8th EUROLAG

EUROPEAN COASTAL LAGOONS SYMPOSIUM

BOOK OF ABSTRACTS

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Coastal lagoons evolution, Functioning & Climatic changes

KEYNOTE LECTURE

Prof. BJÖRN KJERFVE

COASTAL LAGOONS: A GLOBAL COMPARISON

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OUTLOOK TO THE FUTURE: WILL THE CLIMATIC CHANGES ALTER THE TROPHIC STATE AND FISHERY OF THE BALTIC COASTAL LAGOON?

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Presentation type: ORAL

The ecosystem of Curonian lagoon, the largest coastal lagoon is known to be highly eutrophic and experiencing heavy cyanobacteria blooms. However, the development of the cyanobacteria is largely controlled by the ambient physical factors such as riverine discharges, wind induced intrusions of marine water and the ambient temperature itself. We did find indications that seasonal dynamic of the water renewal time could be used as good indicator for the possibility of cyanobacteria bloom development as well a temporal patterns in summer temperatures. We did run the SHYFEM model to reproduce the hydraulic circulation of the Curonian lagoon including the spatial structure of the renewal time for years 2004-2016 to produce statistical evidence of the relationship between the hydrological and climatic characteristics as riverine loads, ambient temperature, renewal time and monitoring data of chlA concentrations during the same period. The same hydrological and climatic parameters including the water levels were used to predict the catches, CPUE and mortality of the most important commercial fish species (see presentations of Ivanauskas et. al) using BBN during the same period.

Using the climate scenarios RCP4.5 and RCP8.5 data downscaled to the Lithuanian coast the SHYFEM model was run to represent the hydraulic circulation of the lagoon in the years 2030-2050 and derive the parameters that could be used to predict both ChlA levels and populations of commercial fish species. Our analysis revealed a clear trend towards the enhancement of cyanobacteria blooms in the future, while the effect on commercial fish population was expected to be more complex.

CLIMATE AND TECTONIC-DRIVEN SEDIMENTARY INFILL OF A LAGOON AS REVEALED BY HIGH RESOLUTION SEISMIC AND CORE DATA (THE NADOR LAGOON, NE MOROCCO)

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Lagoonal coastal systems are vulnerable environments in the present day context of global climate change. The study of their sedimentary infill is critical to understand marine and continental factors controlling their evolution, by this way evaluate their future behaviour, and make their management more efficient. In that context, Mediterranean lagoons are particularly exposed due to their social and economical values. The Nador lagoon, located along the Western Mediterranean coast, is the largest Moroccan lagoon. In order to study its sedimentary infill, very high-resolution seismic reflection data were acquired, providing for the first time an image of the architecture of the Holocene deposits. The combination between sediment core information and seismic data allows reconstructing the lagoon history of the last millennium. We demonstrate that the time between the 15th and 19th century has been a key period in the recent history. Sand bodies of marine origin dominated the sedimentary infill of the lagoon during that time. We propose that this stage of the Nador lagoon evolution and infilling is closely linked both to the local tectonic and Little Ice Age climatic contexts. These results are important to understand the mode of evolution of other comparable lagoons along microtidal coasts.

WATER LEVEL VARIATIONS IN A SYSTEM OF INTERCONNECTED NON-TIDAL COASTAL LAGOONS FROM DAILY TO CENTENNIAL TIME SCALE – THE VISTULA AND CURONIAN LAGOONS (BALTIC SEA)

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The fact that transboundary Curonian and Vistula lagoons are interconnected via Pregolya and Deyma rivers is very seldom tackled in publications. The main part of the Vistula Lagoon catchment is partly shared with the Curonian Lagoon. The main stream of the Pregolya River divides into two branches and brings about 60% of water to the Vistula Lagoon, while its branch the Deyma River draws about 40% of the water volume to the Curonian Lagoon. Therefore these lagoons and the Pregolya-Deyma rivers form a combined natural hydraulic system, in which the proportions of discharge of fresh water to both lagoons are regulated by water level in each of them.
We tried to distinguish an explicit transformation of global tendency in sea level rise upstream the water catchment cascade based on example of the system North Sea – Baltic Sea – Baltic lagoons, but failed. Only the common trend of the level's rise in the last 100 years and the overall intensification of this process from the 1970s were evident. The long-term evolution of the mean sea level in the Baltic lagoons cannot be explained only by the rise of the World Ocean's level or sea level's evolution in the adjacent Baltic Sea area or trends in NAO variations, but is likely caused by the variations of wind and precipitation, or local neotectonic movements.
The interannual variations in the annual mean sea level in both lagoons are high correlated (0.91–0.96), but the extreme values appear not at all synchronously. Both lagoons can be considered uniform from the point of view of the general tendencies in the interannual variability, but it is strongly non-uniform from the point of view of the extreme values' realization.
The study of extreme conditions at daily time scale showed that the upstream intrusion of water from the Vistula Lagoon may enters the Curonian Lagoon and vice versa. Moreover there are the situations when intrusions from both lagoons enter the Pregolya-Deyma rivers during hot summer that is in analogy to hypersaline Mediterranean lagoons.

Study was supported by theme FASO 0149-2018-0012 (centennial variations) and 18-55-7813 (daily variations).

THE ROLE OF THE BARRIER EFFICIENCY IN THE HOLOCENE SEDIMENTATION OF THE SANTO ANDRÉ LAGOON (SW PORTUGAL)

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The conceptual model of the Holocene evolution of the Santo André lagoon, located in SW coast of Portugal, is well known. An open marine shallow environment, corresponding to a wide gulf, formed during the early Holocene when sea-level (a global forcing factor) rose at high rates. Sea level rise deceleration took place ca. 6000 cal BP allowing the formation of a sandy barrier and transforming the lowland area in a coastal lagoon. Since then, sedimentation was essentially controlled by local forcing factors, among which the frequency of water and sediments exchanges between the lagoon and the ocean (endorsed by a tidal inlet) were the most important.
To understand how the efficiency of the sandy barrier (presence/absence of the inlet) controlled lagoonal sedimentation and its evolution, a 4.96m-long core (LSA4) was collected from the permanently flooded lagoonal domain. These sediments were studied using an environmental-sensitive multi-proxy framework (sedimentology, micropaleontology, chronology, elemental and isotopic analysis). LSA4 sediment core dates back to 6300 cal BP, and is composed of mud and muddy sands with different organic and carbonate contents, allowing the differentiation of five major stratigraphic units. A highly organic sedimentation occurred until c. 5000 cal BP, followed by the deposition of a carbonate mud (CaCO3 content reaching almost 75%) until c. 4900 cal BP (probably due to total isolation from the sea). After 4900 cal BP, two main periods (*c.* 4100-3900 and 2500-1100 cal BP) of low barrier efficiency were registered, with abundant marine calcareous nanoplankton as well as coarser and less organic sediments. In the last millennium, the sedimentation pattern remained constant, sediments consisting in muds, low in organic and carbonate contents. Artificial breaching of the barrier has been systematically undertaken since at least the 18th century, allowing for annual water exchanges between the lagoon and the ocean. However, this disturbance does not translate in coarser sedimentation as in the two earlier periods of lower barrier efficiency mentioned above. Two reasons can be pointed out for this: human-induced breaching of the sandy barrier following the winter season and the short period (few days to one month) of inlet activity.

COASTAL OBSERVATORIES OF GLOBAL CHANGE IN MEXICO: MONITORING OCEAN ACIDIFICATION

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Adaptation to the impacts of global and climate change requires long temporal series that allow the estimation of their effects on coastal ecosystems. The coastal observatories of global change in Mexico aim to offer a scientific platform of long-term physicochemical data and has produced over 6 million data since 2013. Ocean absorption of *circa*30% of the excess CO_2 emitted to the atmosphere reduces its global thermal impact, but it also causes ocean acidification, which may become the largest global climate change impact. However, little is yet known about acidification trends in coastal ecosystems, and even less in the tropical regions. In this on-going effort, we present the first pH data series from a coastal lagoon in the NE Pacific, at the continental entrance of the Gulf of California, and from a coral reef lagoon in the Mexican Caribbean, by using both sample analysis and sensor time series. Temporal variability and spatial gradients are discussed. We expect that this data will be useful to coastal zone managers and policy-makers to plan proper adaptation plans locally and globally. Future work requires the development of cheaper instruments, training of human resources and financial support to maintain this effort in the long-term.

Acknowledgements: This work has been partially funded by projects from CONACYT (PDCPN2013-01/214349, SEMARNAT-2016-01-278634 and CNR-C0013-2016-05-277942) and the IAEA Technical Cooperation (RLA7020 and INT7019).

SYSTEMS APPROACH FRAMEWORK (SAF); CASE STUDY VISTULA LAGOON, POLAND

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The Vistula Lagoon is located in the Baltic Sea and shared by Poland and Russia; 91 km long, 6.8 to 13 km wide and 2.7 m deep. It is separated from the Baltic Sea by the Vistula Spit. Economic decline after transition to market economy and isolation of the Polish part from the sea are the major problems. Economic recovery requires integrated management including multiple ecological, social and economic interactions. For this purpose the SAF framework was applied.

The issue for this case study (SAF step 1) was identified after consultations with local authorities, coastal and environmental managers, fishermen and tourist operators using the DPSIR and CATWOE frameworks to identify inter-connections among society, economy and environment and map the main stakeholder groups. This study revealed that the recovery of Lagoon's economy may be attained by construction of new and rehabilitation of existing harbors, marinas and navigational channels which will contribute to increase of tourism, shipping and fishing. In SAF step 2 inter-dependencies among activities and states, e.g. tourism vs. water quality, were identified. In step 3 toxicity of sediment samples were analyzed and the soil parameters were established for the modeling of silting-up of new and refurbished navigational channels. Silting up processes were modeled with the Delft3D suite. A special emphasis was laid on the modeling of siltation by cohesive sediments, whose litho-dynamic characteristics are much more complicated than ordinary sandy sediments. Mechanisms such as wave and current-driven sediment transport were modeled with the inclusion of sliding phenomena of submerged slopes of navigational channels, built of cohesive sediments with angle of repose close to zero.

The computed silting-up rates were then used in the cost-benefit analysis for the evaluation of channels maintenance cost vs. benefits from increased tourism, shipping and fishery thanks to the new navigation infrastructure. In the step 4 the modeling results were presented to main stakeholder groups to discuss the feasibility of the proposed measures (costs of erection and maintenance of the new infrastructure) vs. enhanced economic benefits. In step 5 the scenario accepted by the stakeholder panel will be recommended for implementation by coastal authorities.

