one of the most common microalgae that produces palytoxin-like toxins (ova-toxin). Ova-toxin represents a threat for human health via entry into the food chain, inhalation or direct contact. Since the 1990s, *O. cf. ovata*-generated HABs have been recorded in the Mediterranean Sea particularly in Spain, France and Italy, sometimes affecting more than 200 individuals. *O. cf. ovata* has been detected all over the Italian coast.

Since summer 2007, in Apulia, a region of Southern Italy, a regular monitoring of the microalgae abundance is performed every two weeks from June to September by ARPA Puglia, the regional agency for environmental protection. The aim of the monitoring set up by ARPA Puglia is to raise alarm through public information in order to prevent beach users' intoxication. As established in the monitoring plan of ARPA Puglia, 30,000 cells/L is the threshold of *O. ovata* concentration in the water column to disclose to the public warning about the onset of risks to human health (Ungaro et al., 2010, <http://www.arpa.puglia.it>)

The causes of *O. cf. ovata* blooming are not completely understood and the relationship with eutrophication and climate change has been hypothesized. However, as shown by separate studies, meteo-marine parameters play a pivotal role in permitting the proliferation of this microalgae. A preliminary descriptive model of *O. ovata* blooms events in the Ligurian Sea highlights a relevant role of seawater temperature and hydrodynamics (Asnaghi et.al, 2012).

In a machine learning based approach, data of *O. ovata* concentrations together with data provided by meteo-marine forecasting models operated by ARPA-Liguria have been already used to develop a predictive tool to forecast HABs in this region of Northern-Eastern Italy (Ottaviani et al., 2020).

More recently, the statistical correlation between with nine weather parameters freely available in databases and *O. ovata* concentration in Molfetta, a city of Apulia region, allowed the identification of dew point as a new parameter that could be useful to forecast blooms of the toxic microalgae along with air and seawater temperature (de Virgilio et al. 2021).

In this study we describe a citizen science and machine learning based approach to predict *O. ovata* blooms in four sites along the Adriatic coastline that are considered *hot spots* for the proliferation of the microalgae, namely Bisceglie, Molfetta Giovinazzo and Bari (Figure 1). The prediction model derives from the statistical correlation between *O. ovata* concentration detected by ARPA-Puglia from 2010 to 2022 and nine meteorological variables collected by volunteers of a Citizen Observatory from open access archives and databases.

Using all available data from both ARPA Puglia and the Citizen Observatory, a new



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predictive model was trained to predict the *O. ovata* blooms using all the meteorological estimates of the last 15 days. Several algorithms were tested to maximize prediction accuracy and best results was obtained with Quantile Regression Forest (QRF). This algorithm is shown to be consistent and competitive in terms of predictive power, evaluated by RMSE and MAD indicators, and allows prediction of HABs with good accuracy (Figure 2). This prediction model proved to be a useful tool not only to forecast concentration estimates but even to anticipate possible bloom events defined according to current regulations and to highlight the relative importance of the used meteorological parameters. More specifically, the model indicates there are specific time lags between such parameters and *O. ovata* concentration. The location of the sampling site and the seasonality appears also important and are kept into the model as predictors, so the approach can be easily extended to other locations where different seasonal behaviour may occur.

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KEY WORDS : *Ostreopsis ovata*, HABs, citizen science, prediction model

Italy



Apulia



Figure 1. Distribution of the 4 sampling sites along the Adriatic coastline of Apulia region analyzed in this study.

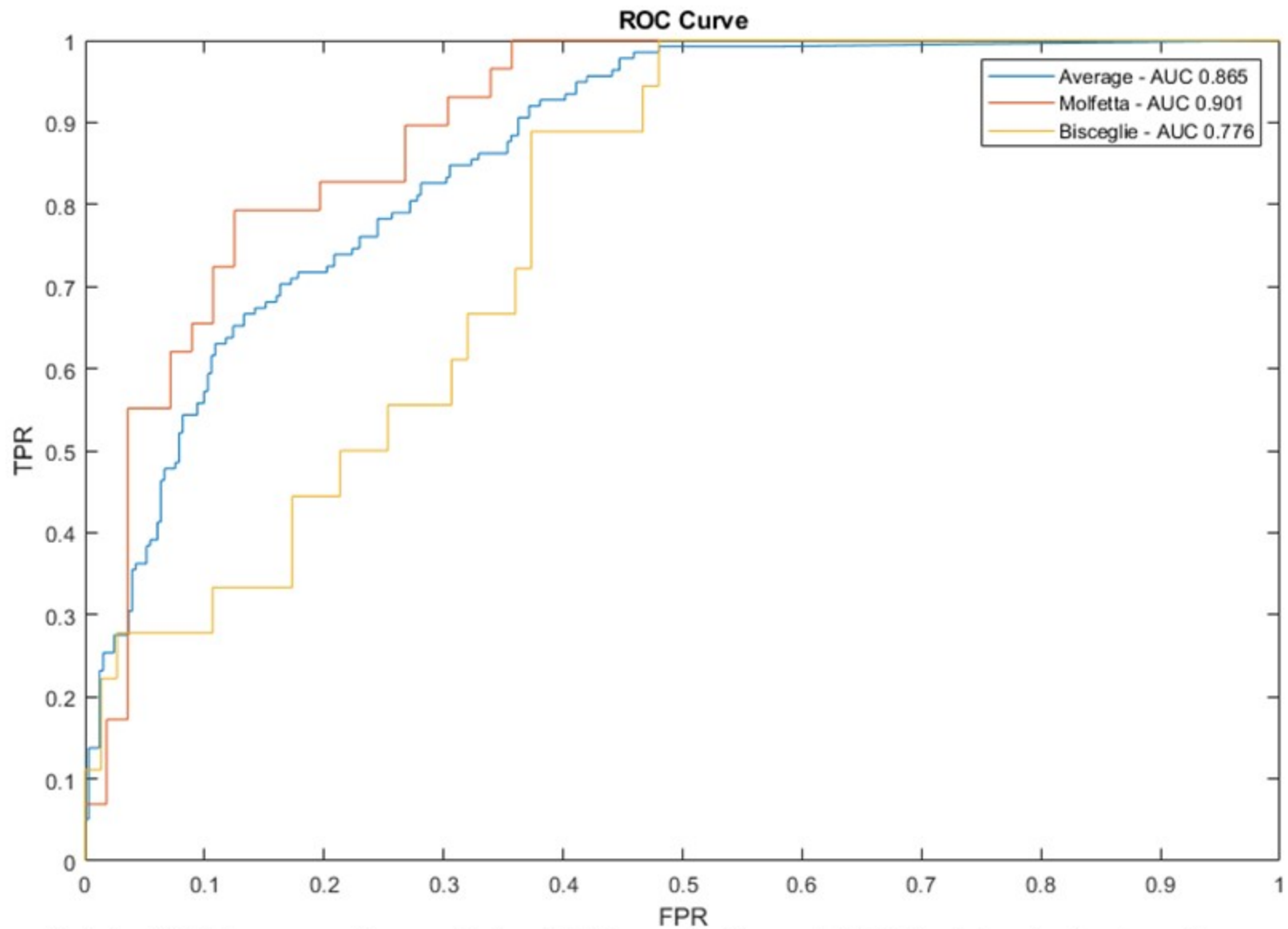


Figure. 2 Cross-validated ROC curves for next-day HAB prediction. A HAB is detected when the predicted concentration exceeds a threshold.



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

THE ITALIAN COAST GUARD SURVEILLANCE AND SPECIFIC ENVIRONMENTAL ACTIVITIES. RESULTS OF THE NATIONAL CAMPAIGN.

SESSION:

COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT:

Over the years, specific environmental maritime police campaigns and complex operational activities have been thoroughly planned and carried out through the use of ITCG specialized units aiming at protecting the marine environment and the safeguard of the coasts and the biological resources, in order to discover, analyze and repress environmental-harming activities.

