

3rd International Congress AGE OF NEW ECONOMY AND NEW JOBS - BLUE ECONOMY AND BLUE INNOVATION

Book of Abstracts

Final version of 15/9/2021
Deliverable Number 2.5.1

CIP - Katalogizacija u publikaciji
SVEUČILIŠNA KNJIŽNICA
U SPLITU
UDK 33(063)

<THIRD International Congress Age of New Economy and
New Jobs - Blue Economy and Blue Innovation>

3rd International Congress Age of New Economy and
New Jobs - Blue Economy and Blue Innovation : book of
abstracts, <october 10 - october 12, 2021> / <edited by
Andrea Russo ... et al.>. - Split :Healthy City, 2021.

ISBN 978-953-7678-13-5

1. Russo, Andrea 2. International Congress Age of New
Economy and New Jobs - Blue Economy and Blue Innovation
(3 ; 2021 ;Split)
I. Ekonomija -- Zbornici II. Gospodarstvo -- Zbornik

190203094

Project Acronym	ECOMAP
Project ID Number	10047543
Project Title	Ecosustainable management of marine and tourist ports
Priority Axis	Environment and cultural heritage
Specific objectiv	3.3
Work Package Number	2
Work Package Title	Communication activities
Activity Number	5
Activity Title	Congress Age of New Economy and New Jobs – Blue Economy and Blue Innovation
Partner in Charge	Healthy City
Partner Involved	All partners
Status	Final
Distribution	Public

The content of this publication reflects the author's views; the Programme
authorities are not responsible for any use that may be made of the
information contained therein.

Impressum

Book of Abstracts

3rd International Congress Age of New Economy and New Jobs - Blue Economy and Blue Innovation

October 10 – October 12 2021

Published by Healthy City, Vukovarska 65, 21000 Split, Croatia

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Design by Ivana Kevo

Printed by Print studio REDAK

Printed in 100 copies

Split, October 2021

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ECOMAP - Ecosustainable management of marine and tourist ports

The project ECOMAP will help smaller ports, the local authorities and organisations managing ports to address environmental issues. Despite their small size, they have important economic, social and environmental links with their surroundings and a large cumulative impact. They face environmental challenges from EU policy and legislation, and higher expectations from their users and local residents, but they lack the knowledge and tools to respond to these challenges.

The aim of “ECOMAP” is to help local ports to design better environmental strategies and to have access to suitable environmental management tools to remain competitive.

Partnership composed of Municipality of Podstrana (Lead partner), Maritime sport society “Spinut”, Healthy City, Sport fishing society “Strozanac”, Institute of Oceanography and Fisheries, Municipality of Ancona, Bibione Mare Spa, National Institute of Oceanography and Experimental Geophysics OGS, University of Ferrara, Consortium Future in Research, Upper Adriatic Technology Park “Andrea Galvani” work together to improve the environmental status of ports, through investments in equipment and small infrastructure, education of staff and stakeholders, and environmental certifications. Best practices by leading-edge small ports will be identified through project communication and study visits. During the 42 months, the partners, supported by experts, share and identify better practice, as well as test and formalize methodological tools for monitoring and prevention of pollution.

The overall objective of the project is to improve the environmental quality conditions of the sea and coasta area, through the use of a new coordination innovative methodologies and use of sustainable and innovative technologies and approaches within the area of port management on Italian and Croatian Adriatic.

The target groups are:

- Local, regional and national authorities
- Regional and local development agencies
- Associations, innovation and environmental agencies
- Educational and training organizations as well as universities and research institutes
- General public

The expected project results are:

- 1/ enhanced capacities of marinas for better environmental management- through prevention of pollution of the sea in marinas and nearby areas;
- 2/ stakeholders at Programme area are educated and aware of importance of sea and coastal area protection- through changed attitudes and more environmentally- responsible behaviour of participants in navigation, service works, policy stakeholders and local inhabitants;
- 3/ quality level of coastal bathing waters at project locations is of good quality - through improved and jointly developed sea pollution monitoring of the in marinas and nearby areas.
- 4/ management of dredging sediment in port areas to return hydraulic functionality (water recirculation) and the depths required to ensure access to boats. Identification of any pollutants and the treatments required for decontamination by pollutants in order to ensure their re-use based on sedimentological, chemical and biological characteristics (absence of pollutants).

The project started on 01/01/2019 and it is expected to be finished by 30/06/2022.

Total budget of the project is 2.834.115,00 € and it is co-financed by European Regional Development Fund with 2.408.997,74 €.

3rd International Congress Age of New Economy and New Jobs - Blue Economy and Blue Innovation

Esteemed Colleagues and Dear Guests,

it is my great pleasure and honor to greet you and welcome each and every one of you to the 3rd International Congress Age of New Economy and New Jobs – Blue Economy and Blue Innovation. We are happy that, despite the uncertain circumstances we are currently in, we managed to gather such a large number of experts, scientists and politicians and we would like to take this opportunity to thank you for coming. Because with that you have confirmed the importance of this year's theme of the Congress.

This is the third congress organized by the Healthy City, this time within the Interreg ECOMAP project in cooperation with partners.

The Congress is called the Age of New Economy and New Jobs because we live in a time of rapid change and constant innovation that brings with them the need for new knowledge and skills. The path to new knowledge is not without its challenges, so innovations bring us new pressures on the labor market. All these problems that go along with the pursuit of quick adaptation, learning and coping in new conditions put the individual and the community in unpredictable situations and require him to adapt quickly.

With that in mind, this year at the Congress we are dealing with the topic of the Blue Economy and Blue Innovations. Our goal is to create a platform for sharing experiences and gaining new information on the economy of sustainability and job management. We want to jointly produce new ideas, new activities and new strategies in the field of environmental protection with a special emphasis on Blue Growth.

In order to better adapt to the era of the new economy and use all the natural and cultural resources at our disposal, it is necessary to develop an elaborate plan based on Blue Growth, as well as connections between local, national and international partakers in sustainable development. Today, blue growth is

recognized as an economic opportunity, a source of jobs and a driver of sustainable development for Europe. Whether through aquaculture, fisheries, mineral resources or through maritime and coastal tourism and coastal protection, the Blue Economy has a large presence in our daily lives.

We believe that by gathering experts from different fields, from microbiologists, physicists, chemists, psychologists, sociologists, anthropologists, geologists, forensic scientists, ecologists, oceanographers to medics, we can create a multidisciplinary discourse and cover all spheres of this topic, including caring for the physical and mental health of each of us.

Thank you again for coming and we hope you enjoy our beautiful city.

Andrea Russo,
NGO Healthy City President and Congress President

Ladies and gentlemen,

It is my great pleasure to welcome you to the 3rd International Congress Age of New Economy and New Jobs and to address you with a few words.

I especially greet the representatives of state and county institutions, representatives of cities and municipalities, associations, scientific institutions, as well as all other participants.

I am glad to salute you all, gathered in the desire to be participants in this important event with the aim of promoting the blue economy and blue growth, despite all the limitations we face in these challenging times.

The congress was organized within the ECOMAP project implemented by the Municipality of Podstrana in the role of a lead partner. This is an extremely valuable project of cross-border cooperation Interreg Italy - Croatia with the aim of protecting the sea and marine environment, which we are implementing in cooperation with our partners: Maritime Sports Society Špinut, Sports Fishing Society Strožanac, Healthy City, Institute of Oceanography and Fisheries Split, Municipality of Ancona, Bibione Mare, National Institute of Oceanography and Experimental Geophysics from Trieste, University of Ferrara, Consortium Future in Research from Ferrara, Technology Park "Andrea Galvani".

The guiding idea of our project is that joint solutions can be effectively developed only if the international cooperation of different organizations is encouraged. This congress is just such an example of cooperation of various experts, members of international environmental organizations, research institutes, educational institutions, port managers, representatives of local, regional and state authorities who will exchange good practices of sustainable use of marine and coastal resources.

The idea of a blue economy recognized the sea as a major driver of economic development with great potential for innovation and growth.

The Republic of Croatia ranks among the countries with the largest contribution of the blue economy to the overall national economy. Coastal tourism is the most

important sector in terms of employment within the blue economy. To ensure sustainability, it is necessary to establish a smart coastal management system, work together to preserve the purity and wealth of the sea in order to reap the maximum economic benefit, bearing in mind that the ecosystem, on which our blue economy is based, is always protected.

Preservation and protection of the Adriatic Sea is of great importance for the Municipality of Podstrana, which is located on the coast and is one of the most developed municipalities in the Republic of Croatia.

The Municipality of Podstrana continuously invests in the tourist offer, striving to keep the identity, tradition and nature intact. I hereby invite all of you, who have not yet visited us, to come and enjoy the natural beauty of our municipality, which, thanks to the projects we have been implementing for years, will be preserved.

Dear lecturers, we will follow your presentations with great attention, and in the spirit of openness and dialogue, I wish you all a successful work at the congress.

Thank you for your attention.

**Mijo Dropuljić,
Municipality of Podstrana Mayor**

What is new and what is next in bathing water regulation?

BRANDÃO J.*

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The new World Health Organisation (WHO) guidelines for safe recreational waters are under peer review to be finalised soon. But what has changed since the last version of 2003 and the addendum of 2010?

1. The title – The former title included more than recreational water; it was about recreational water environments. The change derives from a decision to focus on water and leave aside subjects that are not causally related to water. Drowning and injury, Sun, heat, and cold, and dangerous aquatic organisms were dropped.
2. The concept of Water Safety Plans, created for drinking water protection, has now been adapted to become the focus of the new recreational guidelines. The core chapters are now System assessment, Monitoring, and Management & communications. The remaining chapters represent threats to the water quality and health of the users and are Faecal Pollution, Other Microbial Hazards, **Beach Sand**, Harmful Algal Blooms (HAB), Chemicals, and Aesthetic & nuisance issues.
3. HAB will be extensively developed in this version
4. **Beach Sand** will present parameters and guidance levels.

Sand as a subject of interest has been going on since 1969, as an exposure setting for dermatophytes, which are causative agents of ringworm, tinea, and athlete's foot. In 1975, Faecal Indicator Bacteria (FIB) from birds on beach sand were identified as a major source of water pollution in Hanauma bay, in O'ahu, Hawai'i. Since then, studies on sand have been published exponentially as a cause of concern, both as a direct public health reservoir of pathogens and as a diffuse FIB pollution source.

Recently, a macular erythematous pruritic rash outbreak in the Azores islands, associated with sand, was detected.

Goal: 30 patients were interviewed to determine possible fomites. Some of the patients reported not to have gone in the water at all, and the patients were limited by beach use only. This led the local team to call for help with a probable sand-associated outbreak.

Methods: On-site, visual inspection revealed micro-plastics and vegetable debris. Samples were taken and processed for several analyses: Bacteriology (FIB), Mycology, Inorganic contaminants (metallic ions and nitrogenated compounds), aromatic compounds and aliphatic organic compounds. The beach was closed to public use until the episode was fully analysed and any causative issues fully remediated. No gastrointestinal symptoms were reported following the rash outbreak.

Results: Mycology results were compatible with the observed vegetable debris since some of the species isolated are typical plant colonisers and pathogens, and with faecal pollution. Melanised fungi, including the red yeast *Rhodotorula spp* break down hydrocarbons, which is compatible with the observed microplastics but also with residual water contamination. Also isolated were *Meyerozyma guilliermondii*, recently being associated with faecal pollution, and *Candida tropicalis*, whose habitat is typically vegetable matter and the gastrointestinal tract of warm-blooded animals.

The high FIB (enterococci and coliforms) in the sand were mapped to a specific area of the beach, indicating a clear faecal pollution episode, though scarcely noticeable in the water. Aliphatic organic compounds and aromatic compounds indicated the volcanic nature of the sand but nothing else worthy of notice. The sand pH was between 9 and 9.2. The HPLC/mass spectroscopy and free chlorine indicated the presence of NaOCl – bleach in the same area where the FIB were high.

Conclusions: Based on the analytical results, the local team suspected of the sanitary infrastructures of the bar above the beach, on the edge of the cliff that limits one side of the beach. Upon searching, the team was able to find a degraded sewage distribution box that connected the bar toilet facilities to the local residual water system. The box was renovated, 80 tons (50 cm deep) of the sand that was contaminated and were lifted and replaced by clean sand from another area of the beach. Follow-up of beach usage thereafter reported no new episodes within 30 days of reopening.

The lack of historical data on the sand analysis of that beach was not helpful in determining the extraordinary values of the parameters analysed. The municipality is now monitoring several beaches to establish baseline values and promptly detect extraordinary results of FIB or Fungi.

Afterword: The new guidelines of WHO will recommend enterococci to be monitored with a limit of 60 CFU/g (colony forming unit per gram of sand) and will provide an average value for the total fungal concentration of 89 CFU/g, for the guidance of beaches with no historical data. More work is necessary to characterise beach sand from beaches all over the world and to revisit some of the

parameters' limits mentioned above. Also, local regulations need to be published. Non-FIB bacteria (*Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Vibrio spp*, *Klebsiella spp* and *Clostridium spp*), parasites, viruses and insects are also mentioned in the guidelines but there is currently little information in the literature. These are currently good research topics.

Keywords: new World Health Organisation guidelines for safe recreational waters, beach sand, enterococci, fungi

Environmental quality as a key for Mediterranean blue economy

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The Mediterranean Sea, one of the most beautiful regional seas in the world, for several decades has been hosting about one-third of world tourism. A large part of this tourism is coastal. The key attractions for coastal tourism are the beach and sea. The environmental quality of the sea as well as of the coastal land and nature are among the key prerequisites for the success of tourism of any type. The main disadvantage of coastal tourism is its high seasonality. A large share of coastal tourism is directly related to sea bathing. Because of this, coastal tourism is highly seasonal.

The fact that the Mediterranean hosts one-third of the world tourism, largely during the summer months, results in extensive consumption of coastal space and a huge demand for water during the summer months. Disproportional use of the infrastructure causes additional difficulties and increase the price of its maintenance. Partial inclusion of environmental costs into the price of the tourism product leaves both, infrastructural and environmental costs largely on the shoulders of the local communities where not everybody shares tourism profits. In many cases, tourists focused on the beach, modestly consume local cultural, even agricultural or manufactural products. In such cases, the local population can only benefit from tourism if they own a flat to rent. This is how the vicious circle of apartmanisation is eating up the coastal space around the Mediterranean shores.

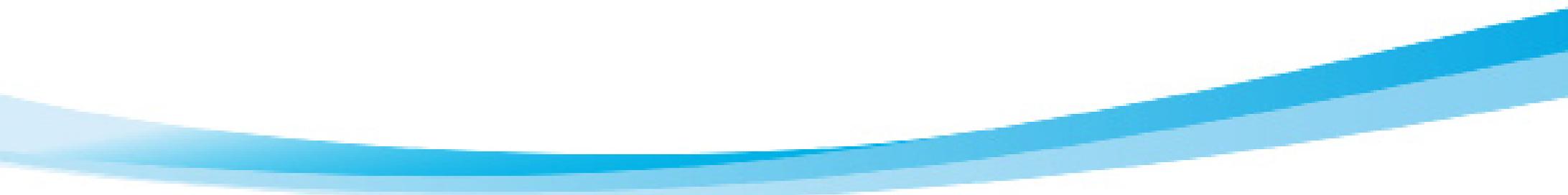
Climate change is adding to the Mediterranean challenges since this region represents a global climate and environmental hotspot. While the increase in the global average temperature has been assessed as 1.2°C above the pre-industrial level, the Mediterranean average is already at 1.5°C. Mediterranean coastal tourism is at particular risk since, due to the location of the key attractions, vacancies are located as close to the sea as possible. Recently, coastal flooding is increasingly occurring around the Mediterranean, caused by more frequent and intensive extreme weather events. These floods are the preview of the impacts of rising sea levels on the crowded Mediterranean coastal zones.

The Paris agreement, ratified by most of the world countries, obliges us to keep the warming at 2°C above the pre-industrial and if possible, at 1.5°C. IPCC reports published after the Paris agreement justified why it is essential to keep the temperature increase up to 1.5 degrees. It is still possible to reach this goal, but the change needed is unprecedented. We must fully transform our economies and societies. Tourism plays a huge role and tourism actors have been mobilized for the COP 26 UN Climate Change Conference in Glasgow. On this occasion, the Glasgow Declaration will be presented and tourism actors will be invited to join the partnership for climate action in tourism.

Since 1975, Mediterranean countries have worked together in addressing common challenges of marine environmental degradation. In 1995, countries adopted the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and, since then, 8 Protocols dealing with different topics have been developed, signed, and offered for ratification to the countries.

UNEP/MAP Centre PAP/RAC has been dealing with coastal management since its foundation in 1976. Today, its mission is to support Mediterranean countries to ratify and implement the Protocol on integrated coastal zone management. An integrated approach to management and the internalisation of environmental costs are the crucial prerequisites for sustainable coastal development in the Mediterranean.

**ENVIRONMENTAL
SCIENCES**



A novel technology for sustainable sediment management in small harbours

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The development of a more sustainable maritime tourism is strongly connected with human activities related to harbours and ports operation. In particular, leisure boating, local fishing, tourists transport are critically dependent on adequate harbours, ports and waterways navigation status (navigability). Preservation of good navigability is a challenging issue since port and harbour access and waterways are often hampered, as the vast majority of 10,000s of ports and harbours worldwide suffer from sedimentation. Traditionally, the sediment that causes the problem is excavated, removed and relocated through maintenance dredging. Nevertheless, dredging is not effective in keeping navigability over time. This objective may be reached through a higher frequency of dredging operations but would result in higher costs and complex authorization and permit procedures, especially for small harbours. Maintenance dredging also has considerable environmental impacts, since dredging operations can: i) destroy or greatly modify underwater habitats and resident flora and fauna, ii) resuspend sediments and contaminants already present in the seabed, thus increasing the Suspended Solid Concentration (SSC) in the water column with negative effects for the ecosystem, iii) impact locally on greenhouse gas (GHG), pollutants and noise emissions, iv) generate a waste to be disposed of, i.e. the dredged material. There is an increasing expectation for infrastructure projects to add value beyond the economic dimension since sustainability issues are of growing importance. The “ejectors plant” technology has been developed as a sustainable alternative to maintenance dredging and has been tested by Trevi SpA and the University of Bologna in the first demo application in the Marina of Cervia (Italy). The demo plant operated from June 2019 to September 2020 with the final aim of keeping water depth at the Marina entrance over 2.5 meters. During the 15 months of operation the demo plant of Cervia has been monitored to assess i) water depth, ii) energy consumption, iii) maintenance costs, iv) seabed features and species diversity, v) equivalent CO₂ emissions through LCA, vi) underwater noise impact. The parameters have been monitored by the University of Bologna in the framework of STIMARE and LIFE MARINAPLAN PLUS projects. In particular, the impact on seabed features and species diversity was assessed by analyzing the characteristics of the sediment

(organic matter and grain size) and the composition of the benthic and fish assemblages, in the two areas of possible impact and control areas located both to the south and north of the port, in the periods before (2018) and after (2020) the installation of the system.

After 15 months of continuous operation of the demo plant in Cervia, a minimum water depth of 2.5 meters was guaranteed. Monitoring actions revealed that seabed features and species diversity were improved and that the impact on underwater noise was absent. Ejectors plant operation resulted in a reduction of the muddy fraction and of the organic matter content present in the sediment in the areas affected by the plant, compared to the initial values that were affected by the previous dredging. The species richness of benthic macroinvertebrates, initially reduced near the port, probably as a result of the previously repeated dredging, significantly increased eight months after the demo plant was put into operation. Underwater noise assessment in the harbour and peri-harbour environment showed that the contribution of hydraulic pumps and ejectors to the increase in underwater noise is not significant. It is therefore believed that the ejectors plant does not constitute an impact on the marine fauna near Cervia harbour. Based on energy consumption, it was also demonstrated that an optimized ejectors plant, if fed by renewable power, could cut more than 80% of GHG emissions and guarantee near-zero pollutants emissions in comparison with traditional dredging.

The results suggest that the technology is effective and efficient and that the demo plant operation is accompanied by an improvement in several parameters related to the ecological status of the marine ecosystem in the area affected by ejectors within one year.

Keywords: small harbour, sedimentation, dredging, ejectors plant, species diversity, underwater noise, Cervia

Cyanobacteria-based bioprocess – research strategies for optimisation of pigments production

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Cyanobacteria have become a significant consumer attractive in recent decades as a source of natural compounds, including pigments (phycobiliproteins and carotenoids). These compounds have been used in a variety of industrial sectors – such as food, feed, nutraceutical and cosmetics – primarily due to their bioactive capacity. However, the use of these organisms is still limited due to the feasibility of the process. In fact, only *Arthrospira platensis* (Spirulina) has been widely promoted worldwide. Technological improvements of such processes are thus critical and require multiple approaches at production and extraction levels.

In this work, the optimization of a bioprocess based in a marine cyanobacterium (*Cyanobium* sp.) was performed using different strategies for both upstream and downstream processing, including photobiology, biotechnology and factorial modulization as tools. The optimization was performed in several steps for upstream processing: i) light intensity and source, and culture medium; ii) light quality supplementation, iii) temperature, pH and salinity; and iv) two-light-stages cultivation process; and for downstream processing: i) solvent selection; ii) scalable technology optimization (pressurized system, homogenization and ohmic heating). Moreover, a bioactivity screening (antioxidant, anti-inflammatory) was performed across the process optimization to guide the further application of the extracted products.