THE OPERATIONAL MODELING OF AGE IN A TIDAL LAGOON FOR COASTAL ZONE MANAGEMENT

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Exchange capabilities between lagoons and the open sea are a fundamental process that contributes to the natural cleaning capacities of lagoons. Indicators of these exchange capacities are the flushing time, the residence or renewal time and the age. Whereas the flushing time is easily computed with basic parameters (volume and discharge), the other time scales need a numerical model to be applied for their estimation.
As it is computed, the renewal time provides an indication of the average exchange capability for a certain period or time span. Therefore, from simulation of several months of the tracer decay, it is meaningless to ask, what the residence time in a certain day was.
However, sometimes, for management reasons, it would be beneficial to have an indication of the actual state of the water masses inside the lagoon. One possibility to do this is the modeling of age. Here a Lagrangian model is used to models single water particles as they travel inside the lagoon. The water particles carry a property of age, which indicates for how long the parcel is already inside the lagoon. By averaging over a convenient area, the average water age of that area can be determined.
Once the model is in a quasi-equilibrium (after a time comparable to the mean renewal time of the basin), the particles provide a snapshot of the age of the water masses. The model can be run operationally even in forecast mode, allowing a prediction of age in the future. Simulations can be restarted at any time, inserting the information of the previous run and without any spin-up time.
The possible applications of this procedure are manifold. It gives the possibility to monitor the water masses on a daily basis, and one single number (average age of the basin) could be used as an indicator for the water status of the basin. In case of environmental problems (low oxygen crisis) and the possibility of interventions into the lagoon dynamics (e.g., the mobile barriers of the Venice Lagoon) interventions could be based on the value of age computed by the operational model.

MODEL DRIVEN DESIGN OF THE TIDE GAUGE MONITORING NETWORK IN THE VENICE LAGOON

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In this study the problem of the optimization of ocean monitoring networks is tackled throughout the implementation of numerical models. Oceanographic models are increasingly used in coastal systems to describe the circulation induced by tide, wind, freshwater and heat fluxes. They are also often used for predicting storm surge events for endangered areas. Numerical models, however, need observations to be calibrated and validated. Once the model is calibrated, new measurements can be used in a continuous validation of the model results. They can however also be assimilated into the model, increasing its capacity to represent the dynamics of the investigated system. One simple assimilation technique is nudging, where a new source term is added to the equations that drag the results toward the observed values.

In this study we show how the nudging technique can be implemented in a hydrodynamic model of the Venice Lagoon to optimize the tidal gauge monitoring network. A total of 29 tide gauge stations were available and the assimilation of the observations result in an improvement of the performance of the model that went from an initial RMS error of 5.7 cm to a final value of 1.2 cm. Once the procedure is implemented, by excluding just one tide gauge at a time, and always the station that contributes least to the improvement of the RMS error, a minimum number of tide gauges can be found that still allow for a successful description of the water level variability. In this way, if some of the tide gauges have to be decommissioned due to a lack of funding, an a-priori choice can be made and the importance of the single tide gauges can be evaluated. The developed procedure may also apply to the continuous monitoring of several ocean variables, like sea temperature and salinity in coastal seas.

MODELING THE IMPACT OF THE NEMUNAS RIVER WATERSHED ON THE NUTRIENT INPUT TO THE CURONIAN LAGOON

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Curonian Lagoon, the largest European coastal lagoon, is under severe nutrient input pressure. More than 90% of water and nutrient input to the Lagoon is provided by the Nemunas River. As the river watershed is shared between several countries, it is important to be able to identify the major contributing areas and point source inputs of nutrients.
To meet the set goal, a sophisticated model of the Nemunas River watershed was developed using Soil and Water Assessment Tool (SWAT), which is used to assess the contribution of the whole watershed in regards of runoff and nutrient input. Previously, several hydrological models (HBV, MIKE, etc.) were applied to the Nemunas River basin in different studies, assessing the impact of various stressors on the system. SWAT was also used by Lithuania's ministry of Environment in development of methodic and modelling system of nitrogen and phosphorus load calculation for surface waters of Lithuania. However, none of the previous studies covered the entire Nemunas River watershed in assessing sediment and nutrient load estimation with satisfactory confidence.
The model, which we have set-up, provides the possibility to assess the possible changes in the watershed due to various stressors, such as climate change, land use change and offers an opportunity to analyze the effectiveness of various nutrient reduction measures undertaken by riparian countries, which will have a direct effect on the eutrophication state of the Curonian Lagoon.

SEDIMENT TRANSPORT MECHANISMS IN THE CURONIAN LAGOON: NUMERICAL MODELING APPROACH

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The sediment transport in the Curonian Lagoon, a shallow lagoon with the average depth of 3.8 m, is still little explored. Most of the sediments are coming with the Nemunas waters, who's discharge per year exceeds the water volume of the lagoon itself by about 3.6 times. In the lagoon the main types of the sediments vary from medium sand, fine sand to coarse silt and fine silty mud.
To understand the sediment transport mechanisms in the Curonian Lagoon, a numerical modelling siute was applied. The SHYFEM modeling system was used to represent the Curonian Lagoon and coastal area of the Baltic Sea. The modeling system consists of a finite element 3-D hydrodynamic model, a transport and diffusion model and a radiation transfer model of heat at the water surface and other modules. For the sediment transport simulations the SEDTRANS05 module were used. This module can be used to simulate cohesive and non-cohesive sediment dynamics induced by wind waves and currents.
The sediment transport model was validated by comparing the simulation results against measured suspended sediment concentration data, which were collected in three stations inside the lagoon in 2015.The stations were chosen with the different hydrodynamic properties and sediment types. The validation gave satisfactory results.
Once validated, the model has been used to carry out short and long-term (10 years) simulations. The main aim of the study was to distinguish the erosion-accretion zones in the lagoon and to estimate the yearly sediment budget of the lagoon. We also investigate the role of the ice cover for the sediment transport mechanisms in the lagoon.

ECOLOGICAL MODELING OF RESTORING MEDITERRANEAN LAGOON: GLOBAL SENSITIVITY ANALYSIS AND MODEL BEHAVIOR

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Since the 1960s, Mediterranean lagoons have experienced nutrient over-enrichment due to nitrogen and phosphorus loadings from watersheds resulting in eutrophication of these semi-enclosed ecosystems. From early 2000s, public policies have been pursued aiming to reduce these external nutrient loadings. A numerical tool, based on the LOICZ methodology, is developed as an attempt to 1) reproduce ecological indicators and 2) bring quantitative responses to the determination of maximal acceptable N and P loadings compatible with the maintenance of good ecological state as requested by the EU water frame directive (WFD). GAMELAG is a simple physical box-model simulating water and nutrients fluxes at the interface of the lagoon coupled to key biogeochemical processes to evaluate matter fluxes between relevant biological compartments. If mathematical models have been largely used to understand ecosystems and to identify relevant management measures, the sensitivity of spatial and temporal scales used to model the system remains poorly studied. We hereby present a model exploration study using global sensitivity analysis (SA) to assess model behavior regarding to temporal scales of driving forces. Temporal scales of forcing affected model outputs and showed that depending on river regime, model was best forced when considering time scale of events for low/high water river regime. Permanent water fluxes, however, were sufficiently described with monthly average. Model produced indicators, as used in the EU WFD, with associated uncertainties. Finally, a tentative to simulate maximum allowable fluxes (MAF) to a lagoon revealed that both DIN and DIP MAF cannot be envisaged separately, hence, stoichiometry of loadings as well as stoichiometry of actual DIN and DIP concentrations in the lagoon shall be taken into account to better assess quantities that a lagoon may tolerate without threatening its ecological state.

INTO THE FLUSHING TIME OF BERRE LAGOON

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The flushing time plays a key role in the ecological functioning of aquatic systems. A measure of flushing time can be useful in determining the transport and fate of nutriments, contaminants and organisms. For example, the risk of eutrophication and deoxygenation of the water column is reduced if the nutriments and oxygen depleting substances are washed out quickly.
Berre Lagoon is a complex system of 155 Km^2 located at the south of France and connected to the Mediterranean Sea throughout a channel. Besides the natural inflows (two small rivers) it has the particularity of having a hydropower plant that discharges into it. In the present, the salinity of the lagoon varies approx. between 17 and 32 g/l. Hence, the lagoon remains stratified (halocline), except under the influence of the strong winds of Mistral that overturns the water column. In this study, the flushing time has been calculated as the turnover time for renewal water (with no distinction between freshwater inflows or marine inflows) with two different methods: Experimental and Modeling. On one hand, we have calculated the flushing time from real time measurements of freshwater discharge and the estimated marine fraction of water that enters into the system throughout the channel. On the other, we have calculated the flushing time from a 3D Hydrodynamic model (Telemac 3D) with the method of the continuous flow stirred-tank reactor (CSTR). The latest consist on initializing the model with a passive tracer and observe the exponential decay. Both methods agree well, what allows us to calculate the flushing time, its evolution, its spatial heterogeneity, the influence of the different forcing and event to infer the flushing time under different scenarios. Within the period 2006-2013, the global flushing time in Berre lagoon had a mean value of 150 days. In mean values of discharge, the flux with the Mediterranean Sea contributes with 42 m^3/s, the hydropower plant with 30 m^3/s and the rivers plus rain with 8 m^3/s. However, the observed variability of the flushing time, between 90 and 200 days, is mainly explained by the variability of the hydropower plant discharge.

NUMERICAL SIMULATION OF RESIDENCE TIME IN THE PAPPAS LAGOON, WESTERN GREECE

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Presentation type: ORAL

The Pappas lagoon is a relatively deep coastal lagoon, located at the northwestern coast of the Peloponnese, adjacent to the Gulf of Patras. The lagoon is subject to extensive aquaculture and is an ecosystem of economic importance. Within the last 35 years, 9 dystrophic crises have been reported, followed by mass fish mortality and benthic fauna; these occurred during the summer months of the years 1979, 1984, 1987, 1996, 1997 and 2004, 2010 and 2012. The last event begun between two inlets, where the waters would have been expected to be best oxygenated due to the tidal exchange flow. This finding clearly demonstrates that if the intricate mechanisms leading to these crises are to be explored, the residence time should be estimated in detail in the lagoon. To this end the hydrodynamic model MIKE 3 FM (HD) coupled with the transport model MIKE 3 FM (TR), DHI (2014), were applied. For the computation, the residence time was considered to be equal to the time needed for a dissolve matter to fall to $1/e$ (~ 37%) of its initial concentration. The simulations to calculate the residence time were carried out taking into account only the tidal action and assuming calm weather conditions, which is expected to be the worst case scenario for water renewal in the lagoon. The numerical results showed that the residence time in the water body is spatially varied. In the region located in front of inlets rapid mixing occurs and these areas have the shortest residence time (~ 5 days). The southern, somewhat isolated shallow region and also the deeper central-western region, which is relatively far from the inlets, seem to remain at a near stagnation state for significant time intervals, having a residence time of more than 40 days. The hydrodynamic gyres due to tidal action cause conservative tracer to be trapped between the two openings in the eastern side of the lagoon. Specifically, the results showed that between the second and the third opening the residence time is relatively height. This area seems to be isolated and nearly in a stagnation state, and the tracer initially distributed in this region was found to have a residence time of approximately 20 days.