In 2023 the Environmental National Coordination Center planned a national campaign to prevent marine pollution and deployed also the Italian Coast Guard Environmental Analysis Laboratory. This campaign was called «Clean Waters» and took place from 27th December 2022 to 30th April 2023: it involved all local Coast Guard offices and mainly focused on sites which could generate wastewater discharges likely to pollute the marine environmental matrices.

Hundreds of checks were carried out on specific targets and 55 wastewater samples were sent to the laboratory for subsequent analysis. Samples of waste water coming from as many discharge points discharging onto the receiving body (seas, rivers, coastal waters) distributed throughout the national territory were analyzed, in order to ascertain any exceeding limits imposed by Italian law and to counteract potential pollution of the Italian seas.

On the samples received we performed approximately 2,000 chemical-physical, chemical and microbiological analyses; 12 samples resulted “non-compliant” due to 20 exceedings limits set by the Legislative Decree 152/2006 and/or individual environmental permits for chemical and microbiological parameters.



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Figure 1 – wastewater sampling phase



Figure 2 – wastewater analysis phase

In the same time frame, 38,380 controls were performed on water discharges and waste cycle resulting into the notify of hundreds of both administrative and penal offences, which were immediately reported to the Judicial Authority.

The Italian Coast Guard's environmental activities are continuous throughout the year: the Environmental National Coordination Center planned an enhanced surveillance in anthropized Marine Protected Areas, which is on-going at present and is involving 19 local Coast Guard offices and the Environmental Analysis Laboratory. In particular, Environmental Analysis Laboratory technicians performed both sampling and analytical activities in Apulia and Sardinia by the Mobile Environmental Laboratory supported by local Coast Guard personnel. On the other hand, Marine Protected Areas located in the other regions were investigated by local Coast Guard officers and agents, which took waste water samples and sent them to the Environmental Analysis Laboratory for analytical determinations. The investigation activities are still underway and some offences have already been notified.

Both activities allowed to test the structure and to create, at the national level, an ascertain methodology in which the specialized units worked in synergy with the local authorities, thus obtaining even more effective results through both documentary and technical verification.

This methodological approach has allowed to increase the effectiveness of Coast Guard operations to prevent harmful behaviors and therefore will continue to be implemented in future activities.

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KEY WORDS:

MEASUREMENT METHODS AND INSTRUMENTS



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PROBLEMS AND MEASUREMENT TECHNIQUES**

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FORM FOR ABSTRACTS PRESENTATION

TITLE:

EARTH OBSERVATION AND GEOMATIC TECHNIQUES: NEW APPROACHES IN
SUPPORTING COASTAL, ISLAND AND MARINE PLANNING

SESSION:

5. COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT,
PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND
MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-
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ABSTRACT:

Scientific debate generally agrees that climate variations are increasingly unexpected and unpredictable. The current transitional era poses the need to think about updating the tools related to planning processes, re-focusing their objectives according to new priorities. Knowledge frameworks emerge as important tools for understanding the state of the art of coastal and marine contexts: the criticalities caused by Climate Change affect these environments with extreme intensity. For this reason, these areas require the construction of dynamic cognitive frameworks, covering different scales of analysis and action.

Coastal management follows the principles of Integrated Coastal Zone Management (ICZM), a protocol that for the Mediterranean area is aimed at integrating all the systems that constitute a coastal area. This is a protocol with current limitations: despite a clarity about the importance of integration, its actual implementation is still hampered by the complexity of the coastal environment. Excessive fragmentation and sectoral management, caused by a subdivision of governance levels for the management of the land-sea interface leads to a lack of homogeneity in the management of these areas, both in terms of competences and in terms of the instruments that currently exist (Shipman & Stojanovic 2007).

To achieve this objective, the academic and scientific communities recognize the necessity of cross-disciplinary collaboration to acquire methodologies that can be applied and appreciated in a comprehensive manner. The responsibilities assigned to spatial planning discipline, in the pursuit of adaptable yet long-term perspectives, continue to expand.

Among the tools currently available is the growing availability of Earth Observation (EO) data, which is now well-established as a supportive resource for decision-makers. Data from EO, especially those related to coastal and marine areas, must be carefully processed and calibrated. In this regard, the collection of in-situ data using geomatics-related techniques becomes essential for the validation of EO data. Also, measuring characteristics connected to the ecological component (including vegetative presence, state and fragmentation) contribute to the development of major environmental standards as well as functioning as a support for the practical application of European Directives (Cabello et al., 2018).

The objective of this contribution is the design and testing of a prototype of spatial information infrastructure to support planning activities focused on protected areas in coastal and marine contexts. Through the acquisition of new data and tools that are expected to optimise the management and protection procedures in these particular areas, the infrastructure shall represent a step forward in decision-making tools. The work is developed within the Interreg Italy-Slovenia "Poseidon" project, identifying the Marine Protected Area of Miramare as an interesting study area. The choice of this area is motivated by its multiple roles as sentinel site for biodiversity and ecosystem values, reservoir of numerous species, and research laboratories for integrated coastal and marine management methods, particularly concerning climate change (Soriani & Tonino, 2015).

The suggested methodology considers the study area's ecological significance and natural heritage, comparing monitored parameters over time. The research focuses on data between 2013-2023, integrating multitemporal data from Copernicus satellites (Sentinel-1 and Sentinel-2) and other satellites (e.g., Planetscope). In-situ surveys using UAVs are also employed.

This contribution aims to assess the employability of a multitemporal information framework regarding the case study area that might serve as a catalyst for processes of enhancement and protection.

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KEY WORDS (MAX 4)

GEOGRAPHIC INFORMATION SYSTEMS
REMOTE SENSING
SPATIAL PLANNING
MONITORING OF COASTAL ECOSYSTEMS



Tenth International Symposium

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FORM FOR ABSTRACTS PRESENTATION

TITLE:

*The unintentional introduction of marine invasive alien species by means of maritime transport.
The juridical framework: where do we stand?*

SESSION:

FLORA AND FAUNA OF THE LITTORAL SYSTEM: DYNAMICS AND PROTECTION

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

According to Regulation (EU) no 1143/2014 on the prevention and management of the introduction and spread of invasive alien species (hereinafter, IAS), *alien species* means «any live specimen of a species, subspecies or lower taxon of animals, plants, fungi or micro-organisms introduced outside its natural range; it includes any part, gametes, seeds, eggs or propagules of such species, as well as any hybrids, varieties or breeds that might survive and subsequently reproduce», while *invasive alien species* means «an alien species whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services» (Article 3).

Still according to Regulation no 1143, IAS «represent one of the main threats to biodiversity and related ecosystem services, especially in geographically and evolutionarily isolated ecosystems, such as small islands» (Recital 2). The threats take different forms, including «severe impacts on native species and the structure and functioning of ecosystems through the alteration of habitats, predation, competition, the transmission of diseases, the replacement of native species throughout a significant proportion of range and through genetic effects by hybridisation» (Recital 3).

Marine IAS in particular have been recognized as a major threat for the well-being of seas and oceans, both at the international and the European level.

At the international level, it is worth remembering, *inter alia*, the Bern Convention (1982), the UNCLOS (1982), the Convention on Biological Diversity (CBD, 1992), and several UNEP Regional Seas Conventions, including the Barcelona Convention (1995) for the protection of the marine environment and the coastal region of the Mediterranean, all of which emphasizing the importance of addressing the impacts of marine IAS.

At the EU level, we can mention, for example, Directive 2008/56/EC (Marine Strategy Framework Directive), by which one of the qualitative descriptors for determining the «good environmental status» of marine waters is the lack of non-indigenous species introduced by human activities at levels that may adversely alter the ecosystems.