The optimal condition for *Cyanobium* sp. pigments production was set as a two-phase process (10 days of white LED + 4 days of red LED) with a light intensity of $200 \mu\text{mol}_{\text{photons}} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$; a modified blue-green culture medium (BG11) with addition of NaCl (10 g L⁻¹), NaNO₃ (3 g L⁻¹), NaHCO₃ (0.1 g L⁻¹) and K₂HPO₄ (0.1 g L⁻¹) and a pH set at 9.0. For extraction of pigments, a successive extraction of ethanol followed by water using Ohmic Heating technology provide the best setup for pigments and subsequent bioactive capacity (antioxidant and anti-inflammatory).

Major findings include:

a) the versatility of the strain in several different conditions, as no inhibition of

growth was found in the tested range of light intensity (50 to 300 $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$), light source (fluorescent, low-pressure sodium and light-emitting diode), temperature (20 to 30°C), pH (6 to 9) and salinity (0 to 30 g L⁻¹ of [NaCl]);

b) the bioactive capacity of *Cyanobium sp.* extracts, namely antioxidant and anti-inflammatory, along with non-cytotoxicity of the optimized extracts; and

c) the feasibility of ohmic heating, continuous pressurized extraction system and homogenization as extraction processes for the obtention of pigments from *Cyanobium sp.*

Overall, optimization strategies led to an increase of 2 times the biomass productivity, and around 6 times more pigments productivity than non-optimized conditions. Moreover, a selective and efficient extraction increased by 30% the final content of pigments in the extract. In the end, a cyanobacterium-based bioprocess was successfully established and may contribute to a future application of this species into a sustainable industrial application, although further studies on the large-scale visibility of this process are still needed.

Keywords: cultivation, light, abiotic factor, carotenoids, phycobiliprotein, antioxidant capacity

Isolation and characterization of PAHs degrading bacteria by *Dietzia* and *Rhodococcus sp.*

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The increasing chemical and biological pressure, conjointly induced by human activities into the ecosystem, had created an adverse effect on public health and the environment. Among others, polycyclic aromatic hydrocarbons (PAHs) are of major concern due to their toxic, genotoxic, mutagenic properties. Microorganisms have evolved numerous metabolic strategies in assimilating hydrocarbons as the sole carbon source and converting them into non-toxic products. Two bacteria of genus viz., *Dietzia*, *Rhodococcus* (identified by 16s rRNA sequencing) isolated from various marine sediments have demonstrated the ability to grow on a wide range of PAHs. Pyrene and phenanthrene were used as model PAHs to study the degradative ability of these two genera. With help of High-Performance Liquid Chromatography, the percentage of degradation of hydrocarbons was obtained. The whole-genome sequencing data of *Dietzia* and *Rhodococcus* reveals the presence of ring hydroxylating dioxygenases and monooxygenases enzymes making them suitable candidates for bioremediation. The work involves a combinatorial approach of analytical and omics approach in unraveling the pathways involved in hydrocarbon degradation. These results help us in choosing suitable and efficient microorganisms for bioremediation for dynamic polluted environments.

Keywords: PAH, degradation of hydrocarbons, *Dietzia*, *Rhodococcus*, bioremediation

Acquisition and processing of high-resolution seismic data on a sandy beach in Bibione (Italy)

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In this work, we illustrate the results of an acquisition of seismic data we performed on a sandy beach on the northern Adriatic coast. The beach is situated very close to the estuary of the Tagliamento river, where the Po plain meets the Adriatic sea. Here, the balance between erosion from the sea and sediment transportation from the rivers generates a lagoonal-like environment. More precisely, thicker-grained, sandy sediments carried by the river overlay the clayish, thinner-grained sediments making the lagoon. This is confirmed by previous geophysical studies, which observe an overall increase in seismic velocities in the shallow sediments moving away from the river, with a maximum close to Porto Baseleghe, where the faster lagoonal clay sediments prevail. The aim is to perform an in-depth characterisation of the sediments forming the beach, identify the depth at which the sediments become sea water-saturated and the transition between the sands carried by the river and the lagoonal muds.

We acquired a seismic line, approximately 200 m long. We used as a source a vibrator, capable of producing both compressional and shear waves. Furthermore, by orienting it parallel and orthogonal to the line of geophones, it can produce horizontally and vertically polarized shear-waves respectively. P-wave geophones were used to record the compressional waves, while S-wave geophones were used to compute the shear waves, re-orienting the latter to record horizontally and vertically polarized shear waves.

We performed three different processing schemes: a travel time tomography on the refracted events, reflection seismic imaging and multichannel analysis of surface waves.

Via the travel time tomography of the first arrivals, we can compute a map of the seismic velocities of the shallow subsurface. These are a good proxy to identify the main geological features of the area. To achieve this, we used the CAT3D software which ray-traces the refracted waves iteratively until it minimizes the error with the “real” travel time observed in the data.

We performed the surface-wave analysis by extracting a phase-velocity versus frequency dispersion curve from the frequency – wavenumber spectrum of the

data. We then inverted the curve to obtain a 1-dimensional shear-wave velocity profile using the Montecarlo random algorithm in the Geopsy open software. As for the reflection seismic processing, after performing some pre-processing to enhance the signal-to-noise ratio, we performed a velocity analysis based on the move-out of the reflecting horizons. Based on this, we obtained a *stacked section* resembling an image of the geological features of the subsurface.

From the travel time tomography, we were able to identify mainly 3 layers: the first, very slow (P-wave velocity < 600 m/s, S-wave velocity < 200 m/s), corresponds to the dry sand. At about three meters we observe the first increase in velocity (P-wave velocity ~ 1000 m/s, S-wave velocity ~ 200 m/s), possibly corresponding to wet sand. An even stronger transition (P-wave velocity ~ 1800 m/s, S-wave velocity ~ 300 m/s) can be observed at 27 m depth. This probably corresponds to the interface with the fully sea water saturated clay sediments. The very high $V_p - V_s$ ratio (> 5 on the whole profile) is typical of unconsolidated sands and muds and its increase in the deeper layers confirms the possible water saturation. Similar results are given by the surface-wave analysis. In fact, the S-wave velocity profiles show layers of similar thickness and velocity as those found with the travel time tomography. The reflection seismic imaging output an image where the most significant reflection is located at 0.3s (S-waves) and 0.05s (P-waves). Furthermore, we observe a clear discontinuity in such reflector at approximately half of the line. Given the velocities, this should correspond to the transition to clay sediments as identified also by the other two methods.

In order to evaluate the geotechnical properties of the sands making the beach in Bibione, we acquired and processed a high-resolution seismic line. Furthermore, we considered all three wavefields (P-, SH- and SV-), which allowed us to give an in-depth characterisation of the sediments. Three processing methods were used: travel time tomography on the refracted arrivals, surface-wave analysis and reflection seismic imaging. The three methods show consistent results, with dry, coarser-grained sand overlaying wet sand. Deeper down, at approximately 27 m depth, sea water saturated clay muds show a significantly higher velocity and produce a strong reflection. These results match quite well previous research performed in the area and prove that the method we used is a valuable tool to investigate the shallow subsurface.

Keywords: travel time tomography on the refracted arrivals, surface-wave analysis, reflection seismic imaging, sandy beach, shallow subsurface

Analysis of in-shore very high-resolution seismic data to define thickness of the sediments and freshwater outflows

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The aim of this work is to show the results obtained by using very high-resolution marine seismic data (boomer) to define the thickness of the sediments at sea close to Podstrana, Spinut, Bibione and Ancona. Another expected result was to investigate the presence of freshwater outflows in the sea saltwater column. The four areas are characterized by different geological settings. Podstrana and Spinut are characterized by small sediment thickness lying over a flysch formation. In Bibione, the sediment thickness is greater with respect to Spinut and Podstrana, but also in this case the sediments are posed over a flysch formation. In Ancona, the sediments are characterized by a landslide phenomenon that affects both land and sea. The sedimentary sequence is consequently highly deformed.

In the four sites were acquired and analyzed several very high-resolution seismic data to define the sediment thickness and the freshwater outflows.

After the acquisition, data were processed to obtain good imaging of the sediment layers and the top of the flysch formation. In Bibione, due to the sediment thickness also sparker data were acquired to be sure to well identify the top of the flysch. Sparker was also tested in Spinut but it furnished the same results as the boomer data. In Ancona, chirp data were used that well image the complex sediment structures of the investigated area. Then, after the application of the geographical coordinates to the data, they were interpreted to obtain a 2D map of the thickness of the sediments and a map of the depth of the top of the flysch. An analysis to identify the presence of outflows in the seawater was also performed.

Analysis and interpretation of the data acquired in Podstrana showed the presence of a sediment thickness from zero to nine meters in the investigated area. In fact, in some places flysch outcrops and no sediments are present. For the computation of the thickness of the sediments, a medium seismic velocity of 1600 m/s was adopted. In the investigated area some freshwater outflows were also identified, confirming that boomer data is a perfect tool to identify outflows in the saltwater column. In the Spinut area, the sediment thickness ranges between five to thirteen meters and also in this area various freshwater outflows were identified. In Ancona, all the sedimentary units in the sediments were mapped and a strong unconformity present in the stratigraphic sequence was mapped. No outflows were identified. Also in Bibione, some outflows were identified, but in this case, these were not

related to the freshwater but the presence of gas. This can be in agreement with the presence of “tenue” which is a marker to identify the possible presence of CH₄. In order to define the sediment thickness and the presence of outflows in the test sites of the ECOMAP project very high-resolution seismic data were acquired. The analysis of the data confirmed the effectiveness of the adopted approach. In fact, a map of the thickness of the sediments was defined. The stratigraphic sequence of the sediment layers was also well imaged. Another important achievement was the identification of freshwater outflows in the seawater column in Spinut and Podstrana. Also in Bibione, some outflows were identified, but they are probably related to the presence of gas. In Ancona, no outflows were identified in the seawater column, but a strong unconformity was identified in the stratigraphic sequence.

Keywords: very high-resolution marine seismic data, thickness of the sediment, stratigraphic sequence of the sediment, freshwater outflow

Shallow water high-resolution seismic reflection method as an effective tool to monitor the buried sedimentary bodies in coastal areas

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The results of two geophysical surveys carried out in the nearshore areas of Podstrana (HR) and Bibione in the framework of ECOMAP Project are presented. Geophysical methods, and seismic methods, in particular, find a number of applications in coastal management: from engineering (preliminary surveys for bedrock identification) to archaeological surveys; from sand resources assessment for beach replenishment to pre and post dredging surveys.

The specific objective of the activities performed in the two study areas was to evaluate the geometries and the thickness of some near-shore shallow sedimentary bodies by means of the acquisition of a series of very high-resolution seismic profiles. To study the sub-seafloor geological features, echographic techniques are used that use small amplitude pressure waves generated artificially by sound sources that are towed behind a boat. The waves travel almost vertically and are reflected upwards whenever a geological discontinuity is encountered along the path. The returning waves (echoes) are detected by devices sensitive to the pressure changes (hydrophones), which record their strength and the time it takes to travel throughout various layers in the seabed and back to the surface. The hydrophones are arranged in arrays that are hosted within streamers, special buoyant rubber pipes towed by the vessel together with the source. The depth and the degree of resolution (that is: the detail) of the investigation can be controlled by choosing an appropriate seismic source. In the two areas of study, two different high-resolution sources were used: a boomer, which releases sound waves by means of an oscillating plate, and a sparker, in which the pulses are produced by the implosion of a bubble generated by a spark between two electrodes. The data were collected by a single channel streamer in the first case, and by a multichannel streamer (to increase the signal to noise ratio) in the second one. In this latter case, a series of leveling devices were used to keep the streamer at a proper depth of around one meter. Once recorded and visually checked during the acquisition, the data were applied a very basic processing sequence aimed at filtering out either the background environmental or artificial noise (such as that caused by the waves or by the boat itself, that is the engine, the power generators and the propeller) and at recovering the amplitudes that naturally decay due to effects of spherical

divergence and absorption.

The results are generally characterised by a good signal-to-noise ratio and allow a fairly accurate and detailed reconstruction of the main seismic horizons at a metric scale. The very high-resolution seismic technique used in the nearshore areas of Podstrana (HR) and Bibione (IT) has proven as an efficient, cost-effective and low environmental impact method to study the geometry of shallow sedimentary bodies from the seafloor up to few tens of meters of depth. From an environmental perspective, moreover, it is important to highlight the fact that the use of relatively weak sound sources such as those that have been employed in the two areas, does not pose any issue in terms of noise pollution.

Keywords: coastal area, shallow sedimentary body, high-resolution seismic reflection method

Plastic weathering experiment in the Goro Lagoon, northern Adriatic (Italy)

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Plastic, under the action of physical, chemical, and mechanical agents, weathers into smaller particles, that are called secondary microplastics if their dimensions are less than 5 mm. The most common environmental factors that cause weathering of plastics are photodegradation (action of sunlight), mechanical agents (such as abrasion, wave action and turbulence), biodegradation (action of living organisms), thermo-oxidative degradation (slow oxidative breakdown at moderate temperatures) and hydrolysis (reaction with water). Once the plastic has been embrittled due to photo-oxidation, mechanical processes can increase weathering processes. As a result, local environmental conditions such as sunlight, temperature, and oxygen play a critical role in determining the rate of the degradation of plastic, as do coastal processes such as waves and tides action, organic activity and sediment type. However, there is still a need to further understand the factors that regulate the weathering of plastics and their interconnection. Therefore, since the weathering rates of plastics depend on the environmental conditions and the plastic material (polymer), an experiment was performed to further analyze and eventually quantify the weathering, fragmentation and mineralization rates of six types of plastics in a lagoon environment.

In this study, the first preliminary results obtained in the test site of Goro Lagoon are presented. The Goro Lagoon covers an area of about 20 km², with an average depth of 1.5 m. The lagoon is separated from the sea by an 8 km long split, which is locally called "Scanno di Goro". The delta area is characterized by a Mediterranean climate with some continental influence (wet Mediterranean climate). The tidal conditions are mainly semidiurnal (mean tidal range 0,8 m). The bottom of the lagoon presents a flat morphology and is characterized by alluvial sediments. Sand is more abundant near the southern shoreline, whilst sandy mud occurs in the eastern area. For this experiment, it was decided to use high-density polyethylene (HDPE), low-density polyethylene (LDPE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), polyethylene terephthalate (PET), because results from several studies suggest the most common resins and fibers are HDPE, LDPE, PP, PS, PVC and PET and PUR resins. The design of the structures consists of plastic strips of 15 cm x 2.5 cm exposed to marine conditions, which were placed in such a way that one face is exposed to the sun and one in shadow/ semi-darkness conditions.

Each strip was anchored in the middle of two slats of raw fir wood measuring 3 cm x 4 cm x 2 m using steel nails with a diameter of 1.9 mm and a length of 5 cm. Once 20 slats with 10 samples of each type of plastics were ready (60 strips for each slat), they were mounted in two galvanized iron frames to group them into 10 frame strips utilizing galvanized bolts and nuts. The installation of the structures in the Goro Lagoon was carried out on 10 July 2020. Two structures were placed: one at intertidal depth and one at subtidal depth so that the intertidal structures are inundated for approximately 12 hours per day, while the subtidal slats are always inundated. Two HOBO sensors were also attached to the structures, one for each structure, to record the temperature and light intensity parameters to which the plastic strips were subjected. The samplings were initially scheduled every 4 weeks and then every 8 weeks. During every sampling, it has proceeded to the sampling of two slats, one intertidal and one subtidal, to the detection of the temperature data recorded by HOBO sensors, to the measurement of pH, conductivity, salinity and TDS through a multiparametric probe and to the sampling of sediment and water. Preliminary results of mass measurements highlight changes before and after exposure, which are related both to the deposition of biofilm and sediment on the strips and the degradation of plastics. Successively the strips will be also analyzed by using the following techniques:

- optical microscopy and scanning electron microscopy to observe the surface modification,
- micro-Raman spectroscopy to identify eventual changes in the spectra caused by the strip's exposure to environmental conditions,
- UV-Vis spectrophotometry to quantify the concentration of chlorophyll in the biofilm deposited on the strips,
- release tests to determine the potential release of pollutants.

Keywords: plastic weathering, environmental conditions, experiment, intertidal depth, subtidal depth, Goro Lagoon

Microbiological quality of seawater in two marinas at Split area

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Responsible managing of marine ports in the Adriatic Sea is of utmost importance to address environmental issues. Most of these ports are small ports, supporting different activities such as boat services, fishing, sports, tourism and recreation. They play an important role in the community, not only economic but also social and environmental. As places where a large number of different activities meet, that can potentially have a negative impact on the environment, thus coordinated and responsible management is very important. A relatively large number of ports and port berths in two countries with the longest Adriatic coast, Italy and Croatia, combined with growing nautical tourism, makes this semi-closed sea very vulnerable to potential negative effect to its well-preserved environment. Microbiological contamination is just one of the possible consequences of irresponsible management of ports and boats they host and service. Although the microbiological quality of seawater in ports is not regulated by legislation, the possibility of introducing periodic or regular controls should be considered for several reasons:

- This would help the local authorities and community to have an insight into how the port owner/concessionaire manages the port,
- This would help the port owner/concessionaire to have an insight into whether port users are behaving responsibly,
- This would help concessionaires of neighbouring beaches to ensure better protection of bathers' health.

To assess the potential impact of small ports on the microbiological quality of seawater in the port themselves and adjacent areas, we established the monitoring program in two small ports (marinas) in the area of Split, marina Špinut and marina Strožanac.

Marina Špinut is located in the north of Split, under the hill of Marjan and next to the protected forest park Marjan. Marina has about 950 berths of which 350 for small boats less than 6 m, and the remaining for boats 6-15 m. Due to its location in semi-closed Kaštela bay and the proximity to adjacent beach Prva voda, the marina presents a potential risk for pollution of the area.

Marina Strožanac is located in the south of Podstrana, next to the mouth of the

river Žrnovnica. Marina has approximately 320 berths for different boat sizes. Since on both sides of the marina there are very popular and frequented public beaches, it is very important to monitor its potential negative impact on these beaches. Monitoring was carried out for two years, from April 2019 to February 2021. Sampling was organized once a month by collecting seawater samples for the determination of indicator bacteria, *Escherichia coli* and intestinal enterococci. Both indicator bacteria were determined by membrane filtration method, ISO 7899-2:2000 for intestinal enterococci and alternative, temperature modified ISO 9308-1:2014 method for *E. coli*. All samples were collected from 30 cm depth, at 6 sampling sites in both marinas, with one additional reference site at both areas. At the beach next to the marina Špinut and at both beaches (western and eastern) next to the marina Strožanac two sampling sites per beach were also included in monitoring to assess the potential effect of marina water on the beach water quality. Additionally, we analysed riverine water to assess potential faecal material load from Žrnovnica River. Since there are no legal criteria and standards for water quality in marinas, water quality was assessed following Croatian national regulation for coastal bathing water quality, using 90th and 95th percentile values of both indicator bacteria.

When analysing the data obtained during two bathing seasons (May-September), all sites in the marina Špinut were of excellent quality. When included the data obtained during the whole year, five of six sites were excellent and one site was of good quality. No negative impact of the marina to the adjacent beach and area was recorded. Seawater quality in the marina Strožanac was excellent at five and good at one site during the bathing season. When included the data obtained during the whole year, four of six sites were excellent and two sites were of good quality. Seawater quality at two sites at the western beach, which is between the marina and the mouth of river Žrnovnica, was poor, both during the season and throughout the year. By analysing riverine water, the river was confirmed as the main source of faecal contamination of the area. The additional source of faecal material contributing to the contamination of the water is seagull droppings since huge numbers of seagulls gather at the area of the mouth of the river. As a result, no negative impact of the marina on the surrounding area was recorded, but on the contrary, the water from the river and river mouth had a negative impact on the water in the marina and the beach between the river mouth and marina. Thanks to the favourable direction of sea currents, no negative impact of contaminated water on the quality of bathing water at the eastern beach was found. Two monitored marinas in the Split area showed at least good quality of seawater, with a dominant number of sites with excellent quality. Anyhow, seawater in both marinas met the set requirements, to be of at least good quality.

This study is co-financed by the ECOMAP project from the Interreg Italy-Croatia cross-border cooperation program, funded by the European Regional Development Fund.

Keywords: small port, monitoring, quality of seawater, *Escherichia coli*, intestinal enterococci

Picoplankton community dynamics in Špinut and Strožanac ports

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It is well known that anthropogenic impacts have significant effects on marine communities. One of the consequences is the increased input of anthropogenic substances into the coastal zone which affects the fragile marine environment through various mechanisms, including high inorganic nutrient loads, organic compounds, sediments and the uptake of heavy metals. Recognition of port waters in coastal ecosystem monitoring programs is increasing as economically important infrastructure is embedded in the coastal environment and its management needs to be considered. General knowledge of the ongoing processes in these waters, which play a strategic role in the coastal environment needs to be acquired, considering abiotic and biotic factors, to implement sustainable development (Blue Growth) in port areas. Typically, the regulation implemented in ports and adjacent areas refers to chemical emissions and the consequent pollution of water and sediments together with sanitary aspects related to microbial pathogens, as basic controls to protect human health. Physicochemical and biotic parameters in the water column are subject to higher variability on shorter temporal scales compared to benthic parameters, related to seasonal changes and inflow/outflow from associated marine and inland waters. Planktonic taxa respond rapidly to environmental perturbations, although they have rarely been considered as descriptors of marine ecological quality. Particularly, bacterioplankton abundance and activity have been recognized as sensitive sentinels of environmental change. From an ecological perspective, bacterioplankton, phytoplankton and zooplankton are the most important planktonic components in the water column in terms of abundance, biomass, diversity, trophic networks and ecosystem services provided. Marine microbes are a diverse group of organisms including bacteria, archaea and eukaryotic protists that drive most biogeochemical cycles and play a central role in the transformation and recycling of carbon and energy in the marine environment. Bacteria dominate the abundance, diversity and metabolic activity of the ocean. Autotrophic picoplankton forms the base of the trophic food chain, while heterotrophic bacteria (HB) use almost exclusively the dissolved fraction of primary production and act as decomposers and transformers of compounds into forms suitable for primary producers. Heterotrophic nanoflagellates (HNF) participate in the material and energy flow towards higher trophic levels in the ecosystem through bacterial predation. Studies on inhabiting biota in ports are scarce. The present study aimed to determine the dynamics of the picoplankton

community to gain insights into the ecology of two Croatian ports, Špinut and Strožanac. We hypothesized that there would be a difference in the bacterioplankton counts between the investigated stations and the control points in the two ports. Maritime Sports Society Špinut, located in the north of Split, has a total of 950 berths, 350 of which are for boats less than 6 m long. Many freshwater springs influence the water temperature and salinity in winter and spring. Sport Fishing Society Strožanac, with 330 berths for various boat sizes, is located near the beach in Podstrana and the mouth of the river Žrnovnica. Submarine freshwater springs also influence the water temperature and salinity in this area.