CONSEQUENCES OF CONTAMINATION ON THE INTERACTIONS BETWEEN PHYTOPLANKTON AND BACTERIOPLANKTON IN LAGOON SYSTEMS

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In coastal seas and lagoons, sediment act as a sink for contaminants, however, this storage is not definitive, particulate-bound pollutants may be remobilized into the water column. This potential of remobilization for pollutants is a major problem for an anthropogenic ecosystem because even the anthropogenic source of pollution is identified and stopped; contaminated sediments represent a non-negligible pollution source that can severely affect the ecosystemic services.
Bacterioplankton and phytoplankton are the main players of the major matter cycles. They are involved in the production of organic matter (phytoplankton) as well as in the mineralization processes (bacterioplankton), either under anaerobic or aerobic conditions. Since they represent the first levels of the marine food web, it is imperative to understand their functioning and their interactions within the environment to gain a better understanding of the consequences of natural or anthropic perturbations for a defined ecosystem.
The goals of the present study were to determine the impact of sediment contamination on the structural diversity of phytoplankton and bacterioplankton and the consequences on the synchrony between both compartments. For that purpose, microcosm incubations were performed in triplicate for 96 hours, with lagoon and offshore waters incubated either with sediment elutriate or with an artificial mixture of contaminants issued from sediment resuspension. Sediment resuspension provoked a strong increase in microbial biomass, with little effects on the phytoplankton and bacterioplankton community structures. Among the pool of contaminants released, few were clearly identified as structuring factors of phytoplankton and bacterioplankton communities, namely simazine, Cu, Sn, Ni, and Cr. Effects were more pronounced in the offshore waters, suggesting a relative tolerance of the lagoon microbial communities to contamination. The impacts of contamination on the microbial community structure were direct or indirect, depending on the nature and the strength of the interactions between phytoplankton and bacterioplankton.

DIFFERENT PHASES IN THE PROCESS OF ARTIFICIAL EUTROPHICATION OF A COASTAL LAGOON (LAGOA IMBOASSICA, BRAZIL)

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Artificial eutrophication can cause regime changes in aquatic ecosystems, leading to different stable phases. Lagoa Imboassica is a coastal lagoon in Brazil that has been receiving sewage for decades. As a tool for the improvement of water quality the lagoon is subjected to artificial openings of the sandbar that separates it from the sea. To follow the eutrophication process and efficiency of management tools related some limnological variables related to trophic degree were monitored: phosphorus (PT, $\mu mol.L^{-1}$), nitrogen (NT,$\mu mol.L^{-1}$), chlorophyll (CL*a*, $\mu g.L^{-1}$), Secchi disk: total depth ratio (S:P) and the frequency and magnitude of sandbar openings (salinity and water level). Monthly values of the variables (1992 and 2016) represent an average of four regions of the lagoon. Principal Component Analysis explained 77% of the data variance and the ordering of the samples was more influenced by the concentrations of nutrients, phytoplankton and the S:P ratio. Samples from the 1990s presented low values of NT (47.41 ± 10.15), PT (0.98 ± 0.50) and CL*a* (9.58 ± 9.20) and high S:P (0, 72 ± 0.18) characterizing a clear water phase with submerged macroalgae dominance. Samples from 1999 to February 2001 presented high NT (165.97 ± 44.25), PT (2.06 ± 0.57), CL*a* (73.60 ± 42.81) and low S:P (0.43 ± 0.21), characterizing an increment in eutrophication and change in the dominance of the producers from macroalgae to phytoplankton. Between March 2001 and 2008 the concentration of nutrients and phytoplankton was lower and the S:P ratio increased less steeply (NT: 83.02 ± 27.65, PT: 2.05 ± 1.07, CL*a*: 20, 29 ± 17,10, S: P 0.58 ± 0.18) suggesting a system similar to the 1990s, but phytoplankton dominated. Between 2009 and 2016, the concentration of nutrients and phytoplankton was the highest (NT: 163.32 ± 74.34, PT: 4.27 ± 2.21, CL*a*: 82.85 ± 55.82) while the S:P was the lowest (0.24 ± 0.08). The results suggest that monitoring captured the dynamics of increment in the eutrophication process of Lagoa Imboassica. Management measures aimed at the export of nutrients led to different phases, but did not recover the initial conditions of clear waters and dominated by macroalgae.

USING WATER TRANSPARENCY AS WATER QUALITY INDICATOR IN A BALTIC COASTAL WATER

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Coastal waters are crucial suppliers of ecosystem goods and services but are at once threatened by eutrophication and a worsened water quality induced by high external nutrient loads. This process resulted often in a shift from macrophyte dominated system to phytoplankton-dominated systems and was often accompanied by a decline of water transparency.
Vice versa, taking the Secchi Depth as measure for the water transparency is a widely used and robust oceanographic method providing a simple quantity for the photic layer of natural waters. Secchi depth observations have been collected for more than a century in the Baltic Sea, what allows the use of water transparency thresholds as water quality indicator. These historical values represent the pre-industrial state and were used to validate newly calculated thresholds (with respect to Secchi Depth) that describe the Good Ecological State (GES), which were calculated with a tailor-made method for the German Baltic coastal waters. The integrated modelling approach combines present days observations with several ecosystem modelling systems to transfer the present situation to the reference state, which is used by EU's Water Framework Directive (WFD).
Acknowledging that high nutrient loads have caused a severe decline of water quality over the last century in most Baltic coastal waters, many measures have be undertaken to reduce the nutrient loads substantially. But due to the permanent internal cycling on previously induced nutrients to the coastal waters, the anticipated water quality improvement is mostly missing, e.g. Small Lagoon of Szczecin Lagoon is characterized by a Summer Secchi Depth of around 60 cm since the last 40 to 50 years. To achieve the targeted GES of the WFD seems therefore only possible if nutrient load reductions are combined with internal measures. Increasing the biomass of filter feeders by adapting mussel farming techniques could substantially increase the water transparency locally and help light-limited submerged macrophytes to reappear. They could vice versa reduce the resuspension of nutrients and particulate material, what would lead to a further improved water transparency.

HOW TO ASSESS NUTRIENT FLUXES FROM GROUNDWATER TO MEDITERRANEAN LAGOONS

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Several Mediterranean coastal lagoons have been highly eutrophicated for decades, despite management actions. Understanding interactions between lagoons and their catchment remains a key issue to implementing efficient water quality management in lagoon systems. Recently, coastal groundwater has been shown to have a significant influence on transitional waters in French Mediterranean lagoons, but their impacts on the hydrological and biogeochemical balance of the lagoons is yet to be fully understood. In our study, groundwater inputs to the eutrophic Or lagoon in the South of France were investigated.^{222}Radon and salinity were used as tracers to locate groundwater sources during high and low water periods. The majority of the groundwater input into the lagoon was found to occur in the downstream part of the watershed into streams, canals and adjacent wetlands, all of which subsequently discharge into the lagoon. The Salaison River is one of the main tributary of the Or lagoon. Nutrient concentrations are measured by a local water management institute (Agence de l'Eau Rhône Méditerranée Corse) on a bi-monthly basis at the gauging station located 3 km upstream from the outlet. This is a common strategy to limit downstream influences on stage/discharge relationship, mainly wind, tidal effects and atmospheric variations. This monitoring is then used to assess nutrient fluxes to the lagoon, without accounting for nutrients inputs from groundwater or nutrients consumption along the last part of the stream and the adjacent wetlands. However, groundwater inputs downstream of a watershed can be significant and nutrient fluxes that reach the lagoon could be underestimated. In the Salaison River, ^{222}Rn concentrations increase from the station down to the outlet, which confirms this assumption even though discharge nor nutrient associated with this additional groundwater input are known. To evaluate the accuracy of the measurement at the gauging station, transects of nutrients, ^{222}Radon concentrations and conductivity along the watercourse were recorded from source (aquifer) to sink (lagoon). The groundwater nutrients fluxes from the stream and the mixing processes into this eutrophic Mediterranean lagoon will be discussed and compared to the actual nutrient measurements. These results highlight the importance of the measurement location for estimating nutrient input into transitional waters, and the influence of groundwater inputs in biogeochemical studies of coastal lagoons.

RESPONSE OF COMMUNITY AND TRAIT PATTERNS TO SIMULATED SPECIES LOSS IN COASTAL LAGOONS

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Presentation type: ORAL

Species loss is usually considered to have negative impacts on ecosystem integrity and stability, but the details of the relationship between biodiversity and ecosystem functioning are still far from being thoroughly understood. In this study we computationally simulate species loss in six Mediterranean coastal lagoons and investigate how the species distribution patterns and the associated biological traits patterns change under scenarios of increasing species loss, using polychaetes as a model taxon. Species were progressively removed from the original dataset and the similarity between the full assemblage and the reduced datasets of both species and associated biological trait patterns was calculated. The results indicate the extent of changes that could follow species loss in the real world, and allow insights into the potential resistance of these lagoons to loss of species, both in terms of community pattern and functional capacity. The results indicate that while the change of species and trait patterns was strongly correlated in most lagoons, each lagoon showed an individual reaction: In several lagoons, the dominance of one or few species was the major driver for the observed patterns and extreme and unpredictable changes followed the loss of these species, whereas other lagoons showed indications for niche partitioning and seemed to have a higher resistance towards species loss. Species richness appeared to be less important for the ability of the lagoons to buffer changes, instead the initial composition of the assemblage and the identity of the lost species determined the observed patterns in each lagoon.

FINGERPRINTS OF WATER EXCHANGE BETWEEN THE NON-TIDAL LAGOON AND THE SEA IN THE ICE COVERAGE AND INLET MORPHOLOGY

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Presentation type: POSTER

The problem is studied by example of the Vistula Lagoon, the Baltic Sea (maximum and average depths are 5.2 and 2.7 m). The lagoon is connected with the sea through the single inlet, the navigable Strait of Baltiysk (10-12 m depth). Regular study (1959-1965) showed that inflow/outflow uniform current were observed in the strait about 75%. Two layers currents (influx near the bottom and outflow at the surface), as well as two streams currents were observed about 12% and 13%.