Many IAS are introduced unintentionally (unlike those introduced e.g. for commercial interests or ornamental purposes), unwittingly transported by travellers or as contaminants of goods or



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packaging or, sometimes, travelling as hitchhikers or stowaways on watercrafts (ranging from kayaks to large vessels), either adhered to the hull (biofouling) or carried inside the ballast tanks. In this regard, it is worth remembering that since 1949, according to the *European maritime transport environmental report 2021 (EMTER report 2021)*, the maritime transport sector has accounted for the introduction of almost 50% of IAS in the seas around the EU. The greatest number is found in the Mediterranean, where 51 IAS are also classified as high impact species (i.e. as capable of affecting ecosystems and native species).

The work aims at exploring the complex juridical framework (including soft law, legally binding regulations, voluntary instruments such as technical guidelines) that, in a multilevel system, has been set up to prevent and – if necessary – to manage the unintentional introduction and spread of marine IAS by means of maritime transport, with a special focus on the two primary pathways, that is ballast waters and biofouling, starting from the main international conventions on the topic – i.e. the Convention for the Control and Management of Ships' Ballast Water and Sediments (BMW Convention, 2017) and the International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention, 2001) – and the IMO guidelines, such as the recently updated *2023 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species*.

The work will follow a top-down approach, to analyse the international, European, and Italian legislation, highlighting possible regulatory gaps and policy inconsistencies.

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KEY WORDS (MAX 4)

MARINE INVASIVE ALIEN SPECIES

MARITIME TRANSPORT

INTERNATIONAL, EU AND ITALIAN LAW



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PROBLEMS AND MEASUREMENT TECHNIQUES**

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FORM FOR ABSTRACTS PRESENTATION

TITLE: SALINATION OF SPRINGS IN THE BAKAR BAY
SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, <u>WATER QUALITY</u>, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, <u>ECONOMIC-ENVIRONMENTAL ASSESSMENT</u>, REGULATORY CONTEXT
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ABSTRACT: <i>With rising sea levels, increasing atmospheric temperatures, and recurring extreme weather events, the vulnerability of coastal waters to salination is a pressing issue. The intrusion of saline seawater leading to the salination of springs follows the principles of the Ghyben-Herzberg relationship, which states that a fall in groundwater levels causes the inflow of saltwater into freshwater. The aim of this study was to investigate the relationship between the occurrence of salinity in the Dobrica, Dobra and Perilo springs in the Bay of Bakar and extreme weather events, but also many other variables that were measured between May of 1999 and June of 2020.</i> <i>The analysis of data collected by the State Hydrometeorological Institute (DHMZ) and the utility company Water Supply and Sewerage Ltd. Rijeka revealed a direct correlation between extreme weather events and the salination of drinking water sources. In particular, the chloride concentration in the Dobrica spring exceeded safe levels and made the water unsuitable for consumption for a cumulative period of 24 days between 1999 and 2009 with a peak value of 2470.4 mg/L. Further analyses underlined the connection between lower precipitation, increased chloride levels, and above-average air temperatures. The strikingly high chloride content in 2012 coincided with a year characterized by persistently high temperatures. In addition, the study conducted a comprehensive panel analysis that considered key variables such as water temperature (°C), electrical conductivity ($\mu\text{S}/\text{cm}$), hardness (mg/L CaCO_3), chloride (mg/L), and other variables.</i>



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The results suggested significant positive correlations between water temperature and chloride content as well as a direct relationship between electrical conductivity and chloride concentration beside the correlation between water hardness and chloride concentration, which emphasizes the interplay between different water quality variables in the salination process. Statistical associations of available data and preliminary graphical representations of air temperature, precipitation, and chloride concentration in the spring water illustrate the direct influence of the weather on the salinity of the springs. It is significant that the highest salination of spring water occurred in 2003 and 2012, years that were characterized by rising temperatures, prolonged heat waves, and extended periods of drought in summer.

To make most use out of the 2700 observations, panel data analysis techniques were used, including the Autoregressive Distributed Lag (ARDL) model, panel Granger “causality” test, and panel data regression techniques with Hausman test for model selection. In addition, the Panel Generalized Method of Moments (GMM) First Differences (FD) was integrated into the study to analyze dynamic effects and falsify causal hypotheses. The results of the study emphasize the urgency of implementing effective climate change adaptation strategies and sustainable water resource management to mitigate the negative impacts of extreme weather events on freshwater resources. The results of this ongoing research have significant implications for policy makers and stakeholders concerned with sustainable water resource management.

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KEY WORDS (MAX 4): CLIMATE CHANGE, SPRINGS SALINATION, COASTAL ENVIRONMENTAL PHYSICS, ANALYSIS OF ECONOMIC ENVIRONMENTAL IMPACTS .



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FORM FOR ABSTRACTS PRESENTATION

TITLE: ASSESSMENT OF THE QUALITY OF MARINE BATHING WATERS USING DIFFERENT METHODS OF PERCENTILE CALCULATION

SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

The quality of bathing water is not only crucial for public health but also for the growth of sustainable tourism. It is influenced by both natural and anthropogenic elements. The main objectives of the European Union's Bathing Water Directive 2006/7/EC, which regulates the management and quality of bathing water, are to preserve and protect the environment, improve quality, and protect human health (1). Escherichia coli (E. coli) and intestinal enterococci (ENT) are the two fecal indicator bacteria used to test the microbiological quality of bathing water. In Croatia, the quality of coastal bathing water has been systematically monitored for more than 30 years. During this time, numerous parameters of the monitoring program have changed: regulations, microbiological criteria and test methods, limit values for individual categories of water quality, but also statistical procedures and methods of data processing.

In Croatia, the quality of bathing water is currently assessed on the basis of the values of the 90th and 95th percentiles. The procedure involves logarithmization and the determination of the arithmetic mean and the standard deviation. Based on the determined values of the 95th and 90th percentiles and predefined intervals, the quality of the sea for bathing is then classified as excellent, good, sufficient or poor. The method described for determining the value of a particular percentile is also known as the parametric method, as the arithmetic mean and the standard deviation are used for the calculation. These are the measures of central tendency and variability for data sets that are distributed according to a normal distribution. Since the data on the bacteria are almost never normally distributed, the question arose as to whether this method is suitable.

In New Zealand, the so-called Hazen method is used to determine the value of a particular percentile. Using the interactive calculator (2), we compared the values obtained using the standard parametric method and the Hazen method. For comparison, we used data from the site where microbiological contamination frequently occurs. The data were obtained for samples collected during the bathing season from 2009 to 2022. A total of 146 data were analyzed for each of the bacteria of interest. The statistical packages jamovi and RStudio were used for the analysis, and the analysis results were interpreted at a significance level of 5%. The pairwise Wilcoxon test was used to compare the 95 percentile values and the Hi-2 test was used to compare the change in marine quality rating for different bacteria. The values for each bathing season and the so-called final classification were compared. The final classification includes data from the season that just ended and the three previous seasons.

The results show that in the case of E. coli, the 95th percentile values calculated using the Hazen method are significantly lower than those calculated using the parametric method, both for the individual seasons ($p=0.03$) and for the final classification ($p=0.005$). For ENT, there was no significant difference, neither for the individual season ($p=0.147$) nor for the final classification ($p=0.206$). When the marine water quality was assessed based on the calculated values, it was found that changes were not statistically significantly different depending on the bacteria ($p=0.815$). In about 50% of cases, there was no change in the bathing quality rating, and in 43% of cases, the bathing quality rating was higher when the percentile value was determined using the Hazen method.