In this study, sampling campaigns were conducted in the surface layer (30 cm below the surface) monthly for a period from April 2019 to January 2021. Flow cytometric counts of heterotrophic and autotrophic picoplankton, including the cyanobacteria *Synechococcus* (Syn) and *Prochlorococcus* (Pro) and picoeukaryotes (PE), were conducted. The Gasol model was used to determine grazing on HB by HNF, i.e., the flux of bacterial biomass to higher trophic levels. To test our hypothesis, we used the paired-samples t-test on HB.

In general, abundances of picoplankton were more evenly distributed in Špinut than in Strožanac port throughout the investigated period. Maximum values in both ports were higher in Strožanac, except for HB whose values were similar (1.7×10^6 cell mL⁻¹) and HNF, whose values were an order of magnitude higher in Špinut (23.85×10^3 cell mL⁻¹ in April 2020). However, the median values were higher in Špinut than in Strožanac, except for Syn. This indicates that both investigated ports are not under anthropogenic pressure as the values of HB abundances rarely exceed 106 cell mL⁻¹ (median 0.3 and 0.4×10^6 cell mL⁻¹), which is a limit for eutrophication. The Gasol model showed that HNF grazed mainly on HB during the studied period with some exceptions. Specifically, HNF was “top-down” predated in Špinut partly in winter 2020 and autumn and in Strožanac partly in winter 2020 and summer, while HB was controlled by some other factors at that time. Carbon stored in bacterial biomass is thus transferred to higher trophic levels, which could further enhance the early developmental stages of pelagic fish.

A paired t-test revealed a statistically significant difference between the studied and control points in Špinut port ($P \leq 0.05$) as predicted. Meanwhile, there was no statistically significant difference between two out of six studied points and the control point in Strožanac ($P < 0.05$ for four stations and $P = 0.12$ and $P = 0.56$ for the other two stations). The observed differences are expected as Špinut is a rather enclosed port in Kaštela Bay, while Strožanac is a small port that communicates more with the outer sea, especially the two sampling points that displayed no difference with the control point.

Taken together, the above results provide one of the few insights into microbial communities in port ecosystems in general. We confirmed the hypothesis that a small statistically significant difference is found in Špinut and Strožanac ports

compared to control points. Therefore, these ports do not contribute to anthropogenic pressures on the adjacent coastal environment.

This study is co-financed by the ECOMAP project from the Interreg Italy-Croatia cross-border cooperation program, funded by the European Regional Development Fund.

Keywords: picoplankton dynamic, heterotrophic nanoflagellate, grazing, anthropogenic pressure

The port of Trieste (northern Adriatic Sea) - a case study of the “ecosystem approach to management”

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Marine areas have been traditionally managed on a case-by-case, sector-by-sector basis, ignoring the interdependent nature of ecosystem components. Although informative, the assessment of the environmental status of a given area based solely on the commonly used parameters such as contaminants in the sediments and ecotoxicological assays could lead to insufficient understanding of the whole ecosystem functioning, overlooking other environmental aspects that should be considered when addressing suitable corrective actions. There is, therefore, an urgent need for a fundamental shift in the way we manage our coast towards the development of a holistic approach that considers all the main components of ecosystem functioning and its integration in management. The idea behind “the ecosystem approach to management” is that the management of human activities is based on the limits within which ecosystem structure, functioning, productivity and biological diversity can be maintained. There are however very few examples of its actual implementation, mainly due to the difficulties in coupling environmental safety and sustainable use of resources with the needs and expectations of stakeholders.

Port terminals play important economical roles but their activities have been recognized to be harmful to marine environments. Indeed, they have several negative environmental impacts on the coastal zone, such as pollution due to the discharge of contaminants, e.g. wastewater, petroleum and its derivatives. Port activities are often associated with aquatic pollution and the spreading of contaminants through different compartments, such as water, sediments and biota. Special attention must be given to sediments, which frequently present higher concentrations of contaminants compared to the water column, and may constitute not only a sink but also a secondary source of contaminants for the water column and biota. Benthic organisms, in particular, due to their limited mobility, are exposed to accumulated contaminants and respond to stress conditions both at individual and community levels through the selection of taxa, the elimination of sensitive ones and abundance changes.

In June 2013 “the ecosystem approach to management” was applied in the port of Trieste to provide practical support to decision-makers in managing a Site of National Interest (SIN) where activities such as fishing, aquaculture and swimming

are restricted. This is a contaminated site divided into a: port area, shipbuilding area, iron foundry area, petroleum area and residential area/centre bay. Benthic ecosystem functioning was assessed to verify whether it would be possible to exclude the less contaminated part from the SIN and its legislative constraints. At seven stations subjected to diversified industrialization and anthropization, and a reference site, we evaluated the structural characteristics of the sediments, heterotrophic and phototrophic communities at several trophic levels (producers, degraders and consumers) and the main processes of production, transformation and consumption of organic matter.

The major organic C content, the highest numbers of hydrocarbon-degrading bacteria and the minor macrozoobenthic abundance clearly indicated that the first three sites are subjected to high anthropogenic pressures, therefore they are rightly included in the SIN. In contrast, stations located in the residential area/centre of the bay should not necessarily be part of the SIN, because the corresponding results were comparable to the ones at the control site.

These findings suggest how the evaluation of the benthic ecosystem functioning could represent a conceptual model applicable to other environmental scenarios as a tool for marine space management. This is one of the first case studies where such an ecosystem approach has been applied to a port area, in order to provide practical support to decision-makers involved in the spatial planning of harbour zones.

Keywords: ecosystem approach to management, benthic ecosystem functioning, anthropogenic pressure, port of Trieste

What do benthic macrofauna tell us about the environmental state of marine and tourist ports?

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In semi-enclosed basins, such as ports and small marinas, the effects of point source and synergistic forms of contaminations are emphasized. The effects of human pressure on benthic macrofaunal assemblages inhabiting marinas and tourist ports are seldom studied, especially in the eastern part of the Adriatic Sea. In the framework of the international European project ECOMAP (ECOsustainable management of MARine and tourist Ports), in July 2019, we investigated the macrofaunal communities in two tourist ports, namely Špinut and Strožanac (Croatia). The macrofaunal abundance, diversity indices, and species composition were used to evaluate the ecological status of both marinas. In each marina, sediments were sampled at five stations positioned considering the morphology of the basins (i.e. confinement gradient) and the surrounding human activities (shipyard and boathouse areas). The macrofaunal features were related to sediment physical-chemical variables (grain size, Organic Carbon-OC, Total Nitrogen-TN, and heavy metals). Both marinas were characterized by muddy sediments in their inner part and higher sand contents at the main port entrances. Špinut and Strožanac displayed higher contents of organic carbon and total nitrogen in the inner part of the basins. Similarly, the major content of the analysed heavy metals was measured at the same stations. In both marinas, we observed higher macrofaunal densities at the main entrances than at the inner sites. A clear confinement gradient pattern was mirrored in the number of species. Overall, the macrofaunal community in both marinas was characterized by the dominance of marine/estuarine species (e.g. the polychaetes *Heteromastus filiformis* and the bivalve *Abra prismatica*). In Špinut, the differences among stations were principally due to grain-size distribution and anthropogenic influence in the basin (i.e. boathouse area). The highest diversity observed at the main entrance was due to the presence of mixed environmental conditions (i.e. major seawater renewal and major content of sand). Conversely, we observed an impoverished community nearby the boathouse area. This long-lasting anthropic activity deeply modified the sediment characteristics (we observed e.g. pieces of antifouling coating), leading to poor environmental conditions. In fact, at this station, the highest values of heavy metals (i.e. Cd, Cu,

Pb, Zn, and Ag) were obtained. In the Strožanac marina the macrofaunal community was not directly influenced by the confinement gradient and grain-size distribution. This is likely due to the morphology of the basin. In this marina, the basin is a more open system compared to Špinut. Principally, the presence of seagrass and seaweed coverage at the bottom enhanced the difference among stations and between the two sampling areas. In particular, we observed higher differences in species composition at the site located in the inner part of the marinas but with high seagrass coverage. Also, the macrofaunal community collected at the station nearby the boathouse did not seem to be influenced by this activity. This station was located toward the outer part of the basin, thus the sediments were directly influenced by a high water renewal improving the quality of the sea bottom. This study confirmed the importance of the renewal time of marine water (confinement) for the dilution and dispersion rates of contaminants. Further, these results indicate that including the macrofaunal community features in monitoring plans could help local managers of ports and marinas design site-specific environmental interventions to mitigate anthropogenic disturbances.

Keywords: ecological status, benthic macrofaunal community, diversity, tourist port, environmental state

Foraminifera as bioindicators of the environmental status of small tourist ports

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To date, touristic ports and marinas have been mostly neglected in traditional monitoring programs. At present, it is increasingly recognized that also these facilities have to be monitored and consequently managed in a sustainable perspective. Although their ecological footprint is surely less profound than that ascribable to large commercial or industrial hubs, their capillary distribution leads, overall, to a footprint that deserves to be managed. In order to support small local ports to design and apply better environmental strategies aimed at sustainable management of their maritime spaces, remaining at the same time competitive, some initiatives have recently been set up such as the international European project ECOMAP (ECO sustainable management of MARine and tourist Ports). ECOMAP is aimed at improving the environmental quality conditions of nautical ports by promoting a coordinated development and implementation of environmentally friendly solutions and the exchange of knowledge and good practices between Italian and Croatian recreational ports. Within the ECOMAP project, in two Croatian marinas, i.e. Strožanac and Špinut located nearby the city of Split, we investigated the foraminifera community. Benthic foraminifera are single-celled protists with a short reproductive cycle, rapid growth, small size and high abundance. They have been reported to exhibit measurable responses to several disturbance factors such as organic enrichment, oxygen deficiency and metals. They are present in sufficient abundances also in heavily impacted habitats, where macrofauna is often lacking. Stressed assemblages display lowered abundances, biodiversity loss, dwarfism and increased abnormalities of the tests. All these peculiarities make the foraminifera suitable bioindicators of anthropogenic pressures in marine ecosystems. In July 2019, foraminifera were sampled in both marinas, at five stations located along a gradient of increasing confinement. Physical features of the water column were registered at each site and samples for the sediment physical-chemical characterization were also taken. Špinut marina was characterized by muddy sediments in the inner part and a higher sand percentage at the port entrance. A similar grain-size distribution pattern was noticed for Strožanac, where the highest percentage of sand was observed at the main entrance. In both marinas, higher

contents of organic carbon and total nitrogen were observed in the inner part of the basins. Similarly, more severe contamination by heavy metals was obtained at the same stations.

In both marinas, foraminifera abundance was higher in the first 2 cm of sediment than in the sub-surface layer. Overall, higher abundances were displayed in Strožanac, up to 2605 ind. 50 cm⁻³, than in Špinut (up to 1879 ind. 50 cm⁻³). Specimens with abnormalities showed low abundance values in both marinas and were mainly observed in the surface sediment layer. For what concerns the taxonomic composition of the assemblage, a total of 32 species were observed. Among them, 14 were found only in the sediments of Strožanac, while only 2 were collected exclusively in Špinut (*Quinqueloculina laevigata* and *Spiroloculina communis*). Considering the surface and sub-surface sediment levels together, on average 89% of the whole assemblage was represented by 8 dominant species (mean RA>2%), i.e. *Ammonia parkinsoniana*, *Ammonia tepida*, *Criboelphidium incertum*, *Elphidium crispum*, *Elphidium macellum*, *Eggerelloides scaber*, *Haynesina depressula* and *Quinqueloculina seminula*. Only *Ammonia parkinsoniana* was observed at all stations and in both marinas.

The most polluted station in Špinut, S4 located near the boathouse, was barren, i.e. no foraminifera were detected at this site, confirming the high sensitivity of this benthic community to altered environmental conditions.

Keywords: foraminifera, sediment, bioindicators of anthropogenic pressure, small port

How touristic ports and marinas can influence the composition and distribution of the benthic macrofauna: A case study of Marina Dorica in Ancona (Western Adriatic, Italy)

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The coastal marine environment is worldwide, the most interested by human activities, especially where modifications to the coastline are present. The realization of touristic ports and small marinas and the related possible point sources of contaminants could be a clear example of the human impacts on coastal marine environments, especially for the benthic macrofaunal communities.

In the framework of the international European project ECOMAP (ECOsustainable management of MARine and tourist Ports), in September 2020 we investigated the macrofaunal communities and the sediments features of Marina Dorica, a tourist port near Ancona (Italy). The macrofaunal species composition, abundance and diversity were used to evaluate the ecological conditions of benthic communities, sampled along a spatial gradient (confinement gradient), identified moving inside Marina Dorica. The sampling gradient was identified considering the basin's morphology and also taking into account the potentially most impacting human activities present in Marina's area (fuel point, shipyard and boathouse areas). In detail, Marina's area sediments were sampled at six stations located along the confinement gradient (one outside MD-RS, one at the port entrance MD1 and four inside MD2-MD5). The macrofaunal communities were also related to sediment physical-chemical variables such as grain size, Total Nitrogen (TN), Total Organic Carbon (TOC), and heavy metals.

A clear decreasing pattern in the sand component and a consequent increase in silt and clay ones were observed, moving away from the outside bottoms to the inside ones. Indeed the Marina Dorica seabed was characterized mostly by muddy sediments, especially in its inner part, while higher sand contents were detected at the port entrance and the reference station sampled outside (MD-RS station). The stations inside the Marina were also characterized by a huge amount of vegetal organic matter and detritus. The outside benthic macrofauna, in the proximity of the Marina, was composed of typical Adriatic sandy communities, characterized by species inhabiting the Mediterranean Biocoenosis of Fine Sand in Very Shallow Waters (FSVSW) and the Biocoenosis of Fine Well-Sorted Sand (FWSS), such as the

molluscs *Lentidium mediterraneum*, *Donax trunculus* and *Chamelea gallina* and the crustaceans *Diogenes pugilator* (Decapoda) and *Ampelisca pseudosarsi* (Amphipoda). The benthic communities sampled inside Marina's bottom showed a clear changing pattern, strictly linked with the confinement gradient and the overall different hydrodynamic conditions determined by the semi-enclosed basin morphology and the presence of the Marina docks. In general, due to the modifications induced on the soft sediment grain size composition by the reduction of water circulation and the consequent increase in the accumulation rate of organic matter, the marinas and in general the touristic ports produce changes in the benthic communities. These communities present some analogies with the ones inhabiting the natural paralic environments, such as small lagoons and coastal saltwater lakes where the confinement, that is the renewal time of marine water, plays a crucial role in their ecological expression. The touristic ports and the marinas could be considered excellent examples to study human impacts on marine coastal environments and can be used to design monitoring plans that could help local authorities mitigate anthropogenic disturbances in marine littoral environments.

Keywords: benthic macrofauna, touristic port, confinement gradient, Marina Dorica

Sustainable management of marinas and beaches: geochemical characterization of sediments of Bibione (NE Italy)

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Coastal lands, located at the boundary between continental and marine environments, are particularly vulnerable to anthropogenic activities and the impact of climate change. Moreover, human presence in these areas has increased considerably in recent years, and tourism activities have often negatively impacted the environment. Anyway, changes in public opinion have compelled policymakers to combine the use of coastal resources sustainably, with the development of the local municipalities. Therefore, only economic support derived from human activities could guarantee restoration and beach nourishment investments.

In this light, the main objective of the framework of the international European project ECOMAP (ECOsustainable management of MARine and tourist Ports), is to improve the environmental quality conditions of Italian and Croatian coastal areas, connected to marine and tourist ports in the North Adriatic Sea. Partners of the project are small ports that have important economic, social and environmental links with their surroundings as well as large cumulative impact. The geochemical characterization of sediments represents a useful tool to assess the environment of coastal and port areas, identify points of vulnerability and developing good practices for sustainable sediment management. This work presents the results of the characterization of the sediments collected in the first sampling campaign in the Bibione (NE Italy) coastal area, one of the test sites of the ECOMAP project. The sampling activities on the most superficial sediments have been performed in different coastal environments: dune/backshore, shoreline, seabed (about 500 meters from the coast) and navigable section of the Baseleghe lagoon. On all collected samples, grain size analysis has been carried out, together with the determination of carbonate content (calcimetric analysis), Total Organic Carbon content and the content of the major oxide. A defined quantity of each sample has been used to prepare pressed powder pellets, analyzed to obtain the content of the major oxide, by semi-quantitative SEM-EDS analysis, using a Scanning Electron

Microscope equipped with an Energy Dispersive X-ray Spectrometer Aztec. On selected samples the Carbon isotope ratios content has been evaluated by Elemental Analysis-Isotopic Ratio Mass Spectrometry, using an Elementar Vario Micro-Cube elemental analyzer in line with an ISOPRIME 100 isotopic ratio mass spectrometer. Heavy metals content has been determined by Inductively Coupled Plasma Mass Spectrometry analysis. All samples show mainly carbonate composition, with dolomite limestones more abundant than calcitic ones. Analytical results highlight textural and compositional inhomogeneity in the different sampling areas; in particular, the samples from the innermost area of the Baseleghe Lagoon (northern side) show silty-clayey texture, low values of carbonate content and high percentages of SiO₂ and Al₂O₃. Despite the sediments related to the other environments are mainly sandy, a non-homogeneity in compositional terms has been observed. Particularly significant is the decreasing trend in the carbonate abundance (total carbonate, CaCO₃, dolomite, CaO and MgO contents) from the backshore towards the seabed. Considering that the seabed sediments had greater abundances of finer fraction, concerning the emerged beach (especially of the backshore) it is hypothesized that the decrease of carbonate terms depends on the particle size differences between these sub-environments. However, only CaO content and the Total Carbonate content are well correlated with the abundance of the particle-size fractions, while CaCO₃, MgO, and dolomite contents are poorly correlated. It could be therefore hypothesized that another factor could be co-responsible for the observed variations, such as the dissolution effect of the seawater on the carbonate sediments of the shoreline and the seabed. This could assume relevant importance considering the acidification processes of the seas, connected to the increase in atmospheric CO₂ concentration. Results have furthermore highlighted that heavy metals concentrations in the sandy sample were below the limit set by Italian legislation, even in the samples collected nearby of the Baseleghe port, proving an overall good quality of sediments. The high correlation between heavy metal concentration and the abundance of the finest particle size fractions suggests that the Baseleghe lagoon, could be the most vulnerable area to heavy metal pollution and, therefore, prevention actions should be particularly targeted to this area.

Keywords: geochemical characterization, sediment, acidification processes of the sea, heavy metal concentration, Bibione

Bathing water quality in the period 2011-2019: Croatia vs Region vs EU

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The aim of this article is to summarize and compare the results of a 9 period (2011-2019) of monitoring the quality of inland and coastal bathing sites in the Republic of Croatia, EU Member States and non-EU countries in the region: Bosnia and Herzegovina (for the entity of the Federation of Bosnia and Herzegovina, FBiH), Serbia and Montenegro. In addition, an individual overview of water quality for the last year of the observed period (2019) is provided. Data on bathing water quality in the EU Member States are taken from the official annual reports on the quality of inland and coastal bathing waters in the EU from the European Environment Agency (EEA). Data for non-EU countries come from their official bathing water quality reports at the national or entity level.