Baltic Sea waters intrusions in the Vistula Lagoon as well as water exchange itself are drove by water level variations. Field study shown that during the penetration into the lagoon area the marine water intrusion occupies the whole water column in first stage and then falling down to the lagoon bottom due to more higher density. The depth of penetration depends on amplitude of water level variations and duration of the phase of its rise.

The main peculiarity of the winter ice coverage is the existence of permanent polynya inside the lagoon near Strait of Baltiysk. The unexpected result of the analysis of the polynya area during 2011-2017 was that in many cases (and in average statistically) the landward side of the polynya is far inside the lagoon than the inner bar, which is formed by sedimentation of the marine sediments and indicate the zone of intensive inlet-outlet currents. This fact shows that inertia of inflowing mass of marine water is rather big and they penetrates more deeply in the lagoon area after overlapping the underwater inner bar.

Another unexpected manifestation of water exchange process is the depression (25-27 m depth) at the outer end of the entrance moles bounded the Strait of Baltiysk. Such a scour hole usual for tidal inlets is not a frequent feature for non-tidal lagoons. The hypothesis that this depression is formed by interaction of alongshore currents with coastal obstacle normal to the shore (entrance moles) was not proved by modelling. The possible reasons connected with interaction of alongshore currents and outflow from the lagoon is discussed.

Study was supported by theme FASO 0149-2018-0012

LONG TERM EVOLUTION OF THE MAR MENOR (SE SPAIN) LAGOON FAUNA DURING 6,500 YEARS OF CHANGES IN CONNECTION-ISOLATION PROCESSES.

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Coastal lagoons biological assemblages are closely dependent on the degree of connection between the lagoon and the adjacent sea. The confinement, more than an expression of the lagoon salinity and temperature, is determined by the possibilities of colonization of the marine species and the connectivity between the lagoon and the sea. Such connectivity depends to a great extent on geomorphology and the number of inlets, but it can also be affected by strong storms that break or overflow the sandy bar separating the lagoon from the adjacent sea. The effects of the same can be more or less durable depending on the capacity of the new species that colonize the lagoon to the resulting environmental conditions. The study of sediment corers, collected in the mar Menor Lagoon (SE Spain), show multiple extreme events and marine incursions during intense storm events that occurred, according to radiocarbon dating, around 5250, 4000, 3600, 3010, 2300, 1350, 650 and 80 years cal B.P. These surge events seem to coincide with the coldest periods in Europe during the late Holocene, suggesting a climatically-controlled mechanism for the occurrence of storm events. Most of the fauna is represented by the phylum Mollusca with a total of 40 different species, belonging to the classes Gastropoda (41.9%), Bivalvia (52.7%) and Scaphopoda with 1 single species. The study of the fauna reveals alternate connection-isolation periods with the first assemblage and a progressive increase in species richness started around 3500 yrcal B.P. and a major palaeoenvironmental change around 2400 yrcal B.P., related to change in environmental conditions from a lagoonal depositional environment with high marine influence to a more isolated lagoonal environment.

IMPACTS OF SEA LEVEL RISE DUE TO CLIMATE CHANGE ON REGIONAL COASTAL WETLANDS AND LAGOON

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Coastal aquatic ecosystems are particularly sensitive and vulnerable to climate change effects. In the Intergovernmental Panel on Climate Change Fifth Assessment Report - AR5 it was reported that the sea level rise is *likely* to range between 0.60 m and 0.74 m globally in 2081-2100 in relation to 1986-2005, while based on more regional models the sea level rise in Mediterranean basin is expected to range between 0.34 m and 0.49 m in 2070-2099 compared to 1961-1990. Based on these assumptions, the 1x1m Digital Elevation Model (National Cadastre & Mapping Agency S.A.) of the coastal area of Maliakos Gulf was employed combined with other resources (orthophotos and topographic maps from Hellenic Military Geographical Service), so as to examine the impacts of 0.3 m, 0.6 m and 1.0 m sea lever rise on the especially vulnerable coastal wetlands, the land use cover and the coastal settlements. In case of 0.3 m sea level rise, the terrestrial zone to be lost in the study area is estimated 6.15 km^2, 58.5% (3.6 km^2) of which comprise wetlands (the estuary of Spercheios River, Livari lagoon and Skarfeia wetland) and 35.5% (2.3 km^2) cultivated areas, while the residential zone to be lost is 3,031.4 m^2. In case of 0.6 m sea level rise, the terrestrial zone to be lost will rise to 18.9 km^2, 35.2% (6.7 km^2) of which comprise wetlands and 61.2% (11.6 km^2) cultivated areas. The residential zone to be lost in this case is 6,227.7 m^2. Finally, 1.0 m sea level rise will increase the total terrestrial zone to be lost to 31.1 km^2 (32.6% or 10.1 km^2 wetlands and 62.4% or 19.4 km^2 cultivated areas) and the residential zone to 10,656.4 m^2. The total financial cost of the sea level rise due to the terrestrial and residential zones lost was estimated to be € 57,421,795.29, € 124,460,155.20 and € 426,734,882.25 respectively. The consequences of sea level rise to the ecosystem services provided are indisputable, while adaptation and mitigation planning is required.

Fisheries and Aquaculture

TROPHIC WEB OF AN OLIGOTROPHIC COASTAL LAGOON: FROM WHERE COMES AND WHERE GOES THE PRODUCTION?

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Coastal lagoons are among the more productive systems in the world. Many marine and freshwater species take advantage of this production entering the lagoons as juveniles and returning to the sea for reproduction. This productivity is also exploited by humans over the world in form of fisheries that takes advantage of that migratory process and intensive aquaculture activities. The Mar Menor lagoon is one of the larger coastal lagoons in the Mediterranean and maintain like the other lagoons a high fishing activity despite the fact that this lagoon has traditionally maintained highly oligotrophic waters. In the last decades, the Mar Menor lagoon has suffered drastic changes as a consequence of human activities leading to a strong eutrophication process started as a consequence of changes in the agricultural practices in the watershed. This produced important changes in the system, as the proliferation of jellyfishes. The aim of this work is to analyse the organization and functioning of the trophic web of the Mar Menor when still maintained oligotrophic conditions as they are so exceptional in coastal lagoons to establish the basis to analyse in future works the consequences of changes in macrophyte meadows distribution and eutrophication process in the reorganization of the ecosystem functioning. We compiled the detail trophic model of 94 compartments using ECOPATH program for the period of 1979-1989.The model results show that the lagoon is an autotrophic system with a high net production that reach 8893.37 gC/m^2/year, being the P/B ratio 30.01 and the total primary production/ total respiration ratio 6,2. The production is mainly benthic (99.4%) due to microphytobenthos and macrophytes. However, despite total landings of the fishery in the study period ranged between 144835.5 and 346708.5 Kg, the system shows a low gross efficiency, representing only 0.0005% of the net primary production. This is partly due to the high trophic level of the fish catch (2,9), but mainly because most of the production (10385,9gC/m^2/year) flows into detritus and is accumulated in the sediment under the *Caulerpa prolifera* meadow.

POTENTIAL OF MUSSEL FARMING IN A BRACKISH BALTIC LAGOON: FIRST RESULTS OF THE TEST FARM IN GREIFSWALD BAY

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In times of rising world population and demand of proteins as well as intensively used agricultural lands, aquaculture is becoming of great interest. Potential aquacultural sites are limited in German coastal waters due to a short coastline and various uses as well as a steep salinity gradient. Since the use of fish meal is in critics and prices are increasing, we are in need of alternative sources of protein. EU strategies as the "Blue Growth" promote the extensive farming of omnivore organisms as e.g. filter feeders. To investigate the potential of blue mussel (*Mytilus spp.*) farming in low salinities, we set up a small (50 x 50 m) longline test farm in Greifswald Bay at an average salinity of 7 PSU.
Although larvae concentrations in the water column were low (< 10 Larvae / 50 L) throughout the entire sampling period, densities of up to 36 Individuals settled per cm^2 collector material. Further biofouling in terms of barnacles and short living macroalgae occurred in high amounts. Possibilities of an expansion of mussel farms in this area as well as different designs and setup techniques are evaluated. Impact studies were accompanied by filtration experiments in and ex situ to reveal clearance rates and in return the potential as a measure of nutrient retention.
Overall, mussel farming in the low saline Baltic Sea shows high potential as nutrient reduction and resource production measurement but more research is needed in regards to the further processing and usages.

IMPACT OF MYTICULTURE IN A SMALL PARTLY CLOSED LAGOON – THE CASE OF LAGOA DE ALBUFEIRA (PORTUGAL)

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Albufeira is a small (1.3 km^2) lagoon located 25 km south of Lisbon. It is separated from the ocean by a welded sand barrier that is breached every year (usually during spring equinox tides) to allow for lagoonal water renewal. The inlet remains active for weeks to few months, but finally closes naturally, essentially forced by waves. The lagoonal water mass is frequently stratified in closed-inlet conditions but inlet activity promotes its homogenization. Bottom sediments are essentially muds and sandy muds sourced in the watershed and transported by streams, except near the inlet where marine sands dominate.

The lagoon hosts diverse recreational and economic activities and uses. Mussel farming has been operating since 1980 and resorts to rafts equipped with ropes that hold growing mussel colonies. Raft emplacement and multiplication generates conflict with other uses sharing the same space, e.g. recreational navigation, windsurfing and kitesurfing. Moreover, the design of rafts is of poor aesthetic value and materials used in their construction make their hygiene and safety conditions questionable. The 14 operating rafts are moored in the deepest area (10-15 m) of the lagoon and their annual production is estimated in 500 ton.

This study presents an assessment of the impact of mussel farming in lagoonal bottom sediments and water quality. Results show that the concentration of dissolved oxygen in the lagoonal hydrosome is lower near the mussel platforms - in the epilimnion (reduction up to 50%) and hypolimnion, regardless inlet activity. We conclude that sediments underneath and around the rafts are coarser (due to accumulation of *Mytilus edulis* shells), more organic (due to fecal production and decantation) and enriched (2 to 5 times) in Zn and Pb. The fecal production reaches as much as 28 kg m^2 year^{-1}; considering a dry mass density of 0.9 g cm^{-3}, it induces a significant surplus in the natural sedimentation rate of about 31 mm year^{-1}. Fecal material essentially corresponds to labile organic matter whose degradation promotes development of near-bottom anoxia and the oxygen-depleted water layer rapidly grows upwards in thickness, especially in closed-inlet periods.