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**KEY WORDS (MAX 4) MICROBIOLOGY, BATHING WATER QUALITY,
STATISTICAL METHODS, HAZEN PERCENTILE**



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FORM FOR ABSTRACTS PRESENTATION

TITLE: Estimating the Amount of Ballast Water from Ships in the Mediterranean: Antalya Bay Case Study
SESSION: COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES,
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): Estimating the Amount of Ballast Water from Ships in the Mediterranean: Antalya Bay Case Study Abstract <p>This study estimated how much ballast water ships can produce in the Gulf of Antalya, an important port city in the Mediterranean. The data used in the calculation was obtained from AIS (Automatic Identification System) of the ships arriving in Antalya Bay between 2018-2021. These ships' ballast water was determined with DWT (Deadweight tons) information using the methods given in the literature. It was calculated as a percentage of DWT according to ship types. As a result of the calculation, it has been determined that three to six million metric tons of ballast water produced in four years originates from bulk cargo ships. In addition, when other ship types are included in the Gulf of Antalya, it is evaluated that 7-12 million metric tons of ballast water may be produced, posing a severe threat to the Mediterranean ecosystem.</p> Introduction While navigating at sea, ships use ballast water to navigate safely in adverse weather conditions, ensuring their balance and stability when empty (Endresen et al., 2008). Ships take water into their ballast tanks when they are not taking on cargo. But the amount of ballast water a ship will discharge will vary depending on the cargo's weight. For example, all ballast must be unloaded to adjust the heel and trim of a ship carrying a heavy cargo load. <p>Although many ports are open to international trade in the Mediterranean, most do not have intercontinental importance. These ports connect to central ports worldwide, while local trade connects them to secondary Mediterranean ports. Therefore, the intense ship traffic in the Mediterranean mainly includes ships passing through transit.</p>



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Central ports in the Mediterranean are the sea at most significant risk, as they are most open to the intercontinental transfer of harmful aquatic organisms, including alien invasive species, and therefore to the primary introduction of Mediterranean invasive species. Shipping within the Mediterranean facilitates the transfer of species brought to central ports and, as a result, causes secondary transfer of invasive species (David et al. 2007a, b).

The number of alien species in European seas has different patterns than in other parts of the world; this is because more than 50% of introductions occur in the Mediterranean, with more than 650 species recorded, of which at least 325 are resident (Katsanevakis et al. 2013).

The ship's water from the marine environment to the ballast tanks contains suspended solids and various organisms (David, 2015). Studies on the content of ballast water have shown that various plant, animal, and bacterial species can survive in ballast tanks and ballast water for a long time (Hamer et al. 2001; Murphy et al. 2002; Briski et al. 2011). Some studies have shown that various organisms can survive in ballast tanks for several months or longer (Gollasch et al. 2000).

It has been determined that a species contained in the ballast water that each ship takes from one port and discharges to a different port has the potential to cause a significant negative impact on the receiving environment (Gollasch 1996). For example, after species introduction from one seashore to another via primary ballast water, secondary dispersal may occur in the receiving coastal waters by recreational boats or fishing activities (David et al. 2013). In addition, other dynamic factors such as weather and sea conditions that ships may encounter while cruising, approaching shallow waters, and fuel and diesel consumption during the journey may also require ballast water operations (David, 2015). For example, this may be the case for larger bulk carriers, which may load water into some central cargo holds to continue sailing safely in a "heavy ballast condition" when encountering heavy sea conditions.

Ship ballast capacity is determined by the ship's cargo capacity and the speed at which cargo operations can be carried out. The more cargo a ship can carry, the more ballast may be required when there is no cargo on board, and the more cargo operations there will be.

As defined in IMO: "Ballast Water Management means mechanical, physical, chemical and biological processes, alone or in combination, to remove, render harmless or prevent the uptake or discharge of Harmful Aquatic Organisms and Pathogens in Ballast Water and Sediments."

The amount of ballast water discharged into the sea by ships on a global scale is estimated to be more than 10 billion tons (J. Tamelander et al. 2010), and Endresen (2004) and other similar studies, it is estimated to be 3.5 billion tons. When these evaluations were made, approximately 5 billion tons of cargo were transported annually in world maritime trade. The cargo transported by maritime trade was 4.651 billion tons in 1995 and 5.871 billion tons in 2000 (UNCTAD 2006). Endresen et al. (2004) evaluation, it was accepted that world maritime trade is 8.734 billion tons of cargo, 5.434 billion tons of international, and 3.3 billion tons of national naval trade.

Ships carry many aquatic invasive species and different pollutants with the ballast water they take from the sea in another port (Feng et al., 2017; Casas-Monroy et al., 2018). With increasing maritime trade and the number of ships sailing in the seas, the volume of ballast water carried will increase and therefore the amount of pathogens and various pollutants in it will increase (Dobbs and Rogerson, 2005).



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Ballast water capacity varies as a function of cargo carrying capacity and ship type, with an average value of 33% of the ship's DWT (Suban, 2006). The BWDA model considers all of this, so the estimated discharge would be 33% of the cargo volume in world maritime trade when excluding light cargo. It has been reported by IMO (2017) that approximately 10 million tons of ballast water containing different marine species are transferred from one port to another in the world.

According to studies conducted in previous years, 3,000-4,000 different species are transported worldwide by ships every day (Carlton and Geller 1993). More recent estimates indicate that the number of species transported by ships is likely around 7,000 each day, and this does not include the transfer of microorganisms such as bacteria and pathogens (Carlton 2001). Additionally, Tolian et al. (2020) in the Persian Gulf, as a result of the analysis of ballast water samples taken from 32 ships, the amounts of Ni, Cd, Pb, and Cu heavy metals were 46.55, 3.93, 5.36, 58.83 and 26.41, 2.12, 2.59, 23.54 ppb (parts per million), respectively. And the values were determined to be above acceptable values.

Countries have coastal monitoring programs, but in most cases, there are no sampling stations at ports where ballast water is discharged or received. Early detection of new species that may be present in ballast water increases the possibility of quickly preventing the damage they may cause to the marine environment (Minchin 2007b). Thus, harmful species can be detected and eliminated early (Bax 1999).

The primary goal of international and national legislation on ballast water is to prevent the effects of the discharge of harmful wastes containing Aquatic Organisms and Pathogens (HAOP) through ballast water. The most fundamental international legal regulation in this regard is the International Convention on the Control and Management of Ship Ballast Water and Sediments, London 2004 BWM Convention. The Convention entered into force on 8 September 2017 and 81 states have ratified the Convention, indicating that it has been accepted by 80.76% of the total tonnage of the global merchant fleet as of 5 August 2019 (IMO 2023). This contract implements ballast water management in two ways: Ballast Water Exchange (BWE) and Ballast Water Treatment (BWT) according to D-2 and D-1 standards, respectively. In the BWE method, ships exchange 95% of their ballast water in waters at least 200 m deep, at least 200 nautical miles from the nearest shore, according to the International Maritime Organization (IMO) Guidelines (Basurko and Mesbahi, 2011 David et al., 2018). It requires that the number of living organisms in the discharge of ballast water be below the limits established by rule D-2. The table created by David and Gollasch 2008 regarding the standards that ships should apply according to their construction date and ballast water capacity has been rearranged and given in Table 1.

Some countries have ratified the BWM convention and implemented its requirements. Most of these requirements are based on the IMO Ballast Water Exchange (BWE) Standard (Regulation D-1). Some countries have implemented the Ballast Water Performance Standard (D-2 standard), and a few countries have implemented applications for onshore ballast water intake facilities. In some countries, ships must keep a BWM plan and a ballast water record book (IMO 2011). If Ballast Water Exchange is not possible in some countries, other measures such as BWE or other water treatment practices are implemented in a designated coastal area. For example, Canada has no regulations requiring saltwater treatment but does offer it as an option for ships arriving with tanks with salinities below 30 ppt. This is a method that can only be applied if the number of tanks to be treated is small or for the remaining ballast (Wang et al. 2012).



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Many European countries have developed practices against invasive alien species that may be found in ballast water. However, for these practices to be successful, they will be effective if the same standards are developed in all European countries. For this reason, the European Commission has initiated work to create a policy on the subject and an early warning system for newly detected non-native species with the document "Towards an EU Strategy on Invasive Species (EU Commission 2008)".

As it is known, the Regional Marine Pollution Emergency Response Center (REMPEC) for the Mediterranean serves as the regional coordination organization. Regarding ballast water management, the Mediterranean strategy document created by REMPEC and the harmonized regulations for BWM in the Mediterranean region has also been adopted (REMPEC 2010).