Monitoring of inland bathing water quality in Croatia started in 2011 and is relatively new compared to marine bathing water monitoring, which has been carried out continuously since 1989. The number of inland bathing water quality monitoring sites in Croatia has increased more than eightfold since 2011, from 4 to 35 sites (in 2019). During the observed period (2011-2019), the highest number of inland bathing sites (N) in the EU was found in Germany (N₂₀₁₁=1938; N₂₀₁₉=1924), while the lowest number of bathing sites was found in Greece (N²⁰¹¹=6; N₂₀₁₉=3). Looking at the total number of bathing sites, which includes all EU Member States, their number increased by 7% from 6,493 to 6,949 bathing sites in 2011-2019, with the share of excellent quality grades increasing from 70.4% to 82.1%. The share of

excellent quality in Croatia varied significantly depending on the season (from 0% in 2012 to 75% in 2011). During the nine-year study period, the highest share of inland bathing waters with poor water quality was recorded for Spain (12.3%), followed by Ireland (4.9%), the Netherlands (4.7%), Belgium (4.6%) and France (3.3%). Croatia, Slovenia, Luxembourg, United Kingdom, Greece and Bulgaria belong to the group of countries without inland bathing waters with poor water quality. The highest share of inland bathing sites with excellent water quality in the last year of the studied period (2019) was recorded in Austria (98.5%). This was followed by Finland (94.2%), Denmark (94%), Germany (93.7%) and Italy (90%). A share of 50% of inland bathing waters with excellent quality was recorded in Bulgaria (25%), Croatia (20%), Poland (18.7%) and Romania (0%). Looking at the EU Member States bordering Croatia, the best inland bathing water quality over the nine-year period was recorded in Italy (85.5% of bathing sites with excellent water quality), followed by Hungary (65.8%), Slovenia (53.4%) and Croatia (26.7%). The EU average of inland bathing sites with excellent water quality is 78% in the same period. The non-EU countries bordering Croatia that also monitor inland bathing water quality are Serbia (78 bathing sites) and Montenegro (47), although the FBiH areas intended for bathing and recreation are not officially designated. During the period covered by this study, the number of coastal bathing sites in HR and EU increased from 906 and 14,538 in 2011 to 953 and 15,032 in 2019 (by 5.2% and 3.4%, respectively). The highest number of coastal bathing sites is recorded in Italy ($N_{2011}=4902$; $N_{2019}=4864$) and the lowest number in Lithuania ($N_{2011,2019}=16$). In terms of coastline length, Italy has the highest number of sites per 10 km of coastline (6.4), followed by Belgium (6.3) and France (6.0). Finland (0.6), the United Kingdom (0.5) and Estonia (0.1) have the lowest number. Nine-year share of coastal bathing sites with excellent quality is significantly higher in Croatia than in the average of all EU Member States (96.5% and 85.0%, respectively). The countries with the highest average share of coastal bathing sites with excellent water quality in the same period were: Cyprus (99.2%), Slovenia (98.9%), Malta (98.4%), Croatia (96.5%) and Greece (95.7%). Taking into account the nine-year average of coastal bathing sites with poor quality in the EU Member States, the highest share of such bathing sites was recorded in Estonia (5.0%), followed by Ireland (3.5%) and United Kingdom (3.1%). Croatia recorded 0.1% of poor-quality bathing areas. Slovenia, Malta and Cyprus belong to the group of countries without bathing sites with poor water quality. In the last year of the observed period (2019), the highest share of excellent quality coastal bathing sites was recorded in Lithuania (100%), followed by Cyprus (99.15%), Croatia (98.4%), Malta (97.7%), Belgium (97.6%), Greece (95.8%) and Slovenia (95.2%). All other EU Member States, except Estonia (51.9%) and Poland (29.4%), had a share of 60% of excellent quality coastal bathing sites. Considering the EU Member States bordering Croatia, the highest share of bathing sites with excellent water quality in the nine-year period was recorded by Slovenia

(98.9%). Montenegro, the only non-EU country bordering Croatia that also monitors coastal bathing water quality, has 100 bathing sites and a share of excellent quality of 89.0% (in 2019). FBiH has three coastal bathing sites with three samples taken during this bathing season and all were excellent.

The data show that the quality of inland bathing waters in Croatia and its non-EU neighbours is generally worse than the EU average, while the share of coastal bathing sites with excellent quality in Croatia is well above the average for all EU Member States.

Keywords: inland and coastal bathing sites, bathing water quality, monitoring

The effect of increased sampling frequency on coastal bathing water quality assessment

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Bathing water quality is crucial to prevent the health risks associated with bathing in coastal and inland bathing waters. As bathing water quality has been identified as one of the most important reasons for tourists' choice of destination, it is an important factor for island and coastal communities that depend on coastal tourism. Bathing water management in the European Union (EU) is regulated by Bathing Water Directive (BWD) 2006/7/ EC. The purpose of the BWD is to preserve, protect and improve the quality of the environment and to protect human health. The BWD sets the guidelines for monitoring, quality assessment, classification and quality status of bathing waters, as well as providing information to the public. Bathing water assessment is based on the levels of two fecal indicator bacteria (FIB), *Escherichia coli* and intestinal enterococci. According to the BWD, the final assessment is based on bathing water quality data sets compiled for this bathing season and the three previous bathing seasons. The bathing water quality datasets used for the final assessment always include at least 16 samples (based on an annual number of four samples) or 12 samples in the case of bathing water located in a region with specific geographical restrictions. Since most water quality exceedances are single-day events, there is only a small chance (5%) of detection at such a low sampling frequency, even at the most frequently contaminated sites. This results in a significant misclassification of 15-20% of bathing water sites. Therefore, estimating compliance based on such a small number of bathing water samples is unlikely to fulfill the main purpose of the Bathing Water Directive, which is to protect public health, as too many poor quality beaches may be classified in the better category. Although the number of samples per bathing season is much

higher than four in all Member States, the World Health Organization (WHO) in “WHO recommendations on scientific, analytical and epidemiological developments relevant to the parameters for bathing water quality in the Bathing Water Directive (2006/7/ EC)” (2018) recommends a further increase to 20 samples per season (80 data for the final assessment). This would certainly contribute to the protection of human health, but could also lead to an additional financial burden and technical difficulties for many Member States. Furthermore, it is questionable whether it is justified to increase the number of samples at sites classified as “excellent” over a longer period of time.

In this study, we investigated the effect of sampling frequency on coastal water quality assessment. The study was conducted during the 2021 bathing season in 5 areas along the coast of the Croatian Adriatic. A total of 27 bathing sites were included in the study, of which 14 bathing sites were rated as “excellent” over a longer period of time, and 13 bathing sites with variations in water quality. Samples were taken weekly at all bathing sites by official laboratories conducting official monitoring and by the Institute of Oceanography and Fisheries, which conducted sampling in Kaštela Bay. Both fecal indicator bacteria, *E. coli* and intestinal enterococci, were determined using the membrane filtration method, ISO 7899-2:2000 for intestinal enterococci and the temperature modified method ISO 9308-1:2014 for *E. coli*. All FIB counts were converted to log₁₀ values and processed in accordance with Annex II of the BWD.

Of the total 13 bathing sites with quality variation, seven had the same quality regardless of whether sampling was every two weeks or every week (three excellent, two good and two poor). At five bathing sites, water quality was poorer when sampling was weekly. At two sites the quality changed from excellent to good and at three from good to poor. All 14 excellent quality bathing sites had the same water quality regardless of sampling frequency (13 excellent and one poor). Based on the preliminary results, it appears that increasing the sampling frequency at bathing sites with variable water quality would improve the health protection of bathers. There does not appear to be any reason to increase the number of samples at sites that have been classified as “excellent” over a longer period of time.

This work has been funded by Croatian Science Foundation under the project „Towards the New European Union Bathing Water Directive“ - EUROBATH (project number: IP-2020-02-1880).

Keywords: Bathing Water Directive, sampling frequency, water quality, fecal indicator bacteria

The effect of precipitation on the bathing water quality at the area under anthropogenic impact

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Monitoring of coastal bathing water quality is necessary to protect human health and to preserve, protect and improve the quality of the marine environment. The concentration of the indicator bacteria used to assess the quality of bathing water, *Escherichia coli* and intestinal enterococci, also known as Faecal Indicator Bacteria or FIB, is fluctuating during the bathing season. It is mostly affected by the type and number of the sources of faecal contamination, eventual short-term pollution events, and environmental variables such as temperature, pH, salinity, solar radiation, and precipitation. The main goal of this study is to examine whether precipitation is affecting the bathing water quality in the urban and suburban areas, which are exposed to anthropogenic impact. Additionally, we tried to examine whether an opportunistic pathogen bacteria, *Staphylococcus aureus* could be used as an additional parameter of microbiological pollution.

To assess the effect of precipitation on the bathing water quality we monitored the concentration of *E. coli* and intestinal enterococci in bathing seawater. For the enumeration of *E. coli*, we used the ISO 9308-1:2014 method, modified by changing the temperature of incubation to enhance selectivity without negative effect to recovery, while the ISO 7899-2:2000 method was used for the enumeration of intestinal enterococci. We also measured physical-chemical parameters that can be related to microbiological contamination (water temperature, salinity, pH) by using a YSI CTD+pH probe. Additionally, we determined the concentration of *S. aureus* by using CHROMagar™ *Staph aureus* medium incubated at 37°C for 48h. Water samples were collected at 11 sites, 10 of them located in the Kaštela Bay and Split area, and one site (Stipan Jaz) located outside of the mentioned areas, which served as a control. The sampling campaigns were organized between May and October 2020, twice a month, and additionally 24h, 48h, and 96h after the precipitation. We analysed 198 water samples in total. We recorded four rain events during the bathing season, with the precipitation level varying between 4mm and 19mm. In six standard monitoring campaigns, the precipitation was absent.

Bathing water quality at three sites located in the Kaštela Bay (Trogir, Kaštel Sućurac, and Vranjic) was classified as poor after the end of the sampling campaign. Trogir site was classified as poor because of the high *E. coli* concentrations, unlike Kaštel Sućurac and Vranjic sites where the concentration of intestinal enterococci was

above the limit for poor quality. The elevated concentrations of *S. aureus* were recorded at all sites situated in Kaštela Bay, with the highest values in Kaštel Sućurac and Vranjic sites. *E. coli* and intestinal enterococci correlated significantly with *S. aureus* (0.52 and 0.51 respectively, $p < 0.001$) at all sampling sites. We found a significant negative correlation with salinity for all monitored microorganisms (*E. coli* -0.37, intestinal enterococci -0.46, *S. aureus* -0.45, $p < 0.001$). The intestinal enterococci showed a weak but significant positive correlation (0.24, $p < 0.001$) with the temperature at all sampling sites. No statistically significant correlation was found between the monitored bacteria and precipitation. These results suggest that small levels of precipitation do not have a significant effect on the quality of bathing water in the studied sites. The moderate positive correlation with FIB and negative with salinity indicated that *S. aureus* is probably originating from the same sources as FIB. Additionally, the results suggest that *S. aureus* could be considered for use as a relevant indicator of microbiological pollution in the areas under the anthropogenic impact. The guideline values based on the relationship between *S. aureus* levels in bathing water and the health risk of staphylococcal infections are yet to be determined. This study is financed by the WATERCARE project from the Interreg Italy-Croatia cross-border cooperation program, funded by the European Regional Development Fund.

Keywords: bathing water quality, *Escherichia coli*, intestinal enterococci, *Staphylococcus aureus*, precipitation, Kaštela Bay

Breakwater design for better sea quality in ports

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Breakwaters are structures that separate a port basin from surrounding seawater and this way disable natural water renewal. Water in marinas must be visually clean (no oil, litter, sewage wastes or other traces of pollution). In order to comply with a high environmental standard, it is very important that such ports themselves and the water around them are visually clean. These requirements are prescribed in a Blue Flag's marina criteria manual as a condition for the Blue Flag mark awarding. The Blue Flag is a popular tourist mark in the world today, which is becoming tourist orientation when choosing a destination. It is today a recognizable model of ecological education and public awareness, when it comes to sea and coastline concerns, especially for the beaches and marinas. Blue Flag Intellectual Property and International Leader of this program are the Foundation for Environmental Education - FEE, founded by the Council of Europe in 1981. This criterion is not only applicable for marinas but also for city communal ports or any small enclosed water bodies in city centers.

Ports in seas with a larger tidal range rely on the process of water renewal where a significant volume of water in port is changed in one tidal cycle. In the seas with small tidal range (as the Mediterranean Sea, Baltic, Caribbean sea, Black sea, etc.), the water in ports suffer from stagnation and lower water quality. Especially are endangered smaller water areas distant from the port's entrance where tidal circulation does not have influence. Measures that could be used for the improvement of the water circulation in ports are generally separated into passive and active measures. The passive measures include the design of the coastal structures such as the layout geometry of the port, the width and position of the port entrance, the sea depth within the port, the slope of the sea bottom and the use of breakwater structures which improve water circulation. Regarding active circulation improvement measures, pumps and aerators are rarely used because of the costs of operation and maintenance.

This article gives some specific structural measures (breakwater types) which application can improve the renewal of seawater in closed basins forced by natural generators: wind, waves and tidal oscillations. All these natural generators make water mass into the movement and improve water exchange between the outer and inner water bodies. Depending on the intensity of each specific natural generator at some location they contribute to a different extent to the overall volume exchange. The problems with low water quality are often expressed during

the warm summer periods when is expected the largest pressure of tourism activities. In the summertime, the expected intensity of winds and waves is moderate to low thus the main generator is tidal oscillations. But some contribution gives wind through the mixing of the water body in the port and waves by pushing some volume of water through the flushing culverts if they are properly designed. Overall water exchange in port is strongly dependent on ratio A_e/A_o (A_e -cross section of port entrance, A_o - cross section of openings in breakwater body). It means that for the larger cross-section area of the openings in the breakwater body, the overall quality of seawater in port is better. This is especially valid when the dominant generator of circulation is wind. From the opposite side, a problem related to the enlargement of the openings in the breakwater body is the excessive penetration of wave energy during winter storms which makes questionable the functionality of the port. This article gives some specific breakwater types which might be used with the aim of having better water quality in the port basins and their limitations of applicability.

Keywords: port, marina, breakwater opening, flushing culvert, water quality, sea circulation

Preliminary results of monitoring the impact of anchoring on *Posidonia* beds in Natura 2000 site Pakleni Islands, Croatia

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Studied Eastern Central Adriatic Sea Natura 2000 site, Pakleni Islands (HR3000095) (Croatia), is an area important for the preservation of *Posidonia* beds that is a priority habitat type under the EU Habitats Directive. Moreover, *Posidonia oceanica* is included in the Red List of marine threatened species of the Mediterranean. *Posidonia* beds cover an average surface area of about 3,26 km² which makes 16,3% of the total studied site surface area. *P. oceanica* covers seabed areas that coincide with the ideal sites for tourist boats anchoring. The Pakleni islands are located in the heart of navigation routes of the Central Adriatic Sea. For such reasons, this Natura 2000 site is under tremendous pressure of tourist boats and free anchoring over the majority of its surface occupied by *P. oceanica* meadow.

In the aim to quantify the anchoring impact and establish long-term monitoring of *Posidonia* beds in this particular Natura 2000 site, we started a yearly monitoring program. Monitoring is based on a widely used population-level descriptor: meadows' coverage measured through Line Intercept Transect or LIT technique on the basis of which the Conservation Index - CI is calculated. In total six sampling stations were chosen: two free anchoring coves, two mooring coves with installed concrete blocks, and two referential coves where anchoring pressure should be minimal (anchoring is not allowed or avoided due to maritime reasons). The meadow of each sampling station was classified according to assumed regional scales for the Conservation Index - CI and translated into adequate conservation status that might be bad, poor, moderate, good or high. Considering the distribution of the *P. oceanica* within the coves and usual anchoring practice on the Pakleni islands, monitoring was done at 10 m depth and performed in October 2019 and October 2020. Both reference sites showed high conservation status with a mean CI 0,92 for one and 0,94 for the second cove. Locations where free anchoring takes place showed the lowest mean value of the CI: 0,63, which is in the moderate category. Sites with regulated mooring systems showed CI values 0,76 for one and 0,82 for the second cove. A regulated mooring system with fixed concrete blocks has been used for more than ten years. Anyhow, it is not expected that regeneration of *P. oceanica* occurred in such period but regulated mooring system protected further

devastation during the last 10 years of intensive nautical tourism comparing to free anchoring areas. Our results pointed out dramatic devastation of the protected species *P. oceanica* and the related priority habitat type within the Natura 2000 site, caused by free anchoring. A positive effect of the installation of mooring systems in the Natura 2000 site was noted however to completely reduce the damage to protected seagrass, a new, environmentally friendly mooring design is required. The impact of anchoring on *P. oceanica* in the Mediterranean is well known but rarely demonstrated in Croatian waters. Taking into account that Croatia has 40 percent of the world's total charter fleet and exceptional slow regeneration of *P. oceanica*, we have to reevaluate our politics on free anchoring, especially in Natura 2000 sites and other areas to prevent the devastation.

Keywords: *Posidonia oceanica*, impact of anchoring, conservation index, Natura 2000 site Pakleni Islands, mooring

Intra-annual oscillation of the European anchovy, *Engraulis encrasicolus* (Linnaeus, 1758) batch fecundity and spawning frequency in the Eastern Adriatic Sea

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The European anchovy *Engraulis encrasicolus* (Linnaeus, 1758) is one of the most important commercial pelagic fish species in the Adriatic Sea, characterised by a short life span, high growth rate, early sexual maturation, long spawning period (peaking from May to July) and high fecundity. Anchovy biomass has exhibited considerable fluctuations over the last few decades in the Adriatic and worldwide. To better understand those biomass fluctuations, we examined the inter-annual oscillation of two reproductive parameters (batch fecundity and spawning frequency) in the context of their environment within the investigated period (2017-2020).

To estimate batch fecundity and spawning frequency matured ovaries of anchovies were sampled during the last four scientific surveys (those surveys were done under the umbrella of MEDITS and ESAmar projects; surveys took place once per year, during June-July to be more precise). Collected ovaries were examined histologically to determine the presence of females with postovulatory follicles (POFs) and hydrated oocytes. The POFs were classified as day-0, day-1 or day-2 and the spawning fraction was determined as a proportion of day-1 spawning females. To avoid biases, when estimating batch fecundity (number of oocytes released per spawning) only ovaries with hydrated oocytes and without POFs were used. During each survey, the sea surface temperature and salinity were measured at sampling stations. Correlations between biotic and abiotic factors were studied and analysed throughout the investigated period (2017-2020).

Results reported here contribute to the knowledge about this species and they will be useful for the implementation of the Daily Egg Production Method which should ensure more reliable values of the spawning stock biomass of anchovies in the Croatian side of the Adriatic Sea.

Keywords: European anchovy, batch fecundity, spawning frequency, POF

Digital Shoreline Analysis System to investigate on shoreline changes: case study of Bibione coast, Italy

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This study focuses on the change detection along the Bibione coast, important socio-economic location along the Venetian Adriatic coast (North of the Venice lagoon), using orthophotos and digital shoreline analysis system (DSAS) during the elapsed period from 1988 to 2018.

In the last 40 years, the coast of Bibione has been subject to intense erosion, especially the northern part near the mouth of the Tagliamento river. Over the years, attempts have been made to stem this phenomenon through the construction of breakwater barriers and nourishment (especially in the summer period) but the problem persists.

With this work, the erosion rate is quantified and the areas subject to different sedimentation rates are identified using a GIS environment by remote sensing techniques and the DSAS tool. The shoreline variation is measured for two areas: Area 1 between the mouth of the Tagliamento (in the North) and Baseleghe lagoon (in the South) and Area 2 in the south of the Baseleghe lagoon. Changes in the coastline are monitored by means of seven orthophotos from 1988 to 2018. Subsequently, the identification of shorelines, the photo-interpretation of the area, is performed to describe the temporal evolution of the area and. In addition, DSAS is used to calculate shoreline displacement rate.

The rates of shoreline changes, in the form of erosion and sedimentation patterns, are automatically quantified by statistical parameters functioned in DSAS, Net Shoreline Movement (NSM), Linear Regression Rate (LRR) and least median of squares (R2) that allow estimating the annual variation rate and the maximum variation in the considered interval. Considering the 1988 and 2018 shorelines, the results show sedimentation of about 0.55 km² in the proximity of the Baseleghe lagoon, and erosion of about 0.51 km² near the Tagliamento river mouth. As already reported in the literature, it is therefore confirmed that the southern part of Area 1 and the entire Area 2, both near the Baseleghe lagoon, are characterized by sedimentation, while the northern part of Area 1, near the Tagliamento river mouth, is characterized by erosion. This process is probably due to the westward littoral drift. The result of the DSAS quantified the erosion and sedimentation rates

along the coastal section considered. The results of the LLR, in particular, indicate that the northern part of Area 1 (towards the mouth of the Tagliamento) had an extremely dynamic feature with an average erosion rate of -3.5 m/year in the time interval between 1988 and 2018, while the southern part of Area 1 and the entire Area 2 (nearby the Baseleghe lagoon) recorded an average sedimentation rate of 1.5 m/year. The result of NSM, on the other hand, shows that from 1988 to 2018 there was an overall coastline retreat varying between 100 and 200 meters near the mouth of the Tagliamento river, and overall progress of coastline between 200 and 250 meters in the spit located in the southern part of Area 1. Furthermore, the statistical analysis on the different degrees of erosion/sedimentation of the entire coast considered has shown that about 40% of the coast is stable, 36% in sedimentation and 23% in erosion (of which 18% in severe erosion).

Keywords: coastal area, Bibione coast, DSAS tool, GIS, shoreline variation, nautical harbor

A redefinition of blue carbony

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Blue carbon is poorly defined and this lack of clarity creates a growing disconnect between its use in science, policy, and carbon markets. The goal of this paper was to examine the existing concepts of blue carbon and to make recommendations for future uses of the term.

A comprehensive literature review of academic research, policy use, funding routes, and carbon markets was used to inform the outputs of this paper. This research also considered the wider political landscape within which blue carbon is framed; it is subsequently set within the context of natural capital mapping, ecological economics, and/or eco-social economics.

The findings of this paper state that blue carbon research and policy are currently focused on the definition of blue carbon as specific habitats or species. The scale and longevity of carbon stocks in marine habitats are used to determine what is blue carbon. This approach is, however, different from that used by carbon trading verification agencies who determine what may be accredited for use in carbon markets. Subsequently, there is a growing disconnect between the different actors involved in blue carbon, with divergent definitions impeding its effective application for climate change mitigation and adaptation.

This paper concludes that to be effective blue carbon must be redefined within the context it was originally introduced, climate change mitigation and adaptation through carbon trading. This does not, however, preclude the biological, ecological, and political considerations of blue carbon; the policy landscape of the post 2015 development agenda recognises the need to integrate economical, ecological, and sociological factors. This approach is also reflected in the criteria that must be met for blue carbon to be included in carbon markets; the baseline, additionality, leakage, permanence, and co-benefits.

Future recommendations include a new standardised terminology of blue carbon as:

- Direct blue carbon – all carbon stored in marine sedimentary stocks; and
- Indirect blue carbon – marine carbon stored in living biomass and/or essential to protecting or maintaining stocks of direct blue carbon.