COUNTING AND MEASURING MUSSELS IN DIGITAL IMAGES: A NEW METHOD

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Mussel spat can be an important component of coastal ecosystems acting as a link between the pelagic and benthic systems. During recruitment periods, mass settlement of juvenile mussels is often observed mainly on the hard substrates, forming dense aggregations. The study of such mussel communities includes, among other, estimations concerning mussel abundance, average individual weight and shell-length frequency distributions. Yet, acquisition of such information can be a cumbersome procedure as it usually involves the counting and handling of thousands of individuals. Aiming to the reduction of the requisite effort for obtaining the aforementioned parameters, we propose a new method based on digital images of mussel samples.
The method uses a specialized software that permits automatic recognition of mussels and the scale in the image, along with batch image processing. Apart from the automatic counting of individuals in the image, the software estimates the surface of each mussel (mm^2). Length and weight of individuals are subsequently estimated by [Surface–Length] and [Surface–Weight] equations. These equations were created from a sample of 165 mussels (*Mytilus* sp.) collected in Amvrakikos Gulf (Western Greece) in summer 2016. Individual shell length and weight in the sample ranged from 3.7 to 74mm and from 0.005 to 15.89g, respectively. Subsequently, shell surface of each mussel was estimated by the software. Both shell-length and weight were strongly correlated with shell surface by the relationships: [Surface (mm^2)] $=1.358 \cdot [\text{Length (mm)}]^{0.523}$ ($R^2=0.995$) and [Surface (mm^2)] $=0.008 \cdot [\text{Weight (g)}] - 0.362$ ($R^2=0.986$).
The digital method allows fast and accurate enumeration of the individuals in the images as well as length and weight estimation of all individuals in the sample, resulting to a large data set concerning length and weight frequency distributions of mussel populations.

GRACILARIA GRACILIS OF CAPO PELORO LAGOON, A POWERFUL PRODUCT FROM SUSTAINABLE AQUACULTURE

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Presentation type: POSTER

The interest in cultivation of Gracilaria genus is principally due to the possibility of agar extraction. Algal cultivation represents also other potential applications in term of nutrient removal from waste water, extractions of bioactive compounds and direct use as food in both human and/or animal diet. Seaweed cultivation comprehends two main benefits: biomass production (with different aims)and water "bio-depuration". Seaweeds use nitrogen salts for their growth removing these from culturing water. This study assessed different features of *Gracilaria gracilis* cultivation in water of "Capo Peloro" lagoon (NE Sicily, Italy). Natural Reserve of "Capo Peloro" (ITA 030008) is a coastal lagoon complex composed of two basins, the Ganzirri Lake, connected to the Faro ones by the "Margi" channel, both coastal lagoons are connected with the sea. Although the heavy anthropogenic pressure, the reserve represents a good reservoir of biodiversity. In situ, two cultivation methods have been evaluated: 1. square raft holding parallel ropes where thalli were inserted 2. nylon net method consists of a cylindrical nylon net filled with the alga. This latter gave the better results with a DGR (Daily Growth Rate) = 4.75 %/day, and a biomass (Y)= 6.31 kg/m^2. The "bio-depuration" potential has been studied in tank with controlled seawater parameters. Results obtained demonstrated the good bio-filtration activity with sensible reduction of NH_4^+ and NO_2^{--}.
Furthermore, in this study, methanolic and ethanolic extracts of *Gracilaria gracilis* were analyzed to test their antibacterial activity against 10 pathogenic microbes, including human and fish pathogens. Classic extraction methods efficiency has been compared to Ionic liquid-mediated extraction in order to evaluate the possibility to replace conventional organic solvents with a new generation solvents that are less toxic, less flammable and less polluting. The bacterial strains used for anti-bacterial assay were obtained from University of Messina. Antibacterial activity of algal extracts was assayed using the agar well diffusion test technique; the minimum inhibitory concentration (MIC) has been evaluated.
The results of this and other studies assessed both the sustainability of *Gracilaria gracilis* cultivation in the natural reserve of "Capo Peloro" and the several possible applications of the seaweed as a multi-product source.

EXPLORING FISHERIES AND FISH NURSERY IN TRANSITIONAL WATER ECOSYSTEM. FROM FUNCTIONING TO SERVICES: WHICH IS THE REAL VALUE?

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Presentation type: POSTER

Transitional Waters are one the most productive ecosystems in the world supporting important fisheries, for this reason their value is inestimable, as they provide goods (such as food) and services (such as waste assimilation) representing the benefits that human populations derive, directly or indirectly, from ecosystem functions. The aims of this review are to examine TW services extrapolated from their ecosystem functioning, especially analyzing in detail the role of fisheries and fish nursery. We also collected from the literature all the necessary data and the informations to give an estimate of the capital stock that our natural ecosystem services provide to the population, which is among the highest economic value, including nutrient processing, direct harvesting, recreation and aesthetic value.
Then at the end we use a particular approach Drivers – Pressures – State change– Impact - Response (DPSIR) as analysis tool, highlighting the impact produced by anthropogenic pressures on transitional waters, in terms of affecting their ability to supply natural goods and services. In fact the maintenance of these highly valued attributes will critically depend on adopting smart practices and management procedure in order to obtain an incrementation of the sustainability. Management and assessment of ecosystem services (MAES) is critical in this century of change, to achieve an integration among economical, political and ecological disciplines and to reach the objectives of good and healthy life for both humans and ecosystems.

Biodiversity & Water quality

SPECIAL LECTURE

Prof. ELENI VOULTSIADOU

ARISTOTLE'S LAGOON AND THE ORIGIN OF MARINE BIOLOGY

Dr Eleni Voultsiadou is a professor in the Department of Zoology, School of Biology, Aristotle University of Thessaloniki. After her biology BSc (1977), she graduated with a bachelor's degree in English language and literature (1985), and got her PhD in Marine Biology from the Aristotle University (1986). She has been teaching for 35 years invertebrate zoology and marine biology at undergraduate and postgraduate levels. She has been doing research on the Mediterranean marine invertebrates (mostly sponges), focusing on their taxonomy, zoogeography, community structure, ecosystem engineering-symbiotic relationships, fisheries biology, and stock assessment. For the last 10 years she has been involved in research on the contribution of ancient Greek language to the international zoological nomenclature, as well as on the history of marine biology and the palaeoethnozoology (i.e. the diversity, distribution, and use of marine organisms in past historical periods) through the study of the ancient Greek literature assisted by the archaeological findings.

INFLUENCE OF NATURAL AND ANTHROPOGENIC DISTURBANCES ON BENTHIC COMMUNITIES IN FOUR LAGOONS OF THE PO DELTA SYSTEM

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Presentation type: ORAL

Benthic communities inhabiting river lagoons are subjected to several anthropogenic disturbances such as excessive organic and nutrient loads from urban, industrial and agricultural discharges and high contamination levels. To investigate how benthic communities (prokaryotes, microphytobenthos-MPB, meiofauna with a focus on foraminifera and macrozoobenthos) respond to these disturbances, in May 2016 four coastal lagoons of the Po River were sampled: two with more marine features (Scardovari and Caleri) and two more directly affected by the Po River flow (Canarin and Vallona-Marinetta). The abundance and structure of benthic communities were related to physical-chemical parameters (grain-size, Organic Carbon and the main chemical contaminants). High densities of Bacteria and Archaea were observed at sites directly influenced by the freshwater input. Beta-Proteobacteria, a typically freshwater class, displayed the highest abundances at sites characterized by the lowest salinity. MPB abundances in Marinetta-Vallona and Canarin were almost twice higher compared to Scardovari and Caleri likely due to freshwater nutrient loads. In Marinetta-Vallona and Canarin, the higher relative abundance of Chlorophyceae, Cyanobacteria and freshwater planktonic diatoms was a clear signature of the major river inflow. The meiofaunal community was well-structured with no evident differences either among lagoons or sites within the same lagoon. Among foraminifera *Ammonia beccarii* and *Haynesina germanica* were the dominant species, with higher values in the pristine lagoon Caleri and the lowest ones in the contaminated lagoon Canarin. The presence of a few specimens with deformed shells could be linked to higher contamination levels in Canarin. Regarding the macrofauna, in each lagoon a confinement gradient was observed due to the prevalence of brackish species in the inner part of the basin (e.g. the polychaetes *Alitta succinea*) and a higher number of marine species (e.g.the bivalve *Abra prismatica*) towards the open sea. In Canarin oligochaetes adapted to low salinity represented 44% of the macrofaunal community. The investigated benthic communities showed to be differently affected by the combined effect of high organic load, contamination and natural forcings: overall, the microbial communities (prokaryotes and MPB) were stimulated, the more sensitive foraminifera were reduced whereas macrofauna were well adapted to salinity gradients by the selection of specific taxa.

A BIOMASS-BASED M-AMBI INDEX MAY REDUCE UNCERTAINTIES IN THE CLASSIFICATION OF THE ECOLOGICAL STATUS OF COASTAL LAGOONS

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Lagoons represent important and fragile ecosystems in the coastal landscape, displaying distinctive features in terms of environmental management, importance of ecosystem services and associated productivity. Coastal lagoons are naturally organic enriched environments, which is reflected on the peculiarity of their fauna. Many studies have suggested that, for the assessment of the ecological status, the use of indices based on the abundance of tolerant/sensitive species need perhaps to be adapted to such environments. Moreover, in a benthic assemblage the abundance of a species can be relatively a poor measure of its functional importance, particularly in stressed situations when the insensitive species tend to be small bodied opportunists. Since coastal lagoons are often characterized by high benthic biomass, and biomass can be considered a measure of ecosystem functions, we explored the performance of a biomass-based M-AMBI index in Northern Adriatic coastal lagoons (from Goro to Chioggia) at which the disturbance status was known. Over 150 species were gathered at our sampling sites, with annelids displaying the highest number of taxa, followed by crustaceans and molluscs. At each site human pressures were quantified and expressed as a pressure index. Abundance- and biomass-based M-AMBI were calculated, and Kappa analysis was carried out to detect agreement in the quality classification between the indices. Regression between indices and pressure index was performed to analyze the agreement in the stress classification, and significance was assessed through regression ANOVA. Our results showed that more sites were assigned to an undisturbed status using the biomass-based M-AMBI. In our lagoonal data set, the proportion of ecological groups into the community (EG-I to EG-V) varied significantly if we considered abundance or biomass-based data. The use of a biomass-based index for the assessment of the ecological quality status in a lagoon is not trivial: in this study many benthic assemblages resulted slightly disturbed, numerically dominated by small-sized tolerant species. The use of biomass may reduce their effect in index calculation. For the evaluation of the ecological status, the metric adopted can lead to changes: results from this study suggest that a biomass-based index may better describe the ecological status of coastal lagoons.