From 1 October 2012, ships leaving the Mediterranean Sea and bound for destinations in the North-East Atlantic or the Baltic Sea, and ships arriving in the Mediterranean from these areas, will be in the North-East Atlantic area and at least 200 nautical miles from the nearest land and at least The obligation to exchange ballast water in waters with a depth of at least 200 m has begun to be implemented. If this is not possible for operational reasons, BWE should be conducted as far as possible from the nearest land, at least 50 nautical miles from the nearest land, and in waters at least 200 m deep (IMO 2012).

In addition to ballast exchange rules for ships arriving and leaving the Mediterranean, it has become mandatory for ships to have a Ballast Water Management Plan and keep records of all ballast water operations (IMO 2011, 2012).

Table 1. The original phase-in plan of the ballast water performance standard (Regulation D-2) about the ballast water exchange standard (Regulation D-1) (David and Gollasch 2008)

Ships built	BW capacity (m ³)	Phase in of the D-2 standard of the BWM Convention								
		2009	2010	2011	2012	2013	2014	2015	2016	
Before 2009	1500 - 5000	D-1 or D-2					D-2			
After 2009	1500-5000	D-1 or D-2					D-2			
2009	<5000	D-1 or D-2		D-2						
After 2010	<5000	-	D-2							
2009- 2012	>5000	D-1 or D-2					D-2			
After 2012	>5000						D-2			

Three methods for Ballast Water Exchange have been identified by IMO (IMO 2005c):
 Sequential method: A ballast tank is emptied and then refilled with reserve ballast water to achieve at least a 95% volumetric change.
 Flow method: A process in which water in one ballast tank is pumped into another, allowing the water to flow through overflow on the deck or other arrangements.
 Dilution method: A process in which water in one ballast tank is filled from the top of another and simultaneously discharged from the bottom at the same flow rate, thus maintaining a constant water level throughout the BWE.



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Besides the requirements that must be met regarding the BWE methods applied, a ship must also meet the criteria regarding where the BWE will be carried out. A ship must first perform ballast water exchange at a distance of at least 200 nautical miles from the nearest land and in a water depth of at least 200 m. If this is not possible, BWE should be carried out as far away from the nearest land, at least 50 nautical miles from the nearest land, and in waters at least 200 m deep (IMO 2004).

Suppose the depth and distance requirements mandatory for BWE cannot be met. In that case, a ballast water exchange area (BWEA) may be determined by the standards specified by IMO, in consultation with other neighboring port states.

The amount of ballast water discharged into the sea from ships engaged in international maritime trade is estimated to be 3.1 billion (3.1x10⁹) tons per year (David 2015). According to the "Ballast Water Performance Standard Regulation" determined by IMO (International Maritime Organization), it is mandatory for ships performing ballast water management to have a ballast water treatment system that will meet the standards specified in Table 2. (D-2 standards) in the ballast water to be discharged. However, this obligation has been applied to ships produced since 2009.

Table 2. Ballast water standards can be discharged into the sea (IMO 2004).

Microorganism Category	Regulation
Plankton, Length > 50 µm	< 10 l/ m ³
Plankton, Length 10-50 µm	< 10 l/mL
Toxicogenic <i>Vibrio cholerae</i>	< 1 cfu (colony forming unit) /100 mL
<i>Escherichia coli</i>	< 250 cfu/100 mL
Intestinal Enterococci	< 100 cfu/100 mL

Although the D-2 standard introduced by IMO leads to a significant reduction in the number of released organisms, it is estimated that it cannot prevent 100,000 different species from entering the marine environment, assuming that ships carry up to 100,000 tons or more of ballast water and approximately 10,000 tons of this is discharged into the sea. Another weakness of the D-2 standard is that it does not take into account organisms below 10 µm (minimum size), such as harmful algae (for example: *Phaeocystis* spp., *Pfiesteria* spp. and *Chrysochromulina* spp.) (David et al. 2015). The study aims to estimate the amount of ballast water originating from ships in the Gulf of Antalya, which hosts one of the important ports of the Mediterranean, and to guide the studies on ballast water in the coming years regarding its possible effects. This provides a basis for structural and legal regulations that can be taken on this subject by ensuring that the extent of the ecological impacts that ballast water may cause in the Mediterranean is estimated.

MATERIAL AND METHOD

Calculating the Amount of Ballast Water a Ship Can Create

General cargo and Ro-Ro ships generally use around 20% of their DWT, and even more than 40% of ballast water, with some exceptions (David et. al. 2015). In addition, ships intended to transport liquid and dry bulk cargo, such as tankers and dry cargo ships, require significantly larger amounts of ballast water, often between 30 and 50% of their DWT. This means using more than 100,000



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m³ of ballast water per ship. A summary of the ballast water capacities for the main ship types identified by different authors and the types of ships placed in the Anatolian Gulf is presented in Table 3 (David et al. 2012).

The ballast water capacity of a ship varies as a function of cargo carrying capacity and ship type (Endresen et al. (2003). With this information, the annual amounts of ballast water carried can be estimated as a function of the total cargo carried annually. However, the amount of cargo carried varies widely. Since this is the case, it would be a more accurate approach to calculate the amount of ballast water according to the ship's DWT.

Table 3 shows that the amount of bilge water that may occur depending on the ship type can be determined according to different percentages according to DWT. This study calculated the minimum and maximum amount of ballast water that can be formed using the smallest and largest ratios according to previous studies. In this study, the values used to calculate the ballast water capacity of a ship are given also in Table 3.

Table 3. Ballast water amounts of ships according to their DWT size (David et al. 2012).

Vessel type/ DWT (Ton)	AQIS (1993)	Carlton et al. (1995)	Walters (1996)	Hay and Tanis (1998)	Suban (2006)	This Study
Cruise Ships	33		38		43	33-43
Bulk Cargo		43	41	60	33	33-60
Bulk Cargo /250,000	30-45					30-45
Bulk Cargo /150,000	30-45				30-45	30-45
Bulk Cargo /70,000	36-57				30-45	30-57
Bulk Cargo /35,000	30-49				33-57	30-57
Tanker		38	26			26-38
Tanker 100,000	40-45					40-45
Tanker/40,000	30/38				43	30-43
Container		32	30	30-60	35	30-60
Container /40,000	30-38				28-40	28-40
Container /15,000	30				30	30
General Cargo			35	30-60	29	29-60
General Cargo /17,000	35					35
General Cargo /8,000	38					38

Determination of the Amount of Ballast Water That Can Be Created by Ships in the Gulf of Antalya

The information of tankers, bulk cargo, general cargo, container, and passenger ships cruising in Antalya Bay between 01 January 2018 and 31 December 2021 was tracked and recorded via AIS (Automatic Identification System). The region where ship movement information is recorded is shown in Figure 1. The amount of ballast water that ships sailing in the region in question can create was calculated using DWT information. They were using the percentage rates given in DWT information Table.3, the minimum and maximum amount of ballast water ships can carry in Antalya Bay has been calculated.



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Figure.1 Registration area where ship information is recorded.

RESULTS AND DISCUSSION

The number of ship movements and DWT averages according to passenger ship types in Antalya Bay between 01 January 2018 and 31 December 2021 are given in Table 4.

Table 4. Movement numbers and DWT averages of ships cruising in Antalya Bay between 2018-2021.

S. No	Ship Type	Number of Ship Movements	DWT Average (Ton)
1	Tanker	261	22.848,57
2	Container	267	23.930,46
3	General Cargo	526	7.000,07
4	Bulk Cargo	244	41.244,83
5	Cruise ship	14	3.436,357

The amount of ballast water that can be produced by the types of ships sailing in the Gulf of Antalya has been calculated using the percentage rates according to the DWT given in Table 3. The maximum and minimum totals of estimated ballast water amounts are shown in Table 5. While calculating the ballast water amounts of the ships, it is not taken into account that they will not receive ballast water when they arrive loaded and will use some of their ballast water capacity according to weather and sea conditions to ensure the ship's stability. These were not taken into account because, in a previous study conducted in Koper Port, it was determined that ships discharged more than 80% of their ballast water (Perkovic et al. 2003). In addition, in this study, the amount of ballast water created by ships was estimated previously by David et al. As stated in the survey conducted by 2007b, it was found that the ballast water coming to a port is critical when evaluated in terms of the content of ballast water (David et al. 2007b). Because in the ballast water sampling study carried out in Koper Port (Slovenia), it was determined that ballast water coming from ports in the same region (Mediterranean and mostly Adriatic Sea) also contained non-native



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species that have not yet been recorded (David et al. 2007a).