This would allow the policy to be more expansive in its remit for climate change mitigation through carbon trading and facilitate research into quantification methodologies of other sources of marine carbon. The carbon verification agencies would refine what specific blue carbon habitats may be accredited for carbon trading, whilst ensuring social factors and sustainable development are considered. A more open definition would also allow free-market economics to steer protection and restoration of these habitats towards the largest, most stable, and most easily quantifiable stocks; this remains in line with the current research and policy perspective. In summary, this approach could:

- simplify carbon accounting processes;
- simplify the protection and restoration of carbon stores;
- drive research and investment into other significant stores of carbon;
- facilitate the inclusion of blue carbon in policy frameworks and carbon trading mechanisms; and
- reinforce the systemic change to value natural capital and consider eco-social economics within the paradigm of sustainable development.

As a microcosm of the climate change crisis, a redefinition of blue carbon can better connect economic, ecological, and social value across the full value chain of stakeholders to drive the larger systemic change needed for effective climate change mitigation and adaptation.

Keywords: blue carbon concept, redefinition, climate change mitigation

The preliminary shell growth rate of *Hexaplex trunculus* (Linnaeus, 1758) after long-term exposure to a range of future ocean acidification conditions

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Over the last 200 years, the level of atmospheric CO₂ increased by 40% as compared to the pre-industrial period, mostly due to the burning of fossil fuels. The world's oceans absorb approximately 30% of the CO₂ released in the atmosphere leading to a perturbation of the seawater carbonate chemistry. As a consequence, the average seawater pH dropped from 8.2 to 8.1 over the last 200 years and is estimated that further decrease by up to 0.4 pH units by 2100. This phenomenon is called ocean acidification and is already affecting a number of marine organisms. This paper presents a long-term experiment aiming to assess the growth rate of a marine predatory gastropod species belonging to the family Muricidae, *Hexaplex trunculus* (Linnaeus, 1758) under a range of pH conditions relevant in the context of ocean acidification. *H. trunculus* has an important role in controlling benthic communities and is also a commercially important species for small-scale fisheries in the Mediterranean.

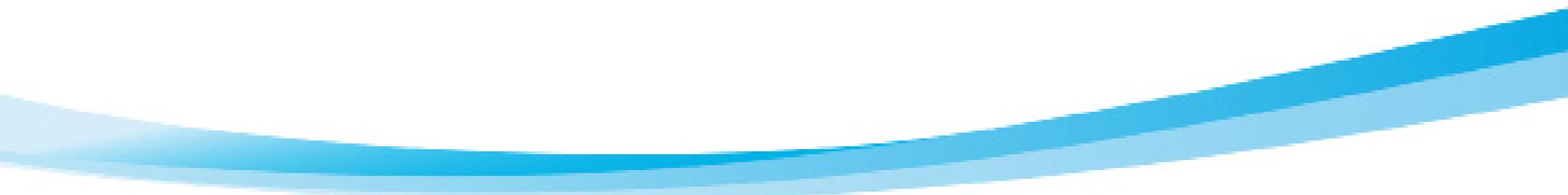
We collected specimens (average shell length, SL= 47,69 mm) from the Mali Ston Bay and maintain them into a flow-through system consisting of 9 tanks (40 specimens per tank). pH was manipulated in each tank by bubbling pure CO₂ gas and using pH controllers connected to solenoid valves to maintain the desired pH value. Filtered, UV-sterilized, and aerated ambient seawater was used. Each tank (T1-T9) was assigned a different pH value ranging from pH_{nbs} 8.2 to 7.4. Temperature, salinity, dissolved oxygen concentration, and pH_{nbs} were measured regularly. Specimens were fed *ad libitum* with mussels, *Mytilus galloprovincialis*. Feces and debris were siphoned every other day, and once a week a complete exchange of the seawater and detailed cleaning was done. Shell length measurements were taken at the beginning of the experiment, and every month afterward with a digital caliper (0.02 mm precision).

Temperature and salinity varied with the seasonal changes, varying between 8.3 and 26.6 °C for temperature and 27.1 and 35.3 for salinity. Dissolved oxygen concentration never fell below 6.28 mg L⁻¹ O₂. Ambient seawater pH_{nbs} fluctuated between 8.23 and 7.91 during the experiment due to the coastal pH variability in Bistrina Bay. Average pH_{nbs} values were T1=8.09, T2=8.07, T3=8.01, T4=7.90,

T5=7.80, T6=7.71, T7=7.62, T8=7.52, and T9=7.42. During the first eight weeks of exposure, a positive SL growth rate was observed in all treatments with an average 0.17 mm SL / week. The highest growth rate was 0.27 mm/week in T7 and the lowest being 0.07 mm in T1. During the next five weeks, the growth rate was significantly lower, on average 0.01 mm SL / week. The highest growth rate was 0.05 mm SL / per week in T3 and the lowest being -0.04 mm SL / week in T8. Negative growth in SL was reported for T6, T8, and T9, and no growth in SL was reported for T7. Eleven weeks later, the SL growth rate was lower, and a trend of negative growth rate continued for tanks from T6 to T9. The highest growth rate in this period was 0.03 mm SL / week in T1, and the lowest was -0.04 mm SL / week in T8 and T9. These preliminary results suggest that pH conditions within the present pH variability from the Bistrina Bay littoral area and 0.1 pH unit lower do not influence the SL growth rate over a 13 weeks of exposure. Lower pH treatments, relevant in the context of near-future ocean acidification affect shell growth and can lead to shell dissolution. This support the idea that marine organisms can be adapted to present local seasonal pH variations and that ocean acidification scenarios should be considered in the light of this variability. Further research is carried on to assess the growth rate after a longer period of exposure.

Keywords: ocean acidification, pH variability, *Hexaplex trunculus*, shell growth, Mali Ston Bay

MARITIME SCIENCES



Tools to enhance sustainable year-round tourism in the Mediterranean islands

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Coastal and maritime areas as tourist destinations affect the area's overall development, creating opportunities for new jobs and additional incomes for locals. The Mediterranean is one of the most visited tourist destinations characterised by high seasonality. Project WINTER MED (Winter Islands Network for all year round Tourism ExpeRience in the MEDiterranean) is a modular project co-financed by the Interreg MED Programme. The project aims to respond to the main challenges related to maritime and coastal tourism sustainability to reduce the high seasonality of tourist demand in island destinations.

The WINTER MED project aims to create an integrated transnational strategy to transition from the overutilisation of a summer tourist destination to a responsible and sustainable all-year-round offer, emphasising tourism activities year-round on the Mediterranean islands. The project started in November 2019 and will run for 32 months, involving eleven partners from six countries (Italy, Greece, Cyprus, Croatia, France and Spain). Its main goal is to use previously developed tools and good practices to create action plans for regions involved as well as general transnational plan. Due to the COVID-19 pandemic and related restrictive measures, partners have continued their activities in the new form of virtual meetings and webinars. This paper presents the work on the project in the online environment and the main challenges we have encountered in the implementation.

From June to October 2020, there were 12 webinars organised to present selected 13 good practices and tools from the previous nine projects. The presented good practices are related to the following themes: managing, measuring and monitoring, strategic planning, indicators and carrying capacity, also taking into account sustainable ways of mobility in the destination, marketing activities including promotional campaigns and tourism itineraries, energy, water and waste management strategies, interoperability information, forms of fundraising and capitalisation. These good practices are grouped within six labels: Governance, Evaluations, Database, Service for tourism, Training and learning, and ICT. The result of selected good practices with applicable tools can achieve the objective of sustainable tourist island destinations year-round. After each of the presented webinars, an evaluation questionnaire was sent to participants using an online

platform for survey development. The evaluation of the webinars was performed with the aim to collect general data on webinars and gather opinions of webinar participants on their usefulness. The evaluation process was carried out after each webinar. The results of the webinar's evaluation process were shared with projects partners and were the project outputs. The experience and solutions applied in dealing with the problems of lack of personal interaction and overall saturation with online content will provide valuable experience in finding the optimal approach in using digital technologies in the implementation of development projects in the tourism sector.

Keywords: sustainable tourism, seasonality, maritime and coastal tourism, COVID-19 pandemic

Smart strategies for sustainable tourism in Lively cultural DESTinations (S.LI.DES)

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In normal, pre-pandemic times, many cultural destinations experienced damaging pressure on local cultural and natural heritage, as well as on the quality of life of the local community, especially during peak season and special events. The spatial and temporal concentration of visitor flows was the most common problem among these destinations. The problem was even more serious in coastal cities that are also home ports or ports of call, such as those on the Adriatic coast, where cruise tourism often contributes to increasing the volume of visitor flows already present in the area.

Aware of this, the partner cities of the project S.LI.DES (Dubrovnik, Šibenik, Venice, Ferrara, and Bari) agreed to plan and build a common knowledge system to support their decision-making processes and develop appropriate transnational strategies, by involving a group of technical partners (Ca' Foscari University of Venice- Department of Management, Ciset- International Centre of Studies on Tourism Economics, Institute for Tourism, CAST- University of Bologna, Ecipa-Service and Training Agency, and Craft College- Institution for adult education Subsidiary Rijeka).

In order to realize this goal, S.LI.DES partners decided to develop a Smart Destination Ecosystem as a method to dynamically analyse different aspects of the cultural heritage of the project destinations, monitor visitor mobility patterns, and identify the potential of valuable skills and "know-how" to enhance the visitor experience. Smart Destination Ecosystem consists of four main components:

1. Destination datahub,
2. Destination mobility models,
3. Mapping of tangible and intangible cultural heritage, with a focus on artisanal activities,
4. Destination dashboard.

The first three components are closely related. The design of the mobility models requires the use of economic, social, tourism, and mobility data contained in the datahub (e.g., data on the local population, on the evolution of tourism flows and their distribution by mode of transport). At the same time, the results of the analysis related to the mobility models provide additional information on local

mobility patterns that are added to the datahub. Real-time mobility data is collected via devices such as sensors and video cameras installed in each of the partner cities. In the same way, data collected through the mapping of tangible and intangible cultural heritage, evolution, and typology of craft activities and CCIs, contribute to populating the related section of the destination datahub. The destination dashboard is cross-section to all blocks, as it translates the outputs of the previous activities into user-friendly knowledge for city managers. The panel layout displays the city performance on different aspects using tabular and visual tools (e.g., graphics, dynamic maps). All data contribute to assessing the competitive and sustainable performance of the destinations, supporting the development of actions aimed at diversifying tourism offer through targeted investments in cultural heritage, and designing a cross-border smart strategy transferable to the EU level. All the above-mentioned components are ready for use and are being tested in pilot actions organized by partner cities. Due to the pandemic caused by COVID-19, tourist destinations are currently experiencing under-tourism but confronted with deadlines, partners have to test the system during this (2021) summer season. They have prepared few different scenarios so that they can easily adapt to any situation. The project S.LI.DES fosters cross-border cooperation between cultural destinations in the program area and joint planning of smart strategies to support a more sustainable and balanced territorial development through the promotion of tangible and intangible cultural heritage. S.LI.DES can support destinations to manage tourism more sustainably, by considering how the following elements are affected: mobility patterns, city users' behaviors, opportunities to experience the destination, business needs. Visitor mobility models can help to better understand how local and non-local city users share public spaces and access to services and attractions, supporting government policies and innovation within tourism destinations. Mapping cultural heritage can help businesses to innovate and improve the visitor experience offer and also become more sustainable. Even though the project S.LI.DES was originally designed to address the problem of over-tourism, some of its features (e.g., management of crowds/people distribution within the city) can also be helpful in these pandemic times.

Keywords: coastal city, visitor flow, sustainable tourism, cross-border cooperation, cultural destination

Digital tools in Maritime Education – Development and Application

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The blue economy, which includes all economic activities related to oceans, seas and coasts, is responsible for more than 750€ billion annual turnover (for EU alone) and offers career opportunities for both young and experienced employees. In particular, 5 million people were working in the various European blue economy sectors in 2018, representing a significant increase in the workforce compared to previous years. One of the key challenges that the selected industries are currently facing, is the need to ensure that staff is properly trained and skilled to cope with new technologies, (commercial) developments and procedures. Careers in the blue economy cover a wider range of skill levels and usually require merging advanced academic studies with demanding fieldwork under stressful and hazardous conditions. Considering that these industries are truly globalised, the need for blue professionals to effectively communicate and collaborate in real-time is of profound importance. The lack of qualified and skilled workers and mariners in the blue economy sectors can be detrimental for the relevant industries with major consequences to their growth and the overall economy.

To address this challenge, this paper explores the application of digital tools for the development of a regional mentoring network for young professionals interested in pursuing a career in selected blue sectors; port operations, shipbuilding and ship repair, maritime transport, and the cruise industry. Mentoring is a personal development tool in which a student or a less experienced professional seeks the advice, counsel and support of an experienced professional. The purpose of the mentoring network is to bridge the skills gap between education offer and labour market needs, especially with regards to technological developments and innovation, strengthen cooperation between industry, academia, and public authorities, encourage mobility of students, teachers and professionals, raise societal awareness, and provide guidance and advance knowledge about blue professions.

This study focuses on the case of the Eastern Mediterranean Sea basin, a region with a historically heavy reliance on sea-related activities and strong maritime tradition. The target audience includes school students (ages 15-18), undergraduate and postgraduate students, young and senior professionals along with professors, teachers and training providers, public authorities and the local society in general.

The digital tools considered within the scope of this paper include the development of 360-degree and virtual reality videos that simulate the experience of in situ visits in selected work areas as well as the implementation of digital competitions that target young professionals. To further maximize the effects of the digital tools, a sharing-pooling e-platform is developed as a fully web-based application that allows remote access to the uploaded content. In addition, the e-platform's built-in communication capabilities facilitate effective communication between e-platforms' users; students, young professionals, and senior experts. This functionality becomes particularly important given the ongoing COVID-19 outbreak that challenges face-to-face interactions and knowledge exchange. This work is part of the Sea of Experience project. The Sea of Experience Project has received funding from the European Union's "European Maritime and Fisheries Fund (EMFF)", one of the five European Structural and Investment (ESI) Funds under Grand Agreement No. 863551.

Keywords: blue economy, blue professionals, regional mentoring network, digital tools, Eastern Mediterranean Sea

Could the combination of cultural and sailing tourism provide us with special products along a country's ports system? Evidence from Greece

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Cruising as a concept is a complex one and it combines much of the well-known "tourism chain": transportation, catering, tourism, entertainment and travel. Today's organized cruise combines product markets, education and sports activities and it is a unique destination. Cruise tourism is defined as any leisure travel by ferry, with the primary purpose of accommodating passengers aboard and visiting a variety of destinations. A key point of the definition is that the purpose is not solely to carry passengers to their destinations but to stay on board.

Greece and its topography are ideal for the development of sailing tourism. Cruises product in Greece is largely based on underpinning visits in cosmopolitan islands such as Mykonos and Santorini providing the chance to passengers to visit various places for short daily visits. 42 ports however are available for cruise ships to be moored. All of those ports are located in various parts of the country which due to isolation conditions throughout centuries have developed their own identities, distinct in architectural features, urban plot configuration, customs, traditions, etc. New cruising products could easily derive, pushing ahead in this way, local cruising industry and that is really a goal to be achieved.

Themed cruises around Greek ports are not a so new approach in the sailing tourism narrative in Greece. Due to trading routes of the past, common conquerors etc., distant places irrelevant at first glance can be matched under a certain prism as it can be filtered through history, gastronomy, art, architecture, winemaking, etc. Certain marketing techniques can be easily applied.

Due to the significant development of tourism in Greece during the last decade, there is a place for the offering of specialized products focused on niches of the global tourism market. In recent years, culinary tourism, as well as wine tourism, has attracted millions of tourists around the world who seek to combine the travel experience with the pursuit of culinary tastes and delights. The search for traditional dishes and local products and their combination with the local customs and its folklore, its history and mythology are now a major motivation for many tourists and that is why many countries are investing in promoting their local cuisine and products. The results of this paper could be the proposal of new cruise products for the Greek cruising industry. Tremendous potential for the development of cultural

tourism developed can be combined with tremendous potential for the development of sailing tourism. *Themes can vary and they could range from culinary adventures contrasting cuisine of the mainland to that of islands, to the visit of battlegrounds of ancient battles such as Salamis, Platee, Marathon and Thermopiles.*

Consequently in this paper, themes of cruises will be presented along the ports and activities selected for each destination. For example, a seven-day thematic cruise on the Greek Islands, with the theme “A Look at Antiquity” is going to take us back through the centuries. Through guided tours, visitors would experience lots of archaeological sites and museums as well as various videos and a glimpse into the life of ancient Greeks.

The conclusions of the paper are going to be focused on how easy could be the formation of new cruising products if the culture in all its forms is stimulated. Greek seas and their ports are an ideal background for the formation of new cruising products which can be applied in other countries too.

Keywords: sailing tourism, cultural tourism, yachting, cruise, Greece

Resource exploration and exploitation in the Mediterranean: Assessment and prospects for blue growth and sustainability transition

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The European Green Deal, announced in late 2019, formalizes Europe’s aim to become the world’s first climate-neutral continent by 2050. The announced targets and priorities pose a prime opportunity for system transformation in the EU Member States and its Mediterranean neighbour countries that are close trade and regional partners of the EU.

This paper assesses resource exploration and exploitation in the Mediterranean and its implications for future growth and cooperation in the region. The aim is to identify and critically evaluate past, present, and future trends with regard to resource exploration and exploitation in the Mediterranean under the prism of the European Green Deal, sustainability transition, blue growth, and regional cooperation. Focus rests with resources critical for meeting the energy-related sustainability transition in the region, i.e., critical, and rare earth materials, renewable energy sources and hydrocarbons. Towards this end a two-step methodology is applied. First, a state-of-the-art literature review is completed with regards to resource exploration and exploitation in the Mediterranean. Second, alternative narrative visions of the future are formulated and evaluated with the use of SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis. The methodology is applied to identify potentially optimal cooperation policies under the prism of the Green Deal priority areas as well as investment, and innovation opportunities related to the blue economy. The focus rests on the social, economic, technology and financial transformations required for the successful deployment of the blue economy and growth prospects in the Mediterranean region. The analysis shows that despite the provisions set by the Green Deal, the bilateral and multilateral fora and agreements between the EU and its Mediterranean neighbour countries in North Africa and the Middle East, a series of challenges and issues remain. Challenges and structural characteristics that may impede blue growth and economic developments in the Mediterranean include expensive carbon lock-in, silos between industries, gaps between developed and developing countries, the global North and South. These challenges may have a real impact on the full capitalisation of blue economy prospects in the Mediterranean if no timely action

is taken to address them. Addressing these challenges requires the uptake of new skills, time, and flexibility from businesses, policymakers and in the labour markets. The analysis concludes with some policy recommendations in support of resource exploitation in the Mediterranean, blue economy and sustainability transition in the Mediterranean. Recommendations include: the well-informed policy design the promotion of cooperation through clusters and regional schemes, emphasis on know-how, technology, and skills transferability, timely intervention in the education system, priority allocation of public funding and international assistance to education, skills, and technological upgrade of the labour force, that can improve job prospects, resilience, and long-term sustainability.

Keywords: European Green Deal, EU neighbour countries, blue growth, blue economy, SWOT analysis, Mediterranean

Do Innovation Centers produce results?

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Over the last decade numerous innovation centers, accelerators and incubators have been developed globally to facilitate startup firms within the maritime arena or as it is a part of what is called the “Blue Economy”. Several of these centers have a venture funding connection as part of their offering. The intent of most of these centers is to spur the development of new technologies to be incorporated within the maritime logistics industry or totally reinvent processes that have been in place for decades. Ideation competitions have been developed in some instances and entrepreneurs are urged to participate in programs that will provide networking opportunities and access to funding. Despite this development, the number of maritime startups that reach minimum viable products for introduction and investment remains quite small. This study will examine the current state of innovation centers around the world and consider the value of these programs in the evolution of the industry. With data from maritime and logistics innovation centers around the world, we look for evidence that their work has resulted in economically viable inventions and generated new businesses. What is the percentage of new startups that results in successful businesses, and what is their value?

Over the last decade incubators, accelerators, and clusters focused on the Blue Economy and blue technology have formed worldwide. The Blue Economy is sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health. It includes many different activities, including renewable energy, fisheries, maritime transport, tourism, and defense just to name a few. The World Bank estimates that the Blue Economy contributes roughly \$1.5 trillion to the global economy each year; very few other natural resources can claim as large an impact. With so many industries and stakeholders that have a vested interest in the Blue Economy, some regions across the world have created marine clusters. A cluster is “a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and externalities” according to management author Michael Porter. In the Blue Economy, ports serve as natural hubs for clusters due to the obvious infrastructure and businesses that they support, so it should come as no surprise that each cluster

is near, or centered on, a major port. Growth in the Blue Economy is driven by new ideas and businesses generating revenue. We call these startups. It is difficult to count and track young companies like startups, but it is relatively easy to track the institutions that support them: incubators and accelerators for example. Incubators and accelerators serve a similar purpose to startups that reefs in an ocean serve young marine creatures. A reef provides a sheltered space for marine creatures early in their lives. Incubators and accelerators provide a safe haven for young companies to test their business models, build relationships, and access cheap resources. This allows the startups that live within these institutions to focus on growth before they go it alone. The line dividing incubators and accelerators have become blurred over time and there are no hard and fast rules that characterize each. Generally speaking, an incubator supports a company in its early stages for several years while the startup attempts to turn an idea into a business. Most incubators are run as non-profits and generally don't take equity in the startups they host.