POPULATION DYNAMIC AND ASEXUAL REPRODUCTION STRATEGIES OF THE BENTHIC POPULATION OF *AURELIA COERULEA* IN THAU LAGOON (NORTHWESTERN MEDITERRANEAN SEA, FRANCE)

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Presentation type: ORAL

Jellyfish are known for their sudden and dense aggregations (*i.e.* blooms) which interfere, directly or indirectly, with several human activities and can have a great impact on ecosystem functioning.
Thau lagoon is a semi-enclosed coastal lagoon under high anthropogenic pressure which supports one of the biggest shell farming facilities in southern France and plays a central role in the local economy. A resident population of the jellyfish *Aurelia coerulea* completes its entire life cycle within this lagoon and proliferates annually. This species presents a complex life cycle, with benthic and pelagic stages turning the research on *Aurelia* spp. ecology a challenging task. The benthic population of polyps are able to reproduce asexually (through different modes), increasing their density and generating the pelagic population. Such ability to perform different asexual reproducing modes allows them to adapt to different environmental conditions and influence their blooming potential. The pelagic stage (comprising ephyrae and medusae) perform large blooms with potential impacts on the ecosystem functioning.
Thau lagoon is in essence a natural laboratory that offers an ideal framework to investigate the whole life cycle of *A. coerulea*, as it is one of the exceptional places in the world where cohorts can be followed. Despite benthic stage is acknowledged fundamental in bloom onset, the *in situ* population dynamics of polyps remains really scarce.
Here we present the results from one year of *in situ* benthic monitoring, sampling every two weeks, focusing not only on dynamics but also on reproduction strategies of polyps. The development of polyp's abundance over time was determined with a quadrate method and underwater image analysis, while the asexual reproduction strategies were monitored from samples collected *in situ*. Environmental parameters were also monitored in order to reveal the drivers shaping the ongoing of the benthic population, together with the contribution of the different asexual reproduction strategies. With such investigation, we aimed to better understand *Aurelia* spp. benthic population dynamics and to increase the knowledge on jellyfish blooms development.

SEAGRASS RESTORATION IN VENICE LAGOON: INTEGRATE ANALYSIS OF ENVIRONMENTAL PARAMETERS AND ECOLOGICAL COMMUNITIES ON TRANSPLANTED SITES

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Over the past few decades seagrass meadows have shown a wide regression worldwide due to multiple anthropogenic impacts. During that period Venice lagoon experienced a significant decrease of *Zostera marina* and *Zostera noltei*, particularly in Central and Northern basins (Site of Community Importance IT3250031). At present, most of the local anthropogenic pressures which caused seagrass decline have significantly decreased, creating the ecological conditions for a new colonization. The LIFE SeResto project (LIFE12 NAT/IT/000331) started in 2014 with the aim to restore and consolidate water habitats no.1150* in the Northern basin of Venice lagoon through the transplantation of seagrass local species (mainly *Z. marina* and *Z. noltei*) on 35 sites.
An environmental monitoring was carried out on the transplantation sites, considering: seagrass transplantation success, abiotic parameters of waters and sediments, biological quality elements (BQEs) macrophyte, macrobenthos and fish fauna. Monitoring results were analyzed to investigate factors affecting transplant success and to assess changes in BQE ecological status (*sensu* WFD, 2000/60/EC) in the surrounding areas.
In the 17 sites transplanted in spring 2014 the mean seagrass cover after 30 months was ca. 60% of the intervention areas (10x10m), while in the other 18 sites transplanted in spring 2015 the mean cover was ca. 44.5% after 18 months. Rooting success greatly varied among sites, ranging from areas where seagrass did not root (cover 0%) to areas with a fast and full colonization rate (cover 100%).
As expected, rooting success resulted strictly related to nutrient concentration on water (DIN r=-0.71, TDP r=-0.76, TSS r=-0.85) and sediment (IP r=-0.86) and to low suspended solid concentration (TSS r=-0.88). Multivariate analysis indicated the presence of different clusters of sites identified on the basis of the environmental characteristics of water and sediment and reflected the coherence among rooting success and the good/high ecological status of macrophyte (MaQI) and fish (HFBI) indexes. Macrophyte community showed a rapid increase of total number of species, with particular reference to the most sensitive, while changes in fish and macrobenthic communities were slower because seagrass meadows are not yet well-developed and the habitat recovery is still in progress.

RESTORATION TRENDS OF THE THAU LAGOON'S WATER ECOLOGICAL STATUS AND PHYTOPLANKTON COMMUNITIES IN RESPONSE TO CHANGES IN ANTHROPOGENIC NUTRIENT INPUTS

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Thau lagoon (south of France) is one of the largest Mediterranean coastal lagoons. It supports many ecosystem services such as shellfish farming, whose production reaches 10 000 tons a year. Since the 1960s, the increase of anthropogenic inputs, linked to the exponential growth of human population, have resulted in contaminations of shellfish farming and the eutrophication of Thau lagoon, with significant ecological and socio-economic impacts. Since the 1970s and the late 2000s, the considerable efforts made to water depuration systems on the watershed have induced a significant decrease of nutrient inputs, and have gradually led to a good environmental status of the lagoon according to the Water Framework Directive (WFD). Dissolved inorganic phosphorus concentrations were reduced by 99% from 1972 to 2016, moving from bad to high WFD ecological status. Dissolved inorganic nitrogen, total phosphorus and nitrogen decreased and corresponded to high status from 1999 to 2016.
Simultaneously with the restoration of the lagoon ecosystem, fishermen and shellfish farmers are facing difficulties in their economic sector and they worry about the potential limiting carrying capacity of the ecosystem.
To address this issue, data on phytoplankton communities of Thau lagoon, available since 1994, were analysed with dynamic linear models and multivariate technics in order:
1) to highlight the changes in the biomass, abundance and composition of phytoplankton in Thau lagoon, in response to the reduction of nutrient inputs since the late 20th century;
2) to compare results collected on two stations to highlight a potential spatial heterogeneity.
Our results highlighted that the mitigation actions carried out on the watershed of Thau lagoon since two decades have induced a decrease of chlorophyll-*a* concentrations, and a modification of phytoplankton communities resulting in a decrease of diatom abundances. They also highlighted a spatial heterogeneity of phytoplankton communities. To address the issue of the potential limiting carrying capacity of the ecosystem raised by Thau lagoon's users, further analyses integrating the other compartments of the ecosystem are planned.

FISH AS DESCRIPTORS OF SEAGRASS RESTORATION EFFECTIVENESS IN LAGOONS: IS THERE A MATCHING BETWEEN STRUCTURAL AND TROPHIC RECOVERY?

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Habitat restoration programs are fully successful when the recovery of the habitat structure is followed by the functional recovery of the system. This involves,in turn, the re-establishment of the faunal community with a stable trophic structure.
In this context, the assessment of trophic structure and trophic niche by means of carbon and nitrogen stable isotopes can be used as an informative tool to quantitatively describe communities, integrating information provided for example by species composition and abundance.
We used community-wide isotopic metrics, such as the Standard Ellipse Area and the Layman metrics, as descriptors to assess temporal variations of the trophic niche of fish communities associated to a habitat undergoing seagrass restoration in the northern basin of the Venice Lagoon (SeResto Project, Life12 NAT/IT/000331).
The fish community was monitored for four years since the beginning of seagrass restoration, and compared to reference communities associated to a stable seagrass meadow in the study area.
Results showed that fish community of the restoration site was characterized by lower species diversity but similar density as the reference site. Descriptors of the trophic niche revealed a slight increase of the isotopic niche width and trophic diversity and a reduced trophic redundancy across time, early signs suggesting the initial trophic recovery of the fish community.
Despite the ecological status and structural complexity of the seagrasses improved during the first three years, longer time is needed for the fish community to restore structurally and functionally. Overall, this study emphasizes the importance of considering the recovery of habitat function (e.g. trophic function), other than structure, among the criteria to assess the success of restoration programs.

COMPARISON OF SEDIMENT MICROBIAL COMMUNITIES BETWEEN WESTERN (RIA FORMOSA, PORTUGAL) AND EASTERN EUROPEAN LAGOONS (AMVRAKIKOS GULF, GREECE)

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Lagoons are naturally enriched habitats, with unstable environmental conditions caused by their constraint from the sea and their shallow depth. The frequent fluctuations of the abiotic parameters cause severe changes in the abundance and distribution of organisms; while this relationship has been studied for macrofaunal taxa, little is known about the lagoonal microbial diversity.
Pyrosequencing has quite commonly been used over the past decades for the assessment of the microbial diversity in various habitats. The continuous drop in the associated costs combined with the increased efficiency of the latest high-throughput sequencing technologies has resulted in an unprecedented growth in sequencing projects.
Sediment samples were collected from five stations at the Ria Formosa lagoon (Atlantic Ocean, South Portugal). DNA was extracted from the sediment upper layer and was further processed through pyrosequencing of the V3-V4 region of the 16S rRNA gene using a MiSeq Reagent Kit v3 (2 x 300 cycles).
The results of the study shed light on the microbial biodiversity of transitional water ecosystems and reveal the effect of environmental parameters on microorganismic species (OTU) diversity. In addition, the retrieved microbial diversity pattern is compared with a similar one from a Mediterranean lagoonal complex (Amvrakikos Gulf, Ionian Sea, Western Greece) and their differences are further discussed.

GENETIC DIVERSITY PATTERNS OF MACROBENTHIC COMMUNITIES IN TRANSITIONAL WATER ECOSYSTEMS

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The environmental conditions can strongly affect the gene flow patterns shaping population dispersal and connectivity. Lagoons are transitional water ecosystems with strong environmental gradients, spatially and temporally. The macrobenthic polychaete *Nephtys hombergii* is a common species of the Mediterranean lagoons with genetic diversity and great dispersal ability, used in many studies as an indicator of the ecological ecosystem status. The patterns of SNP clusters of N. hombergii from the lagoonal system of Amvrakikos Gulf were investigated with the ddRAD sequencing method. The method can provide a good estimate on the fluctuations of the populations demography and elucidate the role of the environment on these shifts. The main objective of the study is to compare the SNP cluster patterns against the spatial and temporal patterns of environmental attributes, in an attempt to elucidate the mechanisms that influence the demography of lagoonal polychaete populations, providing insights for biodiversity and conservation biology.