Table 5. Ballast water amounts of ships cruising in the Gulf of Antalya in 2018-2021.

S. No	Ship Type	Minimum Amount of Ballast Water (Ton)	Maximum Amount of Ballast Water (Ton)	Annual average (Ton)
1	Tanker	2.107.945,1	2.628.075,51	657.018,8775
2	Container	1.589.642,88	2.477.380	619.345
3	General Cargo	-	1.339.794,37	334.948,5925
4	Bulk Cargo	3.019.121,4	5.387.920,14	1.346.980,035
5	Cruise ship	15.875,97	20.686,87	5.171,7175
Total		6.732.585,35	11.853.856,89	2.963.464,22

When Table 5 is examined, it is seen that the highest amount of ballast water is the bulk carriers, which are evaluated to have a ballast water capacity of approximately 8.5 million tons for 4 years. It is seen that the annual amount of ballast water varies between 619-1,346,980 tons. Since the amount of ballast water discharged into the sea by ships on a global scale was previously estimated to be more than 10 billion tons, and in other similar studies, it was calculated to be 3.5 billion tons (J. Tamelander et al. 2010; Endresen 2004), the amount of ballast water calculated in this study is also calculated in the Mediterranean Sea. It can be said that it is mainly acceptable for the Gulf of Antalya, one of Turkey's essential traffic lines.

Considering the total amount of ballast water calculated, the amount of ballast water is approximately 7-12 million tons for four years. Considering that this amount comes from different ports of the world and takes ballast water from these ports and discharges it in the Gulf of Antalya, an important port city in the Mediterranean, it will not be difficult to predict the severe damage it will cause to the marine ecosystem. As previously mentioned in the introduction, ballast water contains many substances that harm the marine environment, including heavy metals and species that are foreign to the ecosystem into which it is discharged.

CONCLUSION

In this study, since ship ballast water amounts are calculated according to DWT information, these issues appear as limiting factors for the calculated ballast water amount since it cannot fully show the quantity of ballast water on the ship, and ships will not receive ballast water when they take on cargo.

Estimating the amount of ballast water discharges alone will not be sufficient to determine the harmful effect of ballast water on the marine ecosystem. In future studies, when samples are taken, and the amount of harmful aquatic organisms and pathogens that may be found in ballast water is evaluated, the effects of the results on the marine environment will be more clearly visible.

Another severe issue from this study is that the intake of ballast water by waste reception facilities in ports and its strict control can prevent the ecosystem degradation caused by ballast water, which poses a significant threat to the Mediterranean and the World seas. However, no legal regulation gives port waste reception responsibility for ballast water.



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KEY WORDS (MAX 4)

BALLAST WATER MANAGEMENT, SHIP BALLAST, MEDITERRANEAN BALLAST WATER.



MONITORING OF MEDITERRANEAN COASTAL AREAS: PROBLEMS AND MEASUREMENT TECHNIQUES

Livorno (Italy), 11th -13th June 2024

TITLE:

Coastal vulnerability assessment in relation to the impact of different hazard sources on marine-coastal ecosystems in Sardinia (Italy).

SESSION:

COASTAL AND OFFSHORE ENGINEERING: ENERGY PRODUCTION AND TRANSPORT, PORT AND OFFSHORE STRUCTURES, WATER QUALITY, MEASUREMENTS AND MONITORING, DATA PROCESSING AND SERVICES, DIGITAL TWINS, ECONOMIC-ENVIRONMENTAL ASSESSMENT, REGULATORY CONTEXT

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Marine-coastal ecosystems play a crucial role for society by regulating the climate, providing food resources and contributing to well-being, but they are threatened by human activities and climate change. For this reason, providing a methodology for studying coastal vulnerability in the broader context of Climate Change (CC) is a key objective in order to assess the exposure of marine-coastal habitats to different sources of environmental hazards.

This study is part of a technical-scientific collaboration between the “Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)” and the “Regione Autonoma della Sardegna (RAS)” for the implementation and revision of the “Strategia Regionale di Adattamento ai Cambiamenti Climatici (SRACC)”. This collaboration involved the characterization of the vulnerability framework for the ecological protection of marine-coastal areas and the assessment of the impacts of climate change and risk propensity aimed at defining the impact chains.

Data available in land management tools such as the “Piano di Gestione del Rischio Alluvioni (PGRA)” and the “Piano di Assetto Idrogeologico (PAI)” represent the main references to describe different types of hazards: coastal flooding, flooding and landslides. The second source of data is the ISPRA Nature Map (scale 1:50000), from which it was possible to extract the layer of the habitats present in the territory of Sardinia and, specifically, in the coastal zone. In view of the complexity of the delimitation of this part of the territory, it was considered functional for the purpose of the study to use what is present in the “Piano Paesaggistico Regionale (PPR)” of Sardinia, which defines a “coastal belt”, identified on geomorphological and phytoclimatic criteria. The geodatabase thus created allowed the spatial analysis of the various sources of hazard at a regional level. The overlapping of information such as the extent of the hazard source and the presence of habitats, including priority habitats according to Directive 43/92/EC and/or endemic to Sardinia, with different characteristics of value and fragility, allowed a easy visualisation and quantify of the vulnerability and therefore the potential exposure of individual coastal habitats. The workflow shown in this study



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provides a tool for the vulnerability assessment of marine-coastal habitats in relation to coastal flooding, flooding and geomorphological hazards.

This methodological approach and the proposed tools can be a useful support in the process of assessing and analysing the hazards affecting the coastal territory of Sardinia, providing indications on the exposure of habitats to the different sources of hazards. Moreover, this methodology can potentially be applied to any other area of interest. The knowledge of the events facilitates the definition of land management methods and makes it possible to establish intervention priorities in order to reduce as much as possible the impact of the different sources of hazards affecting the territory.

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KEY WORDS (MAX 4)

VULNERABILITY – HAZARDS – COASTAL ZONE – MARINE-COASTAL HABITAT



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FORM FOR ABSTRACTS PRESENTATION

TITLE: INCREASING OF THE PREDICTIVE CAPABILITY OF THE DISPERSION OF PLASTIC PARTICLES IN THE COASTAL ENVIRONMENT
SESSION:
AUTHORS: SAKTIVEL S. AND CAPPIETTI L. CONTACT PERSON AND E-MAIL ADDRESS
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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS): <p>In recent years, drastic increases in the use of plastics without proper disposal mechanisms have resulted in large quantities of plastic litter ending up in the open environment. Moreover, the issue of plastic trash has been more acute in recent times due to the steady increase in the consumption of this multipurpose material. Furthermore, rivers often play a crucial role in transporting marine litter from inland to the marine environment. About 80% of marine litter enters the oceans by land, while the remaining is due to maritime activities, such as shipping, crushing, fishing, etc. According to the International Union for Conservation of Nature (IUCN), plastic is produced in more than 300 million tons annually for a comprehensive range of products. A minimum of 14 million tons of plastic wind up in the ocean yearly, and plastic comprises 80% of all marine debris observed from surface waters toward deep-sea sediments. Plastics are classified as microplastics (particle sizes less than 5 mm), and nanoplastics (particle sizes less than 0.1 μm) caused by the degradation of larger plastics and direct response to the marine environment from point resources such as wastewater outflows.</p> <p>Moreover, marine species consume or are intertwined by plastic debris, which causes severe damage and death. Even though plastic pollution threatens food safety and quality, human health, and coastal tourism, it contributes to climate change. However, the impact of plastic pollution at sea has now reached alarming levels. It is necessary to act urgently to limit this phenomenon. In this view, among more actions, it is also essential to increase the predictive capability of the</p>



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dispersion of plastic particles (micro and macro particles) in the coastal environment.