An accelerator helps a business with developing a marketable product or service in its more adolescent stages. This is a more intense phase of growth and most accelerators are typically only several months long in duration. Accelerators are more likely to take some equity in the companies that they host in exchange for the services they provide (legal, human resources, finding investors, accounting, etc.). Some other institutions call themselves "innovation centers" or similar, but they serve similar purposes as an incubator. This ratio of incubators to accelerators could imply that the Blue Economy startup scene itself is still immature. Perhaps there just aren't enough startups to justify the more advanced services of accelerators, assuming of course that the number of incubators and accelerators will fluctuate to meet market demand. The lack of large corporate entities running their own blue tech accelerators or incubators, or even partnering with existing ones, is indicative of a nascent Blue Economy, but also of the growth to come. There are many different focuses of these incubators, accelerators, and clusters. Some choose to cover a broad range of topics with catchall phrases like "blue technology", while others are more specific in their focus areas, listing topics such as "coastal recovery" or "marine transportation".

Keywords: innovation center, accelerator, incubator, blue economy

Sustainability manifesting as a multi-material network effect - a case study on boat-sourced sewage management facilities in Finnish small ports

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The European Union specifically highlights the potential in coastal tourism for fostering blue growth. Although providing employment and generating income, coastal tourism may, in some areas, risk the health and viability of the ecosystems upon which the tourism livelihood depends. Marinas are a part of coastal areas' touristic appeal, but also hotspots for boat-sourced pollution. In the nautical tourism context, leisure boaters depend on marina infrastructure, which makes both privately and publicly run marinas crucial sites for governing boaters' environmental behaviour. Simultaneously, many boaters value the possibility to take care of the environment by properly disposing of their boat-sourced wastes, considering this an important marina service.

We analyse and describe one socio-eco-technical system, where marina infrastructure has the key role facilitating both the sustainability of boating and marina operation itself. The aim of this effort is to provide a novel type of systemic insight and this way help the marina operators to better design their facilities as services that support both their business, public health and quality of life in coastal regions.

Our analysis applies actor-network theory, conducting a conceptual systems analysis on boat-sourced sewage management, which is seen as one important socio-eco-technical sub-system of sustainable nautical tourism in our case study area. The analysis is based on interview and questionnaire data collected among two marina stakeholder groups – boaters and port actors – during a research and development project conducted in the eastern Gulf of Finland, Baltic Sea, and the reflection of this data against literature. Arising from both the literature review and the project data, boat-sourced sewage management is used as a practical example of a so-called core marina service that can either serve to promote sustainable nautical tourism business or, if neglected, hinder operating the business sustainably. The analysis demonstrates how managing boat-sourced sewage successfully is an outcome of establishing a multi-sited network of heterogeneous elements that

together enable both sustainable boating and marina operation practices as network effects. The network is presented as a visualized collective of the interrelated human and non-human entities of marina operation that operate on, but also link together, different spatial scales of society and environment. We suggest this collective is one important sub-system that can either advance or hinder the materialisation of sustainability under the wider system of nautical tourism, including both the touristic experience and the business perspective. Our analysis reveals that the sustainability of boating and marina operation are tightly intertwined. The dynamically interacting human and non-human actors and factors of the presented boat-sourced sewage management collective have the potential to simultaneously enable both sustainable boating practices and the sustainability of marina operation, if not hindered by situational constraints. The constraints can be related to the infrastructure, instructions and information available for boaters, or boaters' environmental motivations and knowledge. The resulting systems description also shows that boat-sourced sewage management facilities serve both as core marina services and as governance artefacts. We believe understanding their dichotomic nature aids in improving marina service performance in a holistically sustainable manner. Additionally, illuminating the effort law-abiding environmental behavior practically requires from an individual, the paper can support planning and implementation of successful environmental regulation practices.

Keywords: sustainable nautical tourism, blue growth, small port, actor-network theory, boat-sourced sewage management

Rescuing Nemo: Sociological Research of Fishermen Impacts on Blue Economy

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The social climate of the 20th and 21st centuries has experienced a major shift due to movements such as the one for animal protection or those for environmental causes. Social responsibility (SR) includes environmental components and akin social, ethical, and other questions regarding business operation. One of the definitions given by the European Commission states that Corporate social responsibility (CSR) *is the responsibility of enterprises for their impact on society* which includes the integration of environmental and ethical considerations into their business model. From the Stanford University Center for Ocean Solutions (COS), comes the definition first published in *Science* which brings attention to SR concerning the small-scale and industrial fisheries. The definition includes three components: the protection of *human rights, dignity, and access to resources*; ensuring equality and equitable opportunity to benefit and the overall improvement of *food and livelihood security*. There are between six and seven thousand different herbal and animal species in the Adriatic sea. Needless to say, *healthy oceans are a precondition for a thriving blue economy. Pollution, overfishing and habitat destruction, coupled with the effects of the climate crisis, all threaten the rich marine biodiversity that the blue economy depends on.*

The concept of *the oceanic economy* or *blue economy* originated from the United Nations congress of sustainable development held in 2012. in Rio de Janeiro. The gist of the concept is separating social-economic development from the degradation of the environment. The concept can be adjusted to economical and trading activities, and it arises out of the need to integrate preservation and sustainability into maritime management. The aspect of sustainability alone suggests the inclusion of activities based on consumption and renewal patterns while generating lower or non-existent greenhouse gas emissions. The aspect also puts forward the sustainability of oceans that supply food to all beings. The wanted outcome of the blue economy concept includes improvement in humankind wellbeing and social equality, while significantly lowering environmental risks and disadvantages, supporting a low carbon level, the efficacy of resources utilisation and social inclusion.

Sociologists, as social scientists, are constantly trying to uncover facts connected with the human population, including finding connections between everyday life and sociology. Modern sociology focuses on the attitudes and behaviours of

individuals towards the environment and certain natural resources. The problems of pollution became pretty relevant long before the public and media gave it attention. On this note, we decided to conduct research that will focus on social responsibility, environmental issues and some ethical questions regarding fishing vessel business whose owners and workers are residents of Split-Dalmatia county. The main goals of the research are to question the attitudes and opinions of the research participants about topics including social responsibility. Furthermore, we aim to determine the level of awareness and knowledge related to environmental issues and knowledge of the law on corporate social responsibility and to examine the specific impacts of fishing on maritime flora and fauna. The research was thorough surveys with participants who are currently employed and/or own a fishing vessel in Split-Dalmatia county. Given the description of their work and the possible consequences of their occupation on the environment, we believe that they are the most adequate sample to examine the issues stated above. The survey seeks to obtain answers to the current blue economy state regarding social responsibility, ecological awareness and maritime sustainability.

The research was conducted in August 2021. on the sample of 20 participants, 19 men and 1 woman. Most of the participant (75%) finds preserving the sea flora and fauna important, which is an exceptionally positive insight given the fact that our participants spend most of their time aboard. At the same time, 15% of our sample believes that preserving the sea flora and fauna is somewhat important, and 10% do not believe it at all. The research participants were asked if they thought that their job affects sea life. Most of them (75%) thought so completely, while 15% believe it affects the maritime biocenosis somewhat and 10% do not see it that way at all. When it comes to throwing litter into the sea, more than half of our participant states that they have thrown paper, plastic, metal, and glass into the sea. The highest percentage of our participants (75%) emphasize that they mostly throw away paper, while one-third (60%) throws metal and glass. Besides the fish, a lot can be found in fisherman's nets. The participants were asked about how they deal with bycatch. Half of our participants discard unwanted catch into bins for mixed waste, 15% separates the waste into specialised containers, while the rest of the participants throws it back to the sea. When it comes to waste management on their vessels, there is an increased consideration shown. Just one participant states that they throw that kind of waste back in the sea. Considering that 80% of the participants recycle into mixed waste, and 15% recycles into the appropriate bin, it is noticeable that the level of awareness is higher in this case than it is when it comes to bycatch. The research participant almost unanimously (95%) agreed that there aren't enough locations for recycling their waste.

Keywords: environmentalism, blue economy, ethical fishing, sustainability, social responsibility

Potentials for exploitation of thermal energy from seawater in the Mediterranean

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Space heating and cooling demand equal or even surpasses electricity demand in some parts of the EU. Since the sector of generation of heat today is dominated by the fossil fuels in the Adriatic region, big changes are needed for an energy transition towards a sustainable low carbon future. In the Adriatic region, air to air heat pumps are often used due to high cooling demand. This in combination with a high ratio of renewable energy sources in the electricity grid gives much lower emissions of greenhouse gasses. Still to get the best results we need to aim for more efficient heat pumps – with a higher coefficient of performance (COP), which can be best achieved with heat pumps using seawater, especially in coastal areas. Best results are obtained for the case with low-temperature heating, which can be a barrier for the older and inefficient buildings. The thermal energy of the seawater is underexploited in the Mediterranean region, but many new projects are developing these solutions. Opportunities for this technology are the new-built hotels that need heating and cooling throughout the whole year with large demand and can achieve significant savings and a high level of comfort. In the COASTENERGY project, the potentials of blue energy are analysed with a specific focus on the thermal energy of the sea and the resulting impact on carbon footprint. For the project needs, the Cres-Lošinj archipelago was analysed, where total emissions of CO₂ in the building sector amount to 2698 tonnes yearly. By substituting all the heating systems using heating oil or LPG in the Archipelago with seawater heat pumps, we could reduce emissions by 654 tonnes of CO₂ which presents 24,2% of total emissions in the Archipelago. The starting point should be publicly owned buildings where we could reduce emissions by 39,3%. Except for benefits for climate, this technology has been proven feasible in many cases. For the case of Cres-Lošinj Archipelago, substituting heating systems using fossil fuels with seawater heat pumps, the payback period is around 6 years with an expected COP of 4. For future projects, where heating systems need to be planned to form the scratch, feasibility is even greater if we compare it with other systems. This technology presents the greatest potential for future hotels and large complexes

that will have high heating and cooling demand throughout the year. Also, they can be used for district heating and cooling systems. Although technology has great potentials, many barriers do exist. In many cases, the investors are repelled by the complicated legal procedures needed for the installation of the seawater heat pumps. Usually obtaining the permits and concession are needed, and the whole procedure is not completely clear. Bodies responsible for the permits are counties, municipalities, harbor's master and in case of drilling a well, the national water management body. The whole procedure should be simplified, especially for smaller projects. A new procedure that would encourage investors to utilize seawater heat pumps, with existing funding schemes should be promoted by the nations and regions in coastal areas.

Keywords: seawater heat pump, COP, space heating and cooling, Adriatic Sea

Offshore wind energy 2100 – pathways for renewable energy transition in Finland

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Scenario analyses have emerged as a powerful tool for long-term and adaptation planning. The Shared Socioeconomic Pathways (SSP) are a scenario framework that includes 5 narrative descriptions of future global developments over the 21st century. The SSPs combine qualitative descriptions of global narratives with quantifications of a select number of drivers, for example, population, economic growth, urbanisation and so on. An emerging area of research is extending these global scenarios to the regional, country or industrial level to create locally relevant narratives. There are different methods for extending the global narratives to the regional level. This research presents extended and downscaled SSP narratives for the offshore wind industry in Finland using a top-down, bottom-up approach. The global SSP narratives are used as the top-down, boundary conditions and a participatory workshop with expert stakeholders is the bottom-up method to create locally relevant narratives. This is the first research to present extended SSP narratives for the energy sector in Finland, with a case study exploring offshore wind development.

The participants represented various sectors and perspectives with links to offshore wind or marine spatial planning from within Finland. Extending the global SSP narratives to the national scale allows us to explore how global and regional level changes may impact the offshore wind industry over the 21st century. Offshore wind energy is relatively underutilised and has the potential to become a major source of energy in Finland. Europe is a worldwide leader in offshore wind energy, with the majority of offshore wind farms located in the North Sea. Finland has identified areas within its exclusive economic area in the Baltic Sea that could be appropriate development areas for offshore wind farms. However, long-term planning and policy measures are needed now to support its development. Offshore wind should also be developed in a balanced manner by accounting for other uses of the land and sea space and minimising the impact on the environment.

The aim of this paper is to create a shared understanding of those drivers that impact the offshore wind industry in Finland and explore how offshore wind may develop over the 21st century, under different global futures. We test the top-down, bottom-up methodology for extending SSP narratives and creating locally relevant scenarios by applying this to a case study in Finland. In the first part of

the workshop, we identify the global and regional drivers impacting offshore wind and rank these based on importance to its development. These drivers, in part 2 of the workshop, are extended and used to develop a set of locally relevant narratives. We used only the 4 extreme SSP cases for this workshop. The 4 narratives that were created explore the development of offshore wind in Finland over the 21st century under different global futures. The workshop was held via Zoom and breakout rooms were used for group discussions. 4 break rooms were used in the first part of the workshop, with 4-5 participants per group, and a facilitator to take notes and guide the discussions. Each group discussed the drivers that they thought were important for offshore wind development and provided examples and descriptions. The second part of the workshop had two breakout groups and each was assigned 2 SSP narratives. The groups then discussed how the drivers identified in the first part of the workshop would change and develop over the 21st century, under the assigned SSPs, and how these developments would impact offshore wind and other forms of energy.

These narratives can be used to support and contribute to policy decisions and implementation of a balanced development of offshore wind regionally and nationally within Finland. Our results can also support the development of other regionally and locally relevant scenarios in other contexts, such as other energy-related research, agriculture and food production, marine and environmental conditions and so on. We aim to use these results in further research and additional workshops to identify the policies, practices and investments needed to create a balanced development of offshore wind.

Keywords: offshore wind energy, renewable energy transition, shared socioeconomic pathways, Finland

Transition to green hydrogen in shipping and ports: legal issues

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Transition to zero or low emission maritime transport sector requires the use of green fuels, such as green hydrogen. In 2020, Commission adopted A Hydrogen strategy for a climate-neutral Europe (COM(2020) 301 final where it pointed out that hydrogen is essential to support European commitments to carbon neutrality and the global efforts to implement the Paris Agreement's goals. Hydrogen can replace fossil fuels also in the maritime transport industry. European countries are developing solutions to introduce green hydrogen in their transport and other industrial sectors. In Norway, for example, the Government has adopted the hydrogen strategy as a basis for developing measures to guide the industry towards the transition to a low emission economy.

This paper focuses on the identification and assessment of legal gaps and barriers to accomplish the transition to green hydrogen in shipping and transport and examines the Norwegian perspective and experiences. Importantly, the international character of transport requires multi-lateral rather than unilateral legal approaches. However, sufficient regulatory frameworks for hydrogen in ports and shipping are lacking at all levels and are not harmonized across countries and regions.

Further, the existing research does not examine how and what legal measures may be applied and which measure will be more feasible and effective in practice, in light of the technical, economic, legal and regulatory setting in which ports and other stakeholders operate. Legal measures may be used to design hydrogen and post-petroleum markets for the port and transport sector, by creating incentives for stakeholders (ports, transport companies, regulators) to implement green solutions and ensuring legal certainty for stakeholders. At the international and regional (European) level, it is necessary to develop common standards for transportation, use and storage of green hydrogen (notably, safety standards for ships). At the national level, it is necessary to examine public and private regulations applicable to operations with hazardous substances.

Disincentives for the stakeholders may exist due to the legal rules, which make certain decisions non-feasible: e.g., prohibiting or unnecessarily restricting certain 'green' decisions, taxation/levies, over- or under-regulation such as the absence of clear emission targets or other criteria, as well as unclear legal implications of certain practices and decisions, notably, for stakeholders' liabilities. At the same time, incentives for green changes may arise from direct legal measures requiring

certain behaviour aimed at more sustainable practices in ports and transport (e.g. setting emission targets) and indirect measures promoting or encouraging relevant commercial behaviour. Importantly, there may be also legal and regulatory measures aimed at necessary changes in structure/infrastructure within which stakeholders operate (e.g., encouraging technical improvements). Private contracts between parties may also encourage – or hinder – transition towards green ports and transport solutions.

The paper will propose pathways to adequate legal and regulatory solutions for the transition to green hydrogen in maritime transport. Some solutions may lie in adopting binding and recommendatory international and European regulations of public character (standards, emissions, liabilities, etc.), while others may take shape of codes or best practices, roadmaps, etc. These measures must be flexible and adaptive enough to respond to the changes in the economic, social and technological conditions while ensuring sufficient legal certainty and adequate safety standards.

Keywords: green hydrogen, shipping, common standards for transportation, legal measure

Enhancement of the underwater archaeological heritage of the Adriatic ports Transition to green hydrogen in shipping and ports: legal issues

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The ports located along the Adriatic coast are characterized by the discovery of several submerged archaeological findings: from the wrecks of entire ships or part of them, transported goods and works of art. Underwater archaeology allows to reconstruct the evolutionary process of shipbuilding in the Adriatic area. In fact, the different morphology of coastlines in Croatia, with rocky coasts and many islands, and in northern Italy, with numerous river mouths and lagoons, involves various navigation possibilities, leading to the creation of different types of boats. The submerged archaeological heritage of the Adriatic area is very rich and tells us a lot about the events and history that took place in these waters. For example, the discovery of the Roman ship of Valle Ponti in Comacchio (Emilia – Romagna, Italy) tells how the Adriatic area of Emilia-Romagna represented a port area of great importance since the Iron Age, both for the Romans and the Greeks. The findings of a specific class of ceramics or sculptures, transported across the Adriatic Sea, testify the contacts between these peoples in ancient times. Each of these ports has its own submerged archaeological heritage that must be enhanced to promote knowledge and to encourage the touristic and cultural development of the area. For example, the Port of Spina in the Municipality of Comacchio, as well as all the other Adriatic ports, has its own archaeological evidence. Nowadays the new technologies (e.g. Augmented Reality, Virtual Reality, underwater robots) starts to be applied to the submerged archaeological sites with the aim to make them accessible to everyone. The solution as underwater sensor networks, placed on the seabed of archaeological sites, can provide real-time data to monitor the findings, the environmental parameters, and the biodeterioration of submerged artefacts. The documentation helps in the conservation of submerged cultural heritage in several ways: providing data for underwater restoration, the safety of operators, and the enhancement of submerged cultural heritage. In fact, these data can be used to realize innovative experience as underwater virtual visits for children and

tourist. The submerged findings, brought to the light, tell us pieces of history that happened along the Adriatic coast and they can be showed to the public once restored. The reconstruction can be provided by digital tools, i.e. the 3D modelling, which aims to increase the cognitive power of archaeological finds during communication and dissemination activities. In this way, the archaeological evidence becomes an important element to increase the touristic attention and cultural value of small touristic ports for people of all ages. In the panorama of the ECOMAP project, the valorisation of the submerged archaeological heritage of the ports can start by creating educational courses, for people of all ages, aimed to improve their knowledge. These courses can be offered to both pupils and tourists and can illustrate the methodologies of underwater archaeology: from the identification of the site, the recovery of the findings, to the analytical, restoration and conservation activities. The new technologies support the creation of digital educational paths and they can also be delivered remotely. The first step of this process is the mapping of the ports in the Adriatic area to define the appropriate enhancement strategies in order to increase the tourist and didactic potential of each involved area. Finally, for an incisive promotion of the cultural behaviour of these ports, it is essential to involve local communities. The identification of the population with their port cultural heritage contributes to its promotion and conservation and can start with education at school and touristic activities. The processes of enhancement of cultural heritage guarantee an important increase in tourism in the territory, consequently providing worthy support to the local and national economy.

Keywords: underwater archaeological heritage, underwater archaeology, cultural heritage, educational course, tourism

The impact of civil society and social engagement on the sustainable development of ports

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This paper describes aspects of nautical activities in the Republic of Croatia and the specificity and importance of sports ports. Great emphasis was placed on the influence of civil society and social engagement that influences the creation and development of local ports. One form of such engagement is the creation of a socially entrepreneurial community that through activities (in this case nautical activities) strives for the creation and development of social and economic changes. The work of civil society organizations is most evident through social engagement that seeks to encourage citizens to act in the public sphere to improve the community for the benefit of all. Social engagement can be reflected through many levels, from volunteering, donating, participating in public forums, etc. An example of such social and economic changes is the creation of a community within the ECOMAP project whose main objective is to improve the environmental quality conditions of the sea and coastal area connected to nautical ports and navigation, within the area of touristic and recreational port management on Italian and Croatian Adriatic. ECOMAP aims to help local ports to design better environmental strategies and to have access to suitable environmental management tools to remain competitive and to contribute to a more sustainable Program area. Despite their small size, they have important economic, social and environmental links with their surroundings and large cumulative impact.

The goal of this paper is to presents the development and application of the ECOMAP project within two ports in Croatia: port Špinut and port Strožanac. Both ports are run by two sports associations, civil society organizations: Sport Fishing Association Špinut and the Association of Sport Fishermen “Strožanac”. The paper also presents the results of an empirical study conducted by the Healthy City within the project Interreg Italy – Croatia ECOMAP, which sought to identify habits and needs of ports and nearby beach users concerning environmentally responsible nautics and services in marinas, both in Croatia and Italy. The study was conducted at the ports of Strožanac, Špinut, Baseleghe and on the beaches Strožanac and Bibione Mare in the summer of 2019.

The survey method was used, and for the instrument, a questionnaire (with two

different approaches) containing a combination of closed and open-ended questions. The first questionnaire was conducted on the beaches and it was about the satisfaction and attitudes of beach users. The second questionnaire was conducted in the ports and it was about the satisfaction and attitudes of port users. The results of both questionnaires should contribute to improving the conditions in ports and the overall conditions of the beaches. The sample included 590 participants of whom there were 374 participants from Italy and 216 participants from Croatia. In Croatia, the questionnaire was conducted in two ports (Špinut and Strožanac) while in Italy was conducted in one port (Baseleghe). The results obtained in the research were statistically processed and a comparison was made between the results obtained in Croatia and those obtained in Italy.