PRESENCE OF *VIBRIO* SPP. IN THE SE BALTIC SEA COASTAL AND TRANSITIONAL WATERS, THEIR DIVERSITY, SPATIAL VARIABILITY AND ASSOCIATED RISKS FOR BATHING WATER QUALITY

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Vibrio spp. are common aquatic bacteria causing severe infections of humans and animals. These organisms inhabit surface waters throughout the world, depending on specific conditions concerning salinity (optimum 0-19 PSU) or water temperature (increased growth rates at higher temperatures). Infections by pathogenic *Vibrio* spp. are mostly attributed to raw shellfish consume or to a direct wound exposure to warmer waters containing these organisms. Although the number of *Vibrio* spp. infections increased throughout the years around the Baltic Sea, revealing in mortality rates of up to 60%, no actual directives exist controlling potential outbreaks. Moreover, at regional level only low attention is paid to this problem and information about this pathogen in lagoons is rare worldwide. This is surprising because coastal environments as beaches and bathing waters are of high ecological and socio-economic importance worldwide. Therefore, persist and distribution of potentially harmful microorganisms that can easily change their original ecosystems and distribution should be regarded with care. Thus, in this study we investigate abundance, diversity and spatial distribution of *Vibrio* spp. and their dependency on environmental conditions from more than 10 bathing sites at the coast of Lithuanian Baltic Sea and Curonian Lagoon, and first data will be presented.

LAGOONAL WATER EXCHANGE AS CONSEQUENCE OF ARTIFICIAL OPENING OF TIDAL INLETS: TWENTY YEARS OF MONITORIZATION IN THREE PORTUGUESE LAGOONS (ALBUFEIRA, MELIDES AND SANTO ANDRÉ)

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Presentation type: ORAL

Albufeira (AL), Melides (ML) and Santo André (SAL) lagoons, located in the SW coast of Portugal are separated from the ocean by welded sand barriers. These small systems (0.4 $km^2$to 2.5 km^2), show different morphologies and depths (5 to 16 m) but all display ephemeral tidal inlets that are artificially opened once every year in March/April. Inlets allow for temporary water exchange between the lagoon and the ocean, and tidal propagation inside the lagoons is rapidly attenuated with time: relative tidal amplitude in lagoons decreases about 24% shortly after inlet opening and about 90% just before inlet closure, which occurs by natural causes in a matter of days (ML), weeks (SAL) or months (AL).
Regular monitoring of physical and chemical characteristics of the lagoonal hydrosome in closed and open-inlet stages was made since the early 1990's, allowing to characterize patterns of seasonal changes in lagoonal water throughout the year. The very shallow ML lagoon (depth <4 m) usually stratifies during closed-inlet periods, its upper most fresh to brackish water layer being high in both dissolved oxygen and turbidity, whereas the lower water layer is more saline, anoxic and clear. In open-inlet stages, the whole of the water column homogenizes, approaching the characteristics of open marine water.
Deeper lagoons (AL, SAL) export the most superficial water layer (corresponding to freshwater to salty epilimnion) to the ocean during the first hours of inlet activity, the thickness of this layer depending on the size of the ebb-channel incised by the first post-breaching ebb. At this point, water remaining in the lagoonal basin mostly corresponds to the pre-breaching lagoonal metalimnion and hypolimnion, with saltier and oxygen-depleted characteristics. The first flood post-dating inlet breaching injects denser marine water via the inlet, that mostly spreads close to the bottom in SAL and at the hypolimnion/metalimnion interface in AL. Full renewal of the lagoonal water is more easily achieved in ML, than in SAL and AL, this rate being controlled by the efficiency of the breached inlet, in turn mostly dependent of the dimensions of the tidal channel developed by the first lagoonal ebb following barrier breaching.

BIOGEOGRAPHICAL AND TRANS-REALM PATTERNS OF LEAF LITTER PROCESSING IN AQUATIC ECOSYSTEMS

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Presentation type: ORAL

Aquatic ecosystems are interconnected in a network of continuously changing biotic and abiotic conditions from the springs of rivers to river mouth and fully marine ecosystems. Along this continuum, aquatic realms, as the freshwater, transitional and marine waters are, can be distinguished characterising transitional waters as the realm playing a major role in filtering and processing internally nutrients and materials received from both neighbouring ones. In all three realms, detritus processing is an important source of energy and nutrients, but trans-realm patterns of detritus processing rates have so far received only little attention. Here, we have studied the patterns of variation of leaf litter decay rates from freshwater to marine waters at different scales; from the water basin scale, including freshwater, transitional and marine components, to the regional and biogeographical scales. The study has been carried out in three biogeographical areas (i.e, Adriatic-Ionian, Eastern Aegean and Ponto-Caspian), also considering the latitudinal gradient in two of them. The study has been conducted during the late spring-early summer season at all sites using *Phragmites communis* leaves as leaf litter substrate. Patterns of dead reed leaf decay rates have been studied against both continuous (e.g. salinity, temperature, dissolved oxygen gradients) and categorical (e.g. scales of observation) predictors. Results show that both abiotic gradients and the scales of observation determine patterns of variation of dead reed leaf decay rates; decreasing decay rates of reed leaf detritus with increasing salinity have been observed at all scales, even though with differences in the model followed by these relationships, but differences in decay rates have also been observed at the regional and biogeographical level, both incorporating and not incorporating expected temperature dependency. The whole dataset allows perspectives on designing scenarios of potential response to global changes of functional processes in aquatic ecosystems.

DIVERSITY PATTERNS IN MEDITERRANEAN LAGOON FOOD WEBS

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Presentation type: ORAL

Biodiversity organization and spatial scales are major issues in community and conservation ecology. In lagoon ecosystems, the spatial extension of ecosystems, on the one side, and the body size of colonizer species, on the other, pose additional constraints to biodiversity organization.
The study has been performed using two databases on phytoplankton, macrophytes, macroinvertebrate and fish guilds on Mediterranean lagoons, hosted in the LifeWatch-ITA infrastructure (http://www.lifewatchitaly.eu/): i. a large one on 220 Mediterranean lagoons, build upon species occurrence data and ii. a smaller one while on 16 lagoons including abundance, functional and morpho-functional data.
The four guilds of the dataset represent the food levels of primary producers, detritus feeders and invertebrate predators and fish predators. Here, we analyze the hierarchical biodiversity organization and its scaling within these food webs in the lagoon ecosystems. The diversity organization has been analysed from taxonomic, morpho-functional and functional level testing if the species densities and perceived spatial heterogeneity are the main drivers of diversity organization patterns across functional and trophic level.
Common patterns of biodiversity organization have been observed across trophic levels, but also peculiarities of the intermediate level, when compared with both primary producers and predators. Across all trophic levels, morpho-functional diversity was relatively invariant when compared with the taxonomic one. Comparing trophic levels, higher connectivity within patches and among lagoons was observed at lower and higher trophic levels than the intermediate one.
Lagoon ecosystems are characterized by a restricted species pools than the marine one, suggesting a relevance of lottery-competition as a mechanism of community organization at intermediate trophic levels, with increasing importance of niche and body size partitioning at the lower and higher levels.

EFFECT OF THE HABITAT STRUCTURE ON THE LIFE HISTORY TRAITS OF A SMALL EURYHALINE TELEOST

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Presentation type: ORAL

Small-sized teleost fish have been widely used as study models to investigate the relationships between environmental factors and life history traits. The South European Toothcarp, *Aphanius fasciatus* (Actinopterygii: Cyprinodontidae) is a small euryhaline killifish, inhabiting shallow brackish waters in the central and eastern coastal zones of the Mediterranean Sea. It is an estuarine resident, commonly found in lagoons and other brackish water ecosystems. In the Venice lagoon, it is mainly found in salt marsh systems, but it also inhabits open or isolated small artificial ditches within lagoon islands. In a precedent study focused only on female *A. fasciatus*, this species proved to be a good model to analyse the variability of life history traits deriving from the interaction among the level of basal environmental resources, the demographic forces and the predation pressures. The present study considered both sexes of *A. fasciatus*, aiming to analyse the variation in life history traits across a higher number of natural and artificial habitats on a small geographic scale. Two predictor variables were considered: predation intensity, related to habitat structure, and trophic resource availability. Somatic and reproductive investments showed a similar pattern in both sexes. In habitats with higher levels of basal trophic resources, fish invested more in the somatic compartment, while the lower reproductive investment observed in the isolated habitats could be explained by the absence of aquatic predators. This work suggests the importance to link habitat characteristics to phenotype variability, for a better understanding of the evolution of life history strategies under contrasting environments. In particular, these results underline the importance of morphological and trophic properties of habitats and provide information that may be useful in the context of management and conservation of both natural and artificial marsh habitats characterizing the European transitional waters.

MARINE MIGRANT JUVENILES DISTRIBUTION IN THE NORTHERN VENICE LAGOON

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A full comprehension of the habitat use of juvenile marine migrant fish species within the estuarine environment is a crucial step in understanding, preserving and managing the functioning of transitional ecosystems. The aim of this study is to analyze the environmental influence on the distribution of eight marine migrant species (*Chelon labrosus*, *Engraulis encrasicolus*, *Platichthys flesus*, *Sardina pilchardus*, *Liza aurata*, *L. ramada*, *L. saliens*, *Sparus aurata*).Sampling took place during spring 2016 in16 stations of the northern sub-basin of the Venice lagoon, considering the most relevant habitats, such as seagrass beds, mudflats, intertidal creeks, and saltmarsh edges. Generalized Linear Mixed Models were used to analyze the effects of habitat type and environmental variables on juvenile distributions (considering both density and presence/absence data). For frequent and abundant species, data were organized considering different size classes, chosen to represent different ontogenetic stages, according to the available literature. The main results suggest that for some species is essential to study the spatial distributions considering separately the stages, while other species do not show a stage-specific distribution or habitat association. For instance, *L. ramada* and *S. aurata* (Standard Length < 20 mm) are at first associated with relatively low salinity areas, and then tend to concentrate in intertidal creeks. On the other side, *E. encrasicolus* and *P. flesus*, once entered in the lagoon, tend to concentrate directly in saltmarsh edges in the most confined part of the basin. Lagoons are composed by a complex mosaic of habitats and a heterogeneous set of environmental conditions. Such a spatial variability influences the distribution of various marine migrant species, which show different preferences in relation to environmental conditions. However, it seems that saltmarsh areas, especially intertidal creeks and low salinity zones, are preferred by many marine migrant species and hence they could play a key role in the nursery function of the lagoon.