Similarly, a recent report by Arpat Toscana (regional agency for environmental protection) noticed massive plastic debris between Italy's Ligurian and Tyrrhenian seas. Corresponding to estimates made through the Dutch engineering environmental NGO Ocean Clean Up, 18,700 kilograms of waste are transported through the Arno river every year, making it one of Italy's most important rivers at some points along its route. Also, it is the longest river (241 km), and is strongly impacted by non-native species: around 90% of fish species and 70% of macroinvertebrate species around Florence are alien species.

The present studies are to develop a regional predictive model based on the TELEMAC-MASCARET open-source tool, which allows the reconstruction of the hydrodynamics and dispersion of plastic particles in a coastal environment. The numerical modelling should be based on a triangular mesh, it should be two-dimensional, and its application must be framed in the so-called down-scaling technique of the dynamics as reconstructed by global models of the Mediterranean (e.g. the Copernicus Marine Environment Monitoring Service modelling systems). The developed model will be applied to the case study of the coast of Tuscany Region. The numerical model is based on finite elements formalism for discretizing the sea domain using TELEMAC 2D. The study includes a coupling of density directional spectrum (TOMAWAC) and depth-averaged free surface model (TELEMAC-2D) performed with the Lagrangian particle approach to realize plastic dispersion in coastal environments at Arno river's mouth in Tuscany region. The main results at each node of the computational mesh are the water depth and the depth-averaged velocity components, which are derived by continuity and conservation of momentum equations, which are followed. Hence, studies show that the possibility of monitoring the tracks followed by each microplastic (particles drogues) introduced into the fluid from the outflow of the Arno river is shown in Figure 1.



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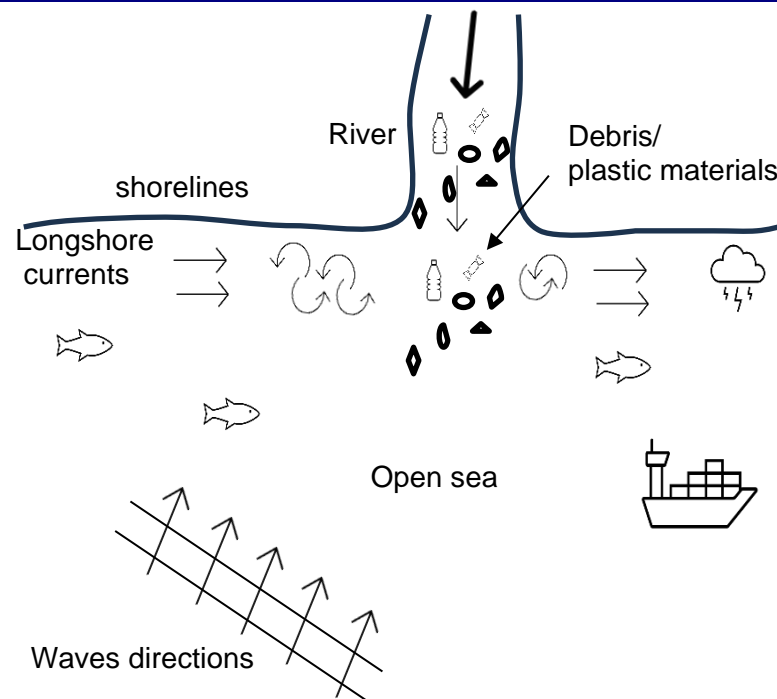


Figure 1 Graphical abstract

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KEY WORDS PASSIVE TRACER, WAVE-CURRENT, HYDRODYNAMIC, MICROPLASTIC



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Livorno (Italy), 11th -13th June 2024

FORM FOR ABSTRACTS PRESENTATION

TITLE: GRAVEL NOURISHMENT & BREAKWATER: THE PROTECTION SYSTEM OF MARINA DI PISA

SESSION: INGEGNERIA COSTIERA E OFFSHORE: PRODUZIONE E TRASPORTO DI ENERGIA, STRUTTURE PORTUALI E OFFSHORE, QUALITÀ DELLE ACQUE, MISURE E MONITORAGGIO, ELABORAZIONE DATI E SERVIZI, DIGITAL TWIN, VALUTAZIONE ECONOMICO-AMBIENTALE, CONTESTO NORMATIVO

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ABSTRACT

Marina di Pisa is a coastal town located on the Northern Tuscan coast on the Tyrrhenian Sea, on the south side of the Arno River delta with erosion noticed right after its establishment in 1872. By the 2000s the town was protected by groins, 2.3 km of seawall, and 10 detached rubble mound breakwaters each 200-270 m long and 3-4 m high (above m.s.l.) and about 50-100 m off the shoreline (Figure 1A). The shore map reproduced by Bini et al. (2021) demonstrates a retreat of about 1km on the unprotected north of the delta of the Arno, showing how fundamental the protection system has been on the south side. In 2002, researchers at the University of Florence started a new strategy by adding gravel nourishment against the seawall and submerging the emerged breakwaters corresponding to the nourished cells (Cappietti, 2011), changing the landscape of cells 7,6,5 and 4 by submerging its breakwaters and adding gravel nourishment at the front and seaward of the existing seawall (Figure 1C).

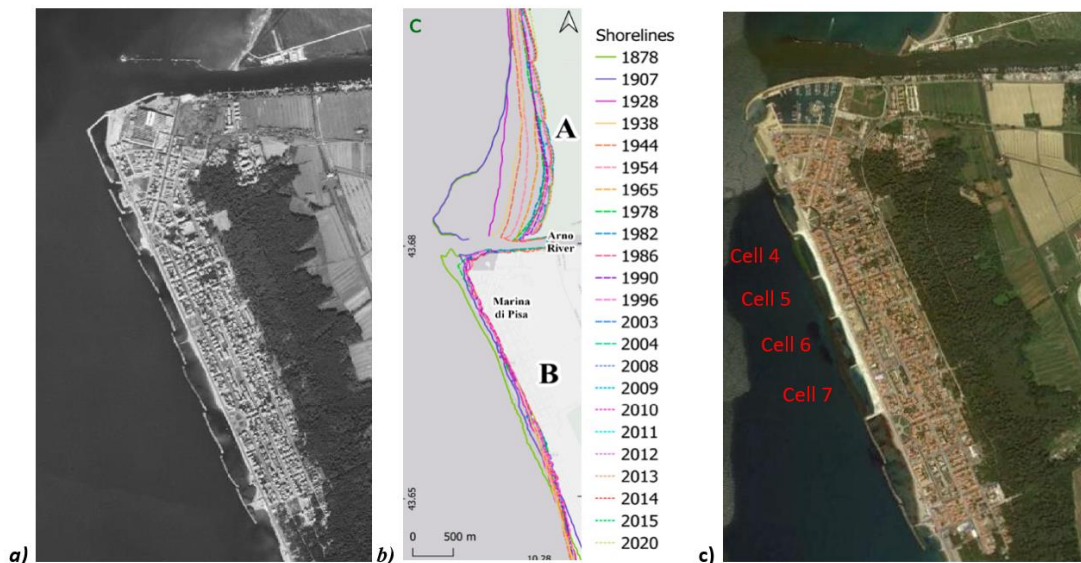


Figure 1A – Marina di Pisa 1988 (I.G.M., n.d.) B – Shoreline retreat map (Bini et al., 2021) C – Marina di Pisa 2021 (Google Earth).

The system guiding gravel morphodynamics results in a crest in response to high energetic waves, as the crest acts as a barrier to protect the coast from high energetic sea events and the high permeability of the gravel allows for large energy dissipation. The mechanism creating the crest can be described by the uprush of wave breaking being higher



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than the settling velocity of the gravel carrying gravel onshore, then its high permeability results in water infiltration decreasing the sediment transport capacity of the backwash (Buscombe & Masselink, 2006).