The results show the top three average priorities found among different participant groups. On the beaches, safeness and clean water are considered crucial among all beach participants. Other priorities would be adaption to the people with disabilities, parking price, and sea quality information. In the ports, fuel stations and public facilities (showers, toilets) are considered crucial. Other priorities are environmental management system, improvement of the harbors piers condition, and access to restaurants and shops. The comparison of the results between Croatia and Italy shows that the priorities on the beaches are quite similar (safeness and cleanliness). Regarding ports, in Croatia, priorities are fuel stations and public facilities (showers, toilets), while in Italy priorities are focused on the places to hang out and also public facilities (toilets).

In conclusion, there is a significant level of satisfaction with small ports in Croatia. This shows that nonprofit organizations managing small ports Strožanac and Špinut are doing a good job that additionally emphasizes the importance of the civil society organizations' involvement and recognizes the importance of this area of social engagement in the development of local small ports.

The research has been co-financed by Interreg Italy – Croatia program within the ECOMAP project.

Keywords: nautical activities, social engagement, marina, sports ports, beach

The ECOMAP geodatabase for monitoring and assessment of the environmental quality conditions of the coastal areas and nautical ports

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The objective aims of the partnership between Italy and Croatia, for the Interreg V-A ECOMAP project, are the development of multidisciplinary analysis methods and cross-border protocols to standardize the management procedures and ensure sustainable costs at the highest possible levels of quality for port infrastructure and services to build the port services (EU R 2017/352) and the network “Single European Transport Area (EU 1315/2013)” by 2050.

To achieve all the goals of the ECOMAP project, the methodologies developed and geospatial tools shared between partners are fundamental. With the creation of a shared database, we can have a unified unique cross-border assessment of the environmental quality conditions of the sea and coastal areas connected to marinas and nautical ports.

The development of an easily accessible database for Italian and Croatian stakeholders is possible thanks to a shared cross-border method of data collection, cataloging, harmonization and management systems among partners, providing one of the fundamental project goals. With ArcGIS software, a common physical model of Geodatabase was set up, in which we are adding available spatial and non-spatial data. The dataset of the ECOMAP project is consisting of structured (e.g. tables, ASCII files, geodata) and unstructured (documents) data. Bibliographic and collected data are georeferenced in GIS-formats as raster, vector and table data. Moreover, to harmonize the data obtained by Italian and Croatian partners, a single reference system with metric coordinates (to reduce conversion errors) was chosen: WGS84 / UTM zone 33N EPSG: 32633.

For the creation of the geographical database for the ECOMAP project, the GEODATABASE technology of ESRI ARCGIS in its “file geodatabase” version was used. It contains all the datasets coming from the delivery products of the research units. The datasets are organized into Feature Classes (single geometry vector datasets) divided into containers, the “Feature Datasets”, one for each research unit, while the datasets in raster format are stored within the “Raster datasets”.

The ECOMAP Geodatabase is organized in:

- Features dataset (vector data);

- Raster datasets (raster data);
- Tabular data, that cannot be georeferenced, is added to the database as table files;
- Text files, (i.e. the methodologies used adopted), and images collected are added as a hyperlink in a text or table file;
- Bibliographic data (used for data processing) is added as vectors, raster, or tabular format.

The ECOMAP geodatabase model includes features and raster datasets divided by study site (Ancona, Bibione, Split and Podstrana), and the information obtained from the different test sites are grouped. By subdividing the dataset according to the test site, the visualization and interpretation will be facilitated. Detailed assessment of the environmental conditions of the individual test sites will significantly contribute to the implementation of cross-border methods and protocols shared between Italian and Croatian partners. Furthermore, with the creation of a WebMap, all the documents carried out with elaboration of the bibliographic data and the data collected during the project activities will be available to the Italian and Croatian stakeholders, totally free of charge.

In conclusion, the literature data, the thematic maps and the data collected for the project were included in the shared database to identify the criticalities, natural and/or anthropogenic, and to provide mitigation solutions in the Italian and Croatian ports areas using unique methods of cross-border analysis and protocols.

Recommended website:

<https://desktop.arcgis.com/en/arcmap/latest/manage-data/databases/databases-and-arcgis.htm>

Keywords: shared geodatabase, ESRI model, coastal area, nautical harbor

Cross border cooperation in sustainable multimodal mobility, from policies to practices: the Crossmoby experience in North-Adriatic Regions

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The goal of this study is to analyse and assess how and in which ways the Crossmoby project (2018-2021) implemented in practices some specific EU transport policies perspectives in its own cross-border Programme area, thus addressing relevant transport needs emerging from Italian and Slovenian cross border regions. At the same time, it illustrates how the project has linked its peculiar methodological approach with the implementation of a wide range of activities and pilots, merging passengers' multimodal solutions, data collection and integration process leading to online repositories for data sharing along with user-friendly webGIS interfaces for supporting an effective information provision to discussion panels for stakeholders' involvement. All of these measures are aimed at enhancing territorial cohesion through the exploitation of multilevel governance and shared visions at cross border level. The overall project framework reflects - and to some extent anticipates - a sectoral policy trend (also found in the specialist literature), starting with the main documents produced by the European Commission. In fact, considering the ten years passed between the Transport White Paper [COM(2011)144final] and the new Sustainable and Smart Mobility Strategy [COM(2020)789final], a change, or perhaps an evolution, has occurred in the prominence given to the issue of cross border connections. While the first strategy assumes the cross-border transport issue as one of the missing links to be tackled by the Trans-European Network (TEN-T), the new 2020 core document describes the cross-border dimension as a fundamental issue recurring in the majority of the transport flagships of this new EU strategy. As a consequence, in recent years the cross-border transport dimension has turned into a key element to be addressed both in terms of physical (e.g. cross-border rail services and automated vehicles, car rental, multimodal solutions, charging and refueling systems) and intangible (e.g. seamless cross-border payments and ticketing) infrastructures and services. It also implies the harmonization of administrative processes and transport management (e.g. harmonized vehicle type approval at EU level, cross-border coordination and cooperation between transport operators and railway infrastructure managers, updating of technical specifications for interoperability - TSIs, joint and cross

-border procurement). This new perspective is combined also with re-thinking mobility as “fair and just for all” (see Flagship 9), addressing all territorial dimensions (“rural, peripheral and remote areas, including the outermost regions and islands”) and shifting the urban & regional mobility from a city-centric vision to a more comprehensive one. In fact, in many cases - due to the existence of geo-morphological barriers as well as consequences of the historical backgrounds - cross-border areas include rural and peripheral contexts. Concerning transport literature, the number of relevant works on cross-border cooperation and policies has increased significantly in the period between the two EC strategic documents mentioned above. Research areas and methodological approaches have broadened, often in an interdisciplinary way. Under these premises, the implementation processes, and the related theoretical framework of the Crossmoby Project, allow for a comparative analysis in the field. At the same time, the project intends to examine in detail the results emerging from a blended approach of data-driven decision making, sustainable urban mobility planning, stakeholders’ cooperation and participatory processes, through an in-depth review of a wide range of multimodal pilot actions. Moreover, the territorial heterogeneity of the Italian-Slovenian border also enables to analyse series of pilots implemented in different territorial dimensions, considering the concept of “mobility for all” declined in the new European strategy. Finally, it is to emphasize the opportunity given by the project of synergically addressing and revise the peculiarities of different transport modes and mobility needs. The methodology of this project review and assessment will be based on a comparative analysis of EU cross-border transport policies (of the last decade) and implemented practices (Crossmoby as a significant case study). The result will consist of the elaboration of a set of indicators aiming at defining a reference framework for the implementation of cross-border policies and practices. Such indicators are conceived to a) assess the complexity levels of different planning, implementation, management and monitoring steps; b) identify the major gaps and mismatches emerged between policymaking and policy; implementation: c) classify obstacles and drivers identified in reaching out and involving stakeholders; d) provide local communities’ feedbacks and perceptions on pilot implementation/testing (before/during/after); e) analyse the objective/result balance of the different pilots according to the territorial level/size of application: urban, rural, peripheral, remote etc.; f) mapping a different kind of gaps that are hampering a full/smooth cross border accessibility and integration. In conclusion, the study will also explore potential methods/procedures to capitalize and adapt this reference framework to different cross-border territories.

Keywords: sustainable mobility, multimodal connection, multilevel governance, cross border planning & social inclusion, rural and peripheral areas

Blue skills for feeding jobs and boosting economic growth in the Mediterranean region

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In line with the EU skills agenda for sustainable competitiveness, social fairness and resilience and the EU strategy for Blue Growth, the National Institute of Oceanography and Applied Geophysics, in partnership with other partners from the public and private sectors (universities, research institutions, governmental bodies, industries), is promoting an articulated training path that aims at overcoming the existing “skill mismatch” in the Mediterranean region between education and training offer and the labour market needs. This programme has been evolving and a project has been submitted to national authority (ministry of university and research – MUR) and positively evaluated and approved. This BlueSkills project is being labelled by the Union for the Mediterranean to be considered one of the successful best practices to be included within the framework of the Med4Jobs initiative and often included in many initiatives: BlueMed, WesMed, EUSAIR, Dialogue 5+5.

The main goal is to create the conditions to promote joint, complementary and concrete actions to maximise the impact of investing in improving existing skills (upskilling) and training in new skills (reskilling) in the identified field throughout vocational education and training and bridge the gap between government-industry-academia in the Blue Economy sector through higher education and building strong skills partnerships in the Mediterranean region with particular focus on youth.

Specific goals are:

- promoting capacity building on Blue Economy sectors in the Euro-Mediterranean region and knowledge transfer among the Blue Economy stakeholders;
- boosting transferable skills and promoting employability for young professionals and researchers in the Mediterranean;
- raising awareness on ocean governance, climate change and sea-level rise, marine biodiversity and ecosystem functioning, sustainable Blue Economy and ecosystem-based management, maritime spatial

- planning (MSP), and all challenges and opportunities related to the marine and maritime sectors in the region; and
- strengthening regional cooperation and networks on Blue Growth in the Euro-Mediterranean region.

To reach these objectives, a tailored made method has been elaborated and it includes a training path which includes:

- a yearly summer school in collaboration with the Euro Mediterranean University addressed to young scientists and researchers (45-50 participants) coming from the Mediterranean countries;
- an advanced master's degree in sustainable Blue Growth jointly organised with the University of Trieste (25 students);
- access to research infrastructures and international mobility programme (10-12 fellowship grants per year);
- support of 2-3 scientists and researchers for conducting Ph.D. studies;
- alternation school-job through an internship for youngest (vocational and education training);
- public outreach and scientific communication to local communities.

The expected results include direct individual beneficiaries (young scientists, researchers and Ph.D. students; project managers, economists, engineers or other professionals; policymakers, administrators) and young individuals and children in the range of 120-140 direct beneficiaries per year, or 600-700 for the five-year project.

In conclusion, youth unemployment is on the rise in the Mediterranean Basin. According to the Union for the Mediterranean (UfM), "almost 60% of the regional population, is today under the age of 30, and the number of young people under the age of 15 is forecasted to increase over 18%. This represents an asset for the region, and therefore, a positive and action-oriented regional agenda on youth employability is indispensable to unleash the region's human and economic potential capital. As requisite for peace and stability in the region, priority actions must be built on promoting competitiveness and enhancing job opportunities, in particular for youth".

The BlueSkills project promotes opportunities for "Blue" marine and maritime careers by developing skills, exchanging knowledge and valorising research for a more sustainable Mediterranean Sea. It aims at developing new curricula and increasing employability in the marine and maritime sectors. By supporting the Euro-Mediterranean communities of the Blue Economy stakeholders through higher education, research and innovation, the project will enhance the shared knowledge of the Mediterranean region. Besides developing skills and building

capacities, the project aims at enhancing the geopolitical dialogue in the Western Mediterranean region through increased international scientific cooperation and Science Diplomacy.

Keywords: BlueSkills project, Blue Economy, Euro-Mediterranean region, blue marine and maritime career

Challenges faced by the early-career marine scientists and conservationists

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The role of marine ecosystems and economy, and the need to make these governed and accessible in an equitable manner, become always more important and recognised. To ensure a sustainable, fair and diverse ocean governance, we need to understand the challenges faced by future ocean scientists and conservationists. To do this, we looked at the two big barriers to entering these professions: accessibility of the entry-level positions and direct challenges, such as economic strain and mistreatment at work. We conducted a worldwide review of the marine biology and conservation job market over three random months in 2019 and 2020. We focused on the geographic distribution of the available full-time entry-level and early career positions, expected qualifications, as well as the proportion of paid vs unpaid work offers. Additionally, we conducted an online survey to understand the experiences of marine biologists and conservationists on their first career stages. In particular, we focused on the expenses on education and unpaid work, as well as abuse experienced at the place of work and study.

Our job market review showed an extremely uneven work distribution, with most positions being offered in North America and Europe. Unpaid and pay-to-work positions were offered more commonly than paid jobs, mostly in economically privileged areas. A major part of such positions requested some and in a few cases strong experience and education background, as well as multiple professional certifications. Unpaid work offers came mostly from private companies and non-governmental organisations, often in breach of local labour protection laws. Additionally, organisations offering uncompensated work seemed to produce less scientific output than those paying for work.

The online survey was shared widely via professional social networks and answered anonymously by 492 early-career ocean professionals. While most of the respondents were highly educated and experienced, 56.10% were not currently employed in a paid job relevant to marine sciences. Over 75% of the respondents did not have access to free education, and their expenses on professional qualifications often reached hundreds of thousands of dollars. Only 56% of the respondents never paid for the possibility to work, and many reported years of uncompensated labour. Such unpaid work rarely translated into the opportunity to

publish or present at conferences, and in nearly half of the cases did not provide even a professional reference. While most respondents felt that they gained relevant work experience and important skills from unpaid work, there was an alarming proportion of people reporting mental health issues, from burn-out to suicidal thoughts, caused or worsened by work in marine biology and conservation. Most respondents reported direct mistreatment at work and discrimination based on at least one factor, most notably gender, age, and country of origin. Only about 15% of the respondents were fully satisfied with their career choice, and roughly one-third felt that pursuing a career in marine science and conservation was worth its costs.

We show an unacceptable state of the entry-level and early-career job market in marine science and conservation. The current state of things is excluding people of less privileged economic background, as well as women, non-binary persons, people of colour, and non-Westerners. These results are alarming, but can hopefully serve as a guide on the way for a better, more equitable and accessible future.

Keywords: job market, work distribution, marine science, early-career marine scientist and conservationist, online survey

Mental health of future seafarers: The role of personal values and subjective well-being

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Seafaring is a very demanding, challenging and specific profession, which has a crucial role in the international merchandise trade. Globalization has led to the constant development of new technologies in the fourth industrial revolution, and management primarily aimed at turning a profit. Consequently, work requirements that had already been high in seafaring have additionally increased. Due to extremely difficult working conditions, seafarers might experience higher levels of anxiety and anger, frustrations, chronic responsibility syndrome as well as burnout. This highlights the importance of studying mental health among seafarers. According to World Health Organization, mental health is defined as a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community. Previous findings in the general population suggest that personal values, which are relatively stable and serve as a motivational basis for goals might be potentially important for the well-being and mental health of future seafarers. Furthermore, it is claimed that some personal values in adolescence are associated with mental health and subjective well-being in adulthood. Considering that studying the relationship between mental health, personal values and subjective well-being of future seafarers represents a research gap, the main aim of this study was to examine the individual contributions of personal values and different aspects of subjective well-being in the explanation of future seafarers' mental health.

The sample involved 239 future seafarers who participated in three different study courses (Marine Engineering, Maritime Yacht and Marina Technologies and Transport, Nautical Studies and Maritime Transport Technology) in four Croatian maritime faculties. The measures included a sociodemographic questionnaire, Personal Values Questionnaire (PVQ-21), Satisfaction with Life Scale (SWLS), Scale of Positive and Negative Experience (SPANE) and Mental Health Inventory (MHI-5). The results of hierarchical regression analysis indicate that three primary components of subjective well-being significantly contribute to the explanation of mental health. Namely, participants who are more satisfied with life, have more positive experiences and less negative experiences have better mental health. Although three higher-order personal values were positively correlated with

mental health at the bivariate level they do not have a significant role in the explanation of mental health. Moreover, one-way ANOVAs were conducted to examine the differences in observed variables between students of different study courses. A higher grade point average (GPA) was achieved by students enrolled in Maritime Yacht and Marina Technologies than Marine Engineering students. Considering ten personal values in Schwartz's theory, significant differences between different students of different courses were only found for conformity; this personal value is more important to students of Nautical Studies and Maritime Transport Technology than students who are enrolled in Maritime Yacht and Marina Technologies.

Students of Nautical Studies and Maritime Transport Technology reported having less positive experiences than Marine Engineering students. Practical implications and theoretical contributions are discussed.

Keywords: future seafarer, mental health, subjective well-being, personal values, Schwartz's theory of basic values

Communicating, informing, and educating on circular economy principles

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In recent years, the topic of a sustainable economy and social responsibility has become increasingly important in the current historical context, evaluating and undertaking several pathways that include also the concept of circular economy, introduced by environmental economists David Pearce and R. Kerry Turner in 1990. A circular economy refers to a model of production and consumption that involves sharing, lending, reusing, repairing, reconditioning, and recycling existing materials and products for as long as possible. This helps to reduce waste to a minimum: once the product has completed its function, the materials from which it is made are reintroduced into the economic cycle whenever possible, generating additional value. Indeed, the circular economic model can be summarized in four main basic principles: minimize waste through an eco-design considering the reuse; the use of a renewable source of energy and materials; optimization of the production system; maximization of the usage value of products. However, the application of good practices of the circular economy requires a systematic transition from the current linear economic model starting from the way in which products and services are designed, produced, and sold. For this reason, implementing awareness among producers and consumers can induce behavioural changes. Since the tourism sector is the 3rd largest socio-economic activity in the EU, it is able to produce economic benefits as well as negative impacts on the environment, which emphasizes the necessity for tourism to be monitored, planned and managed in the direction of sustainability.

Regarding beaches and port areas, sustainable tourism requires optimization of resources and the right actions of environmental behaviour that can lead to the formulation of an eco-marine. Maritime tourism, which includes tourists, leisure and recreation activities, and the hospitality sector has serious consequences on the environment since coasts and seas are among the most vulnerable and

sensitive natural ecosystems. However, the negative pressures on coastal and marine areas can be avoided or mitigated through green technologies and good environmental management practices such as the use of renewable energy providing energy autonomy for boats and port services and the adaptation of ecolabel programmes like the Blue Flag. The Blue Flag programme meets circular economy principles through the application of best practices for sustainable development. Indeed, the eco-labels evaluation criteria include several aspects dealing with water quality, environmental education, safety and services at the beach, and environmental management which encourage to conquer ocean and coastline pollution. In this regard, great attention is paid to the use of recyclable materials, and waste management.

In the framework of the ECOMAP project, good practices promoted by the EU has been taken into account and they became part of the main objectives and actions of the project, together with the circular economy principles. The actions carried out within ECOMAP are addressed to a wide and varied public of stakeholders, both in terms of age and specialization. The activities, in fact, aim to reinforce the processes of lifelong learning concerning the sustainable development of marine and port environments, and the environmental issues connected to it. This objective is pursued through the exchange and the transferring of good practices and knowledge for the sustainable management of marine and tourist ports within the field of Blue economy. In particular, project results and outputs are disseminated through communication and educational events addressed to a varied group of stakeholders, including professionals, experts, organizations, associations, the general public and young adults, among others. Through its participation in international congresses and fairs, the ECOMAP project aims to: disseminate information about the project itself and its main achievements; to inform the public, especially local marinas, beach users and inhabitants about the importance of project implementation in order to introduce sustainable technologies in marinas and beaches; finally, to raise awareness and educate stakeholders in port management, nautical and related services. Moreover, carrying out educational activities such as the organisation of alternate school-work programmes and laboratory activities concerning the Blue Flag, ECOMAP project aims to raise awareness also among young people, about the environmental issues connected with the development of marine and tourist ports. Therefore, the educational activities organised in the framework of the project are intended to link the concepts of tourism, leisure, and development with the concept of sustainability, which dwells in the circular economy theory.

Keywords: circular economy principles, tourism, sustainability, port area

Environmental competitiveness: An extension to the balanced theory of port competitiveness

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The balanced theory of port competitiveness simultaneously considers customer competitiveness and investor competitiveness. However, growing environmental awareness of customers and pressure from regulatory authorities to reduce emissions from maritime transport is forcing port authorities to improve their environmental competitiveness. Thus, this study proposes an extended balanced theory of port competitiveness simultaneously considering three dimensions of port competitiveness — customer, investor and environmental competitiveness. The extended framework is also more in line with the definition of sustainability. Using the Best-Worst multi-criteria decision-making method, we show an implementation of the proposed framework through a case study of a major developing economy port. The proposed framework can be used as a port competitiveness evaluation tool worldwide and help port managers in strategic decision-making.

Keywords: balanced theory of port competitiveness; best-worst method; multi-criteria decision-making; sustainability

Specific features of security protection in the nautical marinas

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Nautical tourism ports are an important segment of the entire touristic and nautical offer and maritime infrastructure of the Republic of Croatia, and therefore must be adequately protected from possible security threats. The aim of this paper is, using scientific methods and expertise, to analyse and assess the security systems of nautical tourism ports of the Republic of Croatia, and to offer effective guidelines for raising the level of their overall security.

The security situation of each nautical tourism port was determined by a team of experienced security experts, using a specific methodology for port security assessments and plans, on a sample of 10 ports.

The general security shortcomings are the lack of a sufficient level of safety and security culture of employees of nautical tourism ports; lack of education of private security staff, where they are engaged; lack of adequate crisis response equipment; and the lack of protocols that prescribe specific actions and activities to prevent and eliminate the consequences related to security threats.