FISH GUILDS IN THE COASTAL BALTIC SEA: THE APPLICATION OF DUAL AND TRIPLE STABLE ISOTOPE ANALYSIS

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Migratory fish species, which compose a significant proportion of fish community in coastal zones, vary by migratory characteristics, residency periods, and roles in food webs. In the Lithuanian coastal zone of the south-eastern Baltic Sea, four main guilds as lagoon freshwater fishes, anadromous fishes, marine migrants and semi-resident fishes could be distinguished. In this study, we used dual and triple stable isotope analysis to discriminate fish species during different periods (at the end of vegetative period and during winter) in the Lithuanian coastal zone.

The dual stable carbon and nitrogen analysis was used to distinguish different migratory guilds. Sampling period of August-September represented the end of vegetative period when stable isotope signatures in individuals were at least partly adjusted to the coastal environment. This dual analysis revealed the contribution of the Curonian lagoon outflow to the fish community along the Lithuanian coast. Moreover, isotopic ratios in fishes reflected their seasonal migrations across the ecosystems of the coastal zone, the Curonian lagoon and the open Baltic Sea.

Triple stable sulphur, carbon and nitrogen isotope analysis allowed to discriminate fish species and model their proportions in diets of wintering birds as red-throated diver, common guillemot, and great crested grebe. This analysis showed an important role of different fishes to wintering piscivorous waterbirds in the coastal zone. This evaluation was possible only using triple isotope analysis because stable sulphur isotope ratios served as an effective supplement to stable carbon and nitrogen isotope ratios for trophic studies in the coastal Baltic ecosystem.

This work increases the understanding of the migratory patterns of fish species in coastal zones, connectivity with adjacent areas, and roles in food webs.

ECOSYSTEM PRODUCTION AND RESPIRATION IN COASTAL CONFINED WATERBODIES UNDERGOING RESTORATION

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The ecosystem metabolism of several confined coastal waterbodies located in the restored saltmarsh of la Pletera was analysed. La Pletera saltmarsh is composed by a set of brackish and hyperhaline lagoons, which were affected by building works for a residential estate in the late 80s. A Life restoration project has been developed with the aim to recover the ecological functioning of these aquatic ecosystems. With this purpose project actions include the excavation and removal of the manmade elements (promenades, levees, piles of debries) and their substitution by new lagoons (permanent or temporary) surrounded by halophilic vegetation. Ecosystem production (P), respiration (R) and the P/R ratio of newly created water bodies is compared with that of existing ones during the first year after the restoration by means of an oxygen probe installed in the centre of each lagoon, which provides oxygen data every ten minutes. Results show how changes in water inputs and nutrient inputs as well as changes in human activity around the lagoons cause fluctuations of P, R and P/R. Ecosystem metabolism arises as a useful technique for monitoring the ecological status of aquatic ecosystems and to analyse the response of these habitats to ecological restoration.

PREDICTING THE RESPONSE OF FISH AND INVERTEBRATE ASSEMBLAGES TO SEAGRASS TRANSPLANTATIONS: ASSESSMENT OF THE PROGRESS OF HABITAT RESTORATION IN THE VENICE LAGOON

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Presentation type: ORAL

One of the major challenges to ensure effective restoration of estuarine habitats is to establish success criteria, allowing to determine whether the goals of restoration are met. In the northern basin of Venice lagoon (northern Adriatic Sea, Italy), the LIFE project "SeResto" started in 2014 aiming at restoring seagrass meadows by means of small-scale manual transplantation of sods and rhizomes. The interventions are expected to increase the cover of *Zostera marina* and *Z. noltei* in the area, and to subsequently restore the typical features of faunal assemblages associated with seagrass meadows. The aim of this work is to propose a method to identify reference conditions and assess the progress of nekton (fish, decapods and cephalopods) assemblages at seagrass restoration sites. Nekton sampling took place from 2014 to 2017 during spring at eight transplantation sites. In spring 2016, five natural seagrass sites in the same area were additionally sampled, and physico-chemical water parameters and habitat structure (seagrass floristic composition, percent cover, canopy height, shoot density, leaf area index and epiphytal load) were also recorded. A multivariate approach based on GLMs was adopted, in order to disentangle the relative effect of water quality and seagrass habitat structure on nekton assemblages of natural habitats. Models were then employed to predict species composition of nekton fauna at each transplantation site under target abiotic and habitat conditions, allowing to identify the reference assemblages to evaluate the progress of fauna towards restoration goals. The analysis highlighted that desired restoration outcomes, i.e. presence of *Z. marina* and greater seagrass cover, are positively linked to presence and density of some pipefishes (Syngnathidae), large gobies (Gobiidae) and some shrimps (Palaemonidae and Hippolytidae) in the nekton assemblage. Sites exhibiting better recovery of habitat structure also supported nekton assemblages more similar to reference conditions. However, none of the sites showed clear trajectories of progress, suggesting that more than three years are needed for nekton fauna to successfully colonise restored seagrass meadows in coastal lagoons.

THE WAYS FISH USE "MEDITERRANEAN SMALL RIVER-MOUTHS": OBSERVATIONS FROM GREECE AND CYPRUS

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Presentation type: ORAL

In the Mediterranean basin small river-mouth systems dominate, since temperate-zone river transitional water systems such as estuaries, are scarce. Yet although these structurally heterogeneous small river-mouths are widespread, they are usually overlooked in transitional water studies; often considered within a catch-all "small wetlands" category. Although these river-mouth segments do not always fulfil the "transitional water category" very little has ever been published about these systems, their habitats or their fish assemblages.
Here, we use our fish sampling data (electrofishing and seine net) from river-mouth sites in Greece (35 sites) and Cyprus (15 sites) to explore summer fish assemblage patterns in these atypical transitional waters. In fact, some of these beach-side river mouth sites are actually quasi-transitional waters and more properly belong to the lowest-most river segments since they have freshwater year-round. Our preliminary results show that small river-mouths in Mainland Greece, it's Islands and on Cyprus usually have very small river basin areas (smaller than 500 Km2) and non-perennial lotic waters dominate their inland catchments. In natural and near-natural river-mouth formations we defined broad river-mouth formation types based the arid-period openness of the river-mouth: a) summer open-large, b) summer open-small, c) summer closed-large, and d) summer closed-intermittent. This preliminary biophysical typology is helpful to explore initial fish community patterns and functional guild assemblages. Marine fish species dominate these systems and very few estuarine dependent species exist. Alien species and freshwater fish species richness is usually low while regionally range-restricted and endemic species do exist at some sites. Assemblages are heterogeneous, but some groups such as the mugilid grey mullets and the European eel are very widespread. As expected, insular assemblages are more species-poor than mainland ones; yet many of these systems are anthropogenically degraded. Despite the difficulty of defining reference conditions, the patterns we found are informative for exploring general fish assemblages. Our observations also provide evidence that these river-mouths are indeed "special habitats" of high biodiversity conservation value in seasonally semi-arid coastal zones. More effort into inventory, sampling standardization, and monitoring is urgently called for in Mediterranean small river-mouths.

A SEARCH FOR INVARIANT PATTERNS IN PHYTOPLANKTON GUILDS OF LAGOON ECOSYSTEMS: A BIOGEOGRAPHICAL APPROACH.

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Presentation type: ORAL

Monitoring ecological status of aquatic ecosystems according to the European WFD is constrained in different European regions by a lack of actual reference conditions. Several approaches have been developed focusing on proxy regional sites or fundamental theoretical expectations. Here, we are investigating the adequacy of pristine sites occurring at same or different biogeographical areas as proxies. The underlying hypothesis is that the overarching community organization would be relatively invariant in pristine ecosystems across biogeographical areas, while taxonomic structure and related descriptors would be highly variable. We have tested this approach on phytoplankton guilds, whose taxonomic composition is less spatially variable than that of other guilds. Following a hierarchical sampling design, taxonomic and non-taxonomic structural components of phytoplankton guilds have been studied in fifteen lagoon ecosystems, distributed across the Mediterranean, North Atlantic, South Atlantic, Indo-Pacific and Western Pacific regions. Species richness and diversity show a latitudinal pattern, both increasing with increasing latitude. Instead, species composition is high and heterogeneous among sites and biogeographical areas. Shape and size of phytoplankton cells, morphological traits proxies of functional ones, also show heterogeneity among sites and biogeographical areas, but at a significantly lower extent. The overall results suggest a hierarchical organization of phytoplankton community with taxonomic and shape structure progressively nested in the phytoplankton size structure. The higher invariance showed by the size structure has direct implications on the assessment tools based on body size, and on the adequacy of pristine sites outside the biogeographical areas of interest, setting reference conditions for the evaluation of phytoplankton ecological status.

FISH DIVERSITY AND PHENOLOGY AS TOOLS FOR DETERMINING FUNCTIONAL DIVERSITY IN MANGROVES LAGOONS OF SÃO TOMÉ ISLAND (CENTRAL AFRICA)

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The functioning and stability of ecosystems is guaranteed by the functional diversity of their species. Moreover, this diversity is supported by their functional redundancy, in such a way that the more species bearing the same ecological, the greater the resilience. Mangrove lagoons are coastal ecosystems that perform important ecological functions for the fish communities, such as breeding, nursery and feeding areas for many resident and coastal fish species, some of which are commercially relevant. The conservation and management of mangroves is essential given that they provide goods and services for the human population, especially as a source for raw material, food and coastal protection. However, they are vulnerable ecosystems and are generally exposed to multiple anthropogenic pressures.
This study aimed to evaluate the fish species diversity and composition in two mangrove lagoons with different levels of anthropogenic pressure: Malanza and São João dos Angulares, in São Tomé Island (Gulf of Guinea, Central Africa). Distribution, phenology and ecological functions were also assessed, to determine functional diversity and redundancy and thus provide information for management and conservation strategies that minimize the loss of ecological functions. A multi-habitat sampling strategy was used, considering all available fishing gear, such as cast nets, seine nets, gill nets, longline, fish traps, hand nets and angling.
Twenty species were identified in Malanza in 2014, while in 2017 only 15 (ongoing work) were identified in both mangroves. Six fish species were found on both systems: *Periophthalmus barbarus, Liza grandisquamis, Mugil sp*., *Monodactylus sebae,Pomadasys jubelini* and *Lutjanus goreensis*. Threatened species, such as *Megalops atlanticus,* and a tolerant non-native species, *Oreochromis mossambicus*, were captured during both sampling surveys, the latter indicating some degradation. A higher diversity