In the case of Marina di Pisa, three cells that used gravel nourishment as a defense mechanism have proven to be successful but cell 4 still suffers from large amounts of gravel and water overtopping on the promenade during major storms. The 2D experiments, of the most critical section were carried out in the 37m long, 0.80 m wide, and 0.80m deep wave flume at LABIMA. Based on Froude's similarity, the model was scaled at 1:36 to the prototype.

The gravel nourishment width was tested at 40m, 50m, 60m, and 70m; the height of the nourishment was tested at 2m and 3m; and lastly, the breakwater crest width originally at 20m was tested at 30m, 40m, and 50m extending seaside. The parameters were matched within 15 configurations (Table 1) all tested under the same wave conditions (worst case) of significant wave height of 4.1m, period of 12s, sea level at 0.8m, and a 6-hour storm (prototype scale). The model was calibrated by testing the current condition under an envelope of the three past storms that caused gravel overtopping. The outputs for each test were gravel and water overtopping beyond the seawall and the final profile after the test.

The goal was to find a configuration that would result in no gravel overtopping and water overtopping >0.1 l/s/m (Accepted results highlighted in Table 1). An increase in gravel nourishment width and height and in breakwater width decreased both water and gravel overtopping. Low amounts of gravel nourishment led to the formation of the crest on the promenade which resulted in gravel overtopping. The gravel nourishment width affected the position of the crest the most, as it increased the crest moved away from the promenade, similarly the submerged breakwater showed a similar trend but with much lower effectiveness. A larger crest further from the promenade will provide greater protection. The configurations with a large amount of nourishment width (often >60 m) and large breakwater form no crest, this can be due to large energy dissipation and the lack of space between the breakwater and nourishment that allows the waves to propagate in a way in which its interaction with the gravel nourishment is less effective in creating the crest.

Test Number	Test Lab Code	Breakwater crest width [m]	Nour. Width [m]	Nour. Height [m] about m.s.l.	Measured Gravel Overtop. (l/s/m)	Measured Water Overtop. (l/s/m)
1	C1	20	40	2	0.8	3.2
2	C2	20	40	3	0.3	1.4
3	C3	20	50	3	0.1	0.7
4	C4	20	60	3	0	0.1
5	C15	20	70	2	0.1	0.1
6	C7	30	40	2	0.1	1.4
7	C6	30	40	3	0	0.2
8	C8	30	50	2	0.2	0.8
9	C5	30	50	3	0	0.2
10	C9	30	60	2	0.1	0.1
11	C10	30	70	2	0	0.1
12	C11	40	60	2	0.1	0.2
13	C14	50	40	2	0.2	0.2
14	C12	50	60	2	0	0
15	C13	50	50	2	0.1	0.2

Table 1: Parameters and output of test in Prototype

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KEYWORDS:

SUBMERGED BREAKWATER, GRAVEL NOURISHMENT, MARINA DI PISA, EXPERIMENTAL MODELLING



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FORM FOR ABSTRACTS PRESENTATION

TITLE:

Wave-transmission at very large and fixed bottom-detached breakwaters in a numerical wave tank

SESSION:

Ingegneria costiera e offshore: produzione e trasporto di energia, strutture portuali e offshore, qualità delle acque, misure e monitoraggio, elaborazione dati e servizi, digital twin, valutazione economico-ambientale, contesto normativo

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ABSTRACT (MIN 3000 MAX 4000 CHARACTERS):

Climate change and energy crisis are fueling wide concern. Coastal areas are prone to the effects of sea level rise and change of wave conditions as the results of extreme conditions and the increasing number of coastal risks. These phenomena drive coastal erosion, and the lack of alternative dwelling space leads to the higher density urban structures in coastal communities. Expanding human's activity space toward exposed offshore marine areas is a big challenge in term of scientific and technological issues. The use of floating structures, such as the Very Large Floating Structure (VLFS), is a potential solution to expand activity space and cope with the sea level rise with a resilient approach. In the past, most of research activities have focused on the relatively small floating structures located in intermediate or shallow waters in naturally protected marine areas. Many experimental tests for studying the transmission coefficient (K_{tr}), which presents the protection performance, were carried out (Liang et al., 2022; Wu et al., 2022), and some empirical equations for predicting K_{tr} of various structures were proposed (Macagno, 1954; Ruol et al., 2013). But it is surprising to notice that the case of floating breakwater with large draft and width, located in deep waters and working in extreme wave conditions has rarely been studied to date.

In this study, a very large and fixed bottom-detached breakwater (VLFB) with large draft (D_{FB}) and width (W_{FB}) was investigated in extreme wave conditions and offshore deep waters, with the aim to limit the wave transmission in the rear protected area. It is necessary to concentrate on investigating the K_{tr} of VLFB for filling the gap and providing more reliable prediction for future engineering development. By using Computational Fluid Dynamics (CFD) tool, Fluent, a 2D numerical wave flume (NWF) was implemented and calibrated. The influence of different numerical settings and the sensitivity analysis of mesh resolution on the relative error and wave decay of wave height were studied. The wave decay of the NWF was optimized and controlled within 5% in different time instants (Figure 1).

Based on the established NWF, the interaction between wave and VLFB was studied, and the sensitivity analyses of K_{tr} to wave conditions and the dimensions of VLFB were conducted. It was found that the K_{tr} of floating breakwater provided by the empirical equations, which were proposed by other researchers for predicting the K_{tr} of box-type floating breakwater couldn't provide sufficiently accurate results for VLFB. As shown in Figure 2, with the increasing of relative draft (D_{FB}/L_w ; L_w is wavelength), which is a key factor influencing the predicting efficiency, the predicting results of K_{tr} under the conditions of different relative width (W_{FB}/L_w) become inaccurate.

Considering the large size and high material requirements of VLFB, it is meaningful to propose an empirical equation for providing sufficiently accurate results of K_{tr} for optimizing the dimensions of VLFB, which could save the construction cost and expand activity space to the greatest extent. In conclusion, this study will provide a research



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reference for designing VLFB in extreme wave conditions and it could be considered as a kick-off study for further laboratory experiment studies and even engineering design.

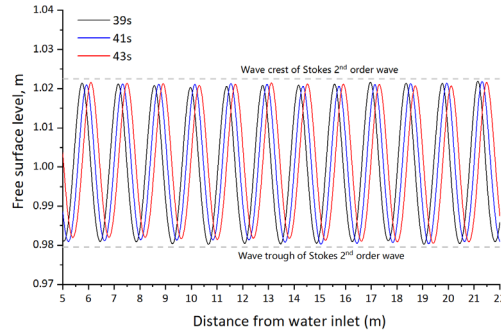


Figure 1 - The free surface level along the numerical wave flume at the selected time instants (39s, 41s, 43s).

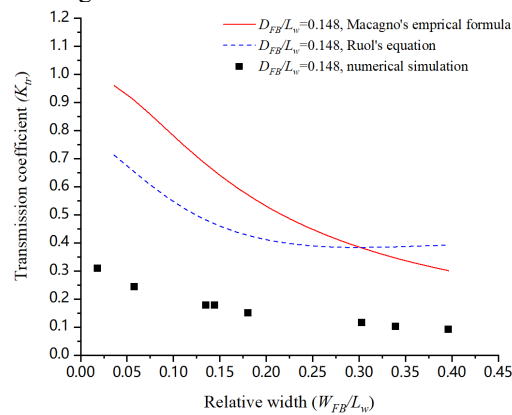


Figure 2 - The comparison of the K_{tr} versus W_{FB}/L_w among the results from numerical simulation and previous empirical equations when $D_{FB}/L_w=0.148$ (W_{FB} : width of breakwater; D_{FB} : draft of breakwater; L_w : wavelength).

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KEY WORDS (MAX 4)

Very large floating structure; floating breakwater; dimensionless analysis