Due to their importance, nautical tourism ports need to be given the same security attention as well as to ports that are opened to international and domestic traffic. Accordingly, with the help of experienced security experts, it is necessary to assess, analyse, plan and implement adequate security systems and procedures in nautical tourism ports.

Keywords: nautical tourism port, security system, security procedure, Croatia

Shipping practices in emission-controlled areas of the Aegean Sea and the role of biofuels

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Emission-controlled areas are defined as “emission-protected sea areas on a global basis where emissions are strictly controlled by regulations” in accordance with Annexes I, II and V of MARPOL 73/78. Due to various biological and oceanographic characteristics, mandatory guidelines have been issued to ensure a significant reduction of marine pollution. Specifically, the International Maritime Organization (IMO), through the revised Annex VI of MARPOL, sets the permissible emission limits of fuels to a sulphur content less than 0.1% by weight from 2015 and down to less than 0.5% by weight from 2020. In addition, this regulatory framework specifies the NO_x emissions in accordance with the engine’s year of manufacturing. All of the above regulations, combined with rising fuel prices, have led ship owners to explore solutions to reduce NO_x and SO_x and reduce fuel consumption and CO₂ emissions. Various techniques have been developed to reduce NO_x, but they do not achieve the desirable 80% reduction levels that are required by law.

This study presents the most notable emission-controlled areas in the Aegean Sea and examines the utilization of biofuels as a means to achieve the ambitious emissions guidelines that are set by the new IMO. Several shipyards have presented plans for developing shipping vessels that operate with conventional and novel biofuels, in the framework of promoting environmentally-friendly (eco-friendly) practices. Combining the “green” label along with cost reduction, new “eco” ships are the future of shipbuilding as they become more attractive to charterers due to lower fuel consumption and the minimization of operating costs.

Keywords: biofuel, maritime transport, sulphur emission, shipping regulation, emission-controlled area

The effectiveness of mobility measures in Mediterranean coastal cities

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Mediterranean coastal cities experience relevant tourism pressure and sometimes see their population doubled or tripled for consecutive weeks during the summer season. This phenomenon raises a number of challenging issues, many of which are related to the transport sector, such as traffic and public transport congestion as well as atmospheric and acoustic pollution. Many EU-funded mobility-related projects have investigated peculiarities of coastal towns experiencing strong touristic pressure, and have tried to address open issues in the planning and strategical approach to tourism-related mobility.

Major mobility planning instruments for European cities, able to provide a strategic framework able to shape the vision of the mobility system and related investments for the forthcoming decades, have been found to often be unable of incorporating the needs and peculiarities of tourism-related mobility, thus missing to focus on the predominant externality-producing phenomenon and meeting the serious risk of pursuing ineffective if not counterproductive strategies.

This paper builds on the outcomes of the Mobilitas project, discussing the peculiarities and major issues of coastal tourism mobility, and further debates the potential contribution of measures in alleviating the negative impact of over-tourism from a comprehensive mobility perspective. Potential strategies for increasing the effectiveness at incorporating tourism-related mobility issues are discussed and the role of the different stakeholders is analyzed with relation to their possible contribution in creating a more successful and comprehensive plan, with particular reference to the role of local Universities within publicly funded mobility projects. Moreover, potentially effective strategies and measures to reduce tourism-mobility externalities, that could be included in Mediterranean coastal cities' SUMP, are discussed for the two case study cities of Rimini and Dubrovnik, which both participated in the Mobilitas project.

Preliminary results show that Universities have the potential for putting their know-how and resources in creating a fruitful dialogue among stakeholders, including those in the tourism sector, to generate more comprehensive plans, capable of addressing tourism-related mobility as well as ordinary work, study and leisure movements. Moreover, the analysis of solutions and strategies for addressing tourism-related mobility impacts shows that small-scale, punctual interventions

can effectively contribute to a diminishment of negative externalities. However, the development of structured strategies seems to be fundamental to ensure long-lasting benefits.

Keywords: tourism mobility, planning strategy, coastal city, Mediterranean

The impact of SARS-CoV-2 pandemic on individual mobility: a survey-based empirical investigation

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Key issue for unification and cohesion, transport represents a striking example of how the SARS-CoV-2 pandemic bears the potential of exerting long-lasting effects on behavioural patterns of citizens. As new variables such as social distancing assume unprecedented relevance and disrupt deeply rooted mobility habits, environmental arguments advocating the use of public transport over private vehicles might be at bitter odds with social aspects such as interpersonal distancing. Building on an analysis of the behavioural determinants of modal choice, our work investigates the effects of the pandemic on individual perceptions, as well as behavioral changes triggered.

While the SARS-CoV-2 pandemic has been hopefully a unique experience, its consequences might be non-contingent and deploy their effects in years to come. Further, the health emergency has shown the fragilities of the European cohesion process, whose hard-fought achievements risk to vanish overnight, in the wake of unexpected exogenous shocks: from the suspension of Schengen to the vaccination policy, nationalist thrusts are hindering international cooperation and solidarity, which represent two core values of the European Union. The question is, therefore, how resilient the progress made so far in terms of union and cohesion is. Paradoxically, the transversal aspect common to a *Europe of separate nations* is represented precisely by its citizens, with their shared needs, fears and desires which seemingly unite Europeans more than governments do: indeed, there is less difference between European citizens in their behaviours and perceptions than there is in the policies of their governments.

Despite numerous claims of active participation, so far unification and cohesion-building have been mainly a top-down process. However, it is never too late to start building the *next* European Union starting from its citizens: a bottom-up process of value unification having its roots in values and beliefs, building on institutional processes so that the overcoming of particularism is real and resilient to crises.

Transport, which is the core of our study, represents a key issue for unification and cohesion and represents a striking example of how the SARS-CoV-2 pandemic bears the potential of exerting long-lasting effects on behavioural patterns (and even value orientation) of European citizens. Mobility choices represent, *per se*, a complex and multi-faceted phenomenon that is the outcome of a process where

different interacting variables play a role. These variables range from attitudes and intentions (stemming from rational cognitive processes) to habits (automatic responses to familiar situations) or even to values and beliefs (considering, for instance, sustainability-oriented worldviews): in the framework of given contextual conditions and alternatives available, individuals typically have different options to choose from and make their decisions based on the salience of each of these antecedents.

The pandemic changed the scenario, with new variables such as social distancing assuming unprecedented relevance and entering the equation with a key role capable of disrupting deeply rooted habits and modifying individual perceptions and priorities when it comes to mobility, both concerning short-range daily commutes and to long-range, international and cross border trips.

On the one hand, it represented an unprecedented case of habit disruption, where commuters and travellers at large have been forced to change long-established habits, given travel restrictions and the need to reconsider mobility trajectories. Consistently with the Habit Discontinuity Hypothesis, the contingent situation also opened up so-called windows of opportunity for behavioural change, where individuals are forced to consider new alternatives of action. On the other hand, an aware elaboration of the pros and cons of different modal choices has been heavily affected by the previously mentioned need to take into consideration the consequences of social interaction, such as that typically entailed by public transportation systems.

New questions arise, as different pillars of sustainability that traditionally pointed to the same direction entail now a trade-off: environmental arguments advocating the use of public transport over private vehicles might be at bitter odds with social aspects such as distancing insofar the use of private cars, by limiting social interactions, could be effective in hindering the spreading of the virus.

But even once the pandemic is over, which will be its lasting effects on our perceptions, attitudes and actual behaviors? What could be done to restore public confidence in transport systems?

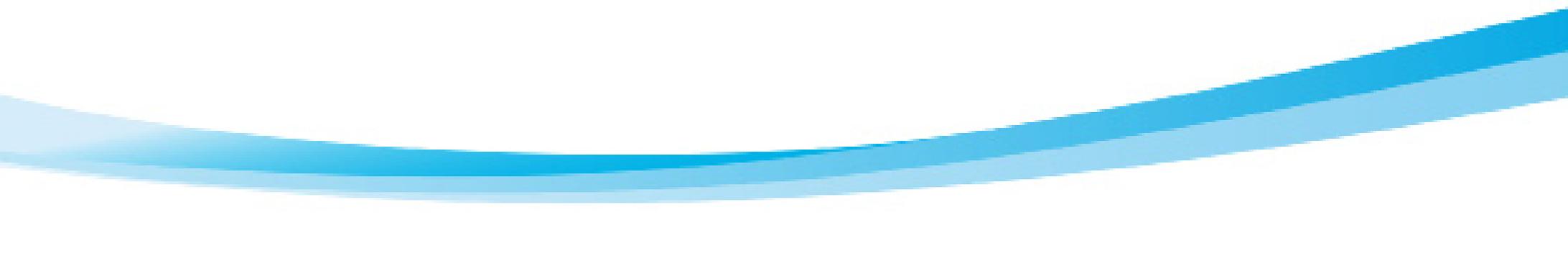
Our study is performed in the framework of the Interreg Italy-Croatia MIMOSA (Maritime and Multimodal Sustainable Passenger transport solutions and services) project and is based on a survey aimed at collecting data on mobility behaviors and antecedents, with a specific focus on the impacts of the SARS-CoV-2 pandemic. More in detail, we investigate i) the behavioural determinants of modal choice, building on the robust literature on individual behaviors in the domain of mobility (intentions, habits and values); ii) the effects of the pandemic on individual perceptions, like for instance safety perceptions concerning different modal alternatives; iii) the behavioral changes triggered, which are affected by the change in perceptions but hindered by situational constraints such as the availability of viable alternatives. Further, a specific section of the survey is dedicated to the role

that social distancing (along with more traditional attributes of public transport such as punctuality or comfort) plays in orienting the behaviors of travelers.

Preliminary results confirm speculations about the role that social distancing is likely to play in the (near) future, heavily affecting individual perceptions and shaping new attitudes. The attitude-behavior gap, connected to the lack of alternatives preventing travelers from shifting transport mode, mitigates to some extent the effects of such changes. What emerges is that operators in the mobility sector are bound to face a new scenario. Since playing by the old rules of the game would lead to misconceptions about the behavioral drivers of demand (and consequently to ineffective public policies in the field of transport and mobility), gaining better understandings of individual perceptions and attitudes represents a *conditio sine qua non* to drive a smooth transition to more sustainable mobility paradigms, increasing at once cohesion within the European Union.

Keywords: habit discontinuity hypothesis; modal choice determinants; SARS-CoV-2

INTERREG PROJECTS



Blueprint, a local strategy for the circular economy

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Goal

Interreg Blueprint aims is to create a strategic framework that enables local authorities and communities to accelerate the transition to a Social and Circular Economy in line with the sustainable development goals of the UN and the EU social and circular economy action plans.

About the Blueprint project

Blueprint is a €5.5 Million Interreg EU France Channel England (FCE) project, focussed on embedding circular economy practices within social enterprises (SE's). The project also aims to contribute to the development of a more sustainable society in the France Channel England Regions, using cluster entrepreneurship of SE's enabled by the Blueprint framework.

Additionally, by Local Authorities supported by academic institutions, Blueprint is able to foster local government support for social enterprises and to reach to individual households and the community in order to engage them with more sustainable practices.

Rationale for the Blueprint Project

Our society is heavily reliant on mass production and frivolous consumption, these industrial practices and social norms place a heavy toll on finite resources and on the environment. The development of the circular economy is a key opportunity to disrupt this current unsustainable trajectory, as well as to capitalise on new technologies and innovations.

There is a rising demand from consumers for locally produced and more sustainable market offerings, alongside a rejuvenated appreciation for practical skills. This is a key driver for SE's as they can facilitate knowledge transfer in these skills which can lead to worker empowerment, job creation, as well as more fulfilled and a more skilled potential employee base for businesses who are seeking sustainable growth. It is also an opportunity for local authorities who are seeking sustainable growth and for them to tackle unemployment and benefit from efficient recycling, reverse logistics and secondary markets.

Methods

The project aims to engage social enterprises, while working alongside local and regional governments across the UK and France, through a series of qualitative, semi-structured interviews that aim to identify their main challenges and barriers to transitioning to a circular economy. These interviews and focus groups will be undertaken by academic institutions across both France and England: Anglia Ruskin University (ARU), Université de Picardie Jules Verne (PJV), UnilaSalle, ESITC and NEOMA Business School).

Expected Results

A major project outcome, derived from interviews and engagements with SE and LA partners, is an innovative social enterprise circular economy accelerator (Blueprint framework) which will widen participation of disadvantaged people in local solutions. This will build on the project goals of supporting sustainable, innovative, and ethical business that engages with communities, supports social justice, and builds social value whilst improving value for money with LA partners. Ultimately the Blueprint framework seeks to aid those seeking to benefit from the vast opportunities the transition to circular economy brings.

Keywords: Circular Economy, Social Enterprise, Sustainability, Entrepreneurship, Policy Making, Careers

Climate change and the adriatic sea ecosystem

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Goal

The purpose of this presentation is to show the consequences of climate changes which occurred so far in the Adriatic Sea ecosystem and point out to changes of climate and their consequences that can be expected in a near future. While further investigations about consequences of climate for the ecosystem are necessary, the results of this kind of meetings are also important and should be spread to all levels of society. Any future campaign for reducing ecological footprint in order to succeed, needs informed and prepared society. So, raising awareness among all categories of people, specialists, and general public including young ones, about potential danger from climate changes is of utmost importance.

Methods and materials

Reviewed is a wide range of scientific literature about the impact of climate changes to the Adriatic Sea. Selected are significant examples that show how small changes of some physical parameters can cause a number of consequences in a fragile marine ecosystem. Influences from the Mediterranean waters are also discussed. IPCC reports and prospects are used to discuss future changes in oceanographic and meteorological parameters with consequences to ecosystem within the Adriatic region and wider.

Results

Sea level rise due to ice melt, although for the moment unnoticed by ordinary people, will affect coastal population worldwide. Some parts of the Croatian Adriatic coast will be particularly influenced, like the Neretva River delta. The influence will vary for different parts of the coast, combined with changes in wind and wave dynamics.

Temperature increase will influence distribution among species, and most probably cause prevalence of some species on account of others, although definite answers are not yet known. Changes in salinity and temperature may cause stress to sensitive marine species who typically are not eurythermal neither eurihaline. Well known fact is that migratory behaviour of fish is governed by temperature, and the Adriatic Sea in the future may become a suitable niche for some subtropical species. Mass appearance of medusae in the Adriatic Sea coincided with positive

temperature anomalies. Abundance of several plankton species are under direct influence of warmer Mediterranean inflow into the Adriatic.

Many alien species of fish, plankton etc. are already present in the Adriatic Sea. Some alien (and invasive) species already established their population in the Levantine basin and their appearance in the Adriatic Sea under changed climate conditions are highly probable. Decrease of storminess and particularly decrease of strength and frequency of Bora wind in the Adriatic will diminish water mixing. This will have huge impact in slowing down overall Adriatic circulation with the consequences on reduced water exchange with the Mediterranean. Lower mixing will also cause lower oxygen content of Adriatic waters. Replenishment of nutrients may also be endangered.

All these changes together may have devastating influence to marine living resources and consequently to several vital economy branches like fisheries and aquaculture and further to fish food supply and tourism, crucial industry branch in Croatia.

Conclusions

Although complexity of Adriatic ecosystem and interconnections between different ecosystems parts are generally known, impact of alien species under conditions of climate changes need further investigation. Also, consequences in the ecosystem within each of the climate scenarios are not satisfactorily assessed for the Adriatic Sea. It is crucial to maintain marine ecosystem monitoring and invest more in this research.

In order to minimize economic damage it is urgent to develop deeper knowledge about consequences of climate changes to fisheries and develop innovative methods for sustainable aquaculture.

The speed of climate changes is not confirmed and 4°C temperature increase may seem far away, but drastic social consequences that these changes will cause require change of our mental paradigm towards working together for the ecosystem preservation to assure our survival.

Keywords: air temperature and precipitation changes, sea level rise, sea temperature and salinity trends, promote sustainable living

ITACA - Innovative Tools to increAse Competitiveness and sustainability of small pelagic Fisheries

ITACA tackles the competitiveness of Adriatic fisheries sector, fostering the introduction of blue innovation and improving the sustainability of catch activities. ITACA focuses on small pelagic (SP) fisheries, meaning the fishing activities targeted on two main ichthyic species: anchovy and sardine that represent a significant share of income for the sector in the Adriatic. Despite the importance of SP fisheries in quantitative terms, the Adriatic SP fisheries SMEs suffers from structural threats that prevent their competitiveness, laying mainly in the scarce capacity of the same enterprises of planning their activities. Indeed, due to the incertitude in the resource's availability and in the market request, SP fishermen are led to increase the level of catches, generating, on one hand, possible surplus in SP fish landings, that finally causes a decrease of selling price and a decrease of SMEs income and, on the other, overexploitation of stocks. Therefore, there is a need to increase the business capacities of SP fisheries SMEs, by providing the enterprises with tools and mechanisms allowing to match the fishing effort with market needs, ensuring therefore the maintenance of the proper producer price of SP fish in the market, to finally protect the SMEs income, and at the same time preserving the SP stocks from overexploitation. In this scenario, ITACA project, thanks to a tight cross-border cooperation among research bodies and representative of SP fisheries SMEs, contributes factually to the growth of the SP fisheries sector setting up (WP3), testing in 7 pilot regions (WP4) and fostering the large scale application (WP5) of innovative SMEs oriented tools to increase the competitiveness of SP fisheries, together with establishing a SP fisheries enterprises cluster for a co-management of Adriatic ichthyic resources oriented to sustainability. To this aim, ITACA adopts a multilevel approach based on the principles: 1.all project outputs are developed according to a scientific advice; 2. all project activities are addressed and developed with the strong involvement of SP fisheries operators; 3. innovation and knowledge transfer are guiding principle, favouring the dialogue between SMEs and scientific actors. Approach reflects also in the partnership composition, by involving business support actors. By achieving the foreseen outputs (i.e. the SMEs oriented tools and the SMEs cluster), ITACA leads to a competitive advantage and a boosted competitiveness of the Adriatic SP fisheries enterprises in the international scenario, while ensuring improved environmental sustainability of SP fish practices, thanks to the adoption of co-management of SP stocks by enterprises participating in the project, contributing lastly to apply in pioneer way the recent provisions of the EU in matter of shared governance of SP resources in the whole Adriatic basin(COM(2017)97). ITACA

tackles the competitiveness of Adriatic fisheries sector, fostering the introduction of blue innovation and improving the sustainability of catch activities. The project focuses on small pelagic (SP) fisheries, meaning the fishing activities targeted on two main ichthyic species: anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*). As outlined in the IT-HR CP, fisheries represent one of economic pillar in coastal economies in terms of employment and associated economic chains and the SP fisheries represent a significant share of income for the sector in the Adriatic, being estimated at € 74 million in 2013, i.e., the 18% of total fishing catches. In this scenario, anchovy and sardine drive fishing activities, accounting for over 97% of catches of SP fish in the Adriatic, where the vast majority are caught by IT and HR fishing fleets (only small fraction of catches are made by other States - based on EU Commission data). Despite the importance of SP fisheries in quantitative terms, its value to its producers

is low and highlights the need to implement appropriate measures to optimize the value of the catch right from the beginning of supply chain. Indeed, Adriatic SP fisheries enterprises, usually small and with high labour and raw material costs, are threatened by structural factors that prevent their competitiveness. In particular, they do not have complete control over the quantities they catch and have to schedule on a day-to-day basis, according to presence of fish stocks as well as their size. Also, SP fisheries SMEs do not have any guarantee in advance on the capacity of the market to absorb the SP fish landings, nor on the profitability of selling price, and therefore SMEs currently lack on planning capability neither on a short or long terms perspective. Incertitude on the market response leads SP fishermen to increase the level of catches, generating, on one hand, possible surplus in SP fish landings (that finally causes a decrease of selling price) and, on the other, overexploitation of stocks. SP fisheries, among the others, have one of the most interesting potential in terms of coordinated cross-border intervention, due to several factors. Firstly, the SP stocks are a unique resource (in terms of common stocks), spread in the whole Adriatic basin and their fisheries are practiced in all the Adriatic regions, by a large number of fisheries enterprises, nevertheless adopting different catch systems and different enterprise business models. Even if the resources are common, SP stocks migrate according to their stages of growth (juveniles and adults live in different areas of Adriatic Sea) and according to seasons, generating periodical local advantages in catches that however negatively affect other fishing areas. Also, different catch systems and business models, being generally scarce the clustering of SP enterprises (especially in HR), generates disparities in the market positioning of the SP fisheries enterprises (familiar managed SMEs coexist with structured organisation of producers - O.P. - merging several single enterprises) that raise down the commercial power of the overall production segment in relation to buyers. In addition, SP fisheries in the Adriatic Sea have been until today governed by several legal frameworks, at regional, national, EU and international level, all based primarily on limitation of fishing

effort and capacity, coupled with several additional measures such as spatio-temporal closures and minimum landing sizes of catches. However, the exact measures vary both geographically (between the Member States and in international waters) and have also been changed several times in recent years, bringing an always stricter regulation of SP catches. Having a single stock managed under different rules in different parts of its range is also less effective (the most recent scientific advice indicates indeed that SP in the Adriatic Sea are still being overexploited, although the strict regulations). There is a need, therefore, not only of a coordinated intervention at policy level for a shared governance (to this purpose the EU Commission recently adopts a common multiannual management plan for the SP stock in the whole Adriatic basin (COM(2017) 97), but also of the setting up of common tools for the co-management of the SP stocks at CB level, such as those developed by ITACA project, able to both raise up the competitiveness in the market of Adriatic SP fisheries enterprise and ensure sustainability in fishing activities.

Keywords: small pelagic fisheries, Adriatic Sea, cross border cooperation, innovative tools in fisheries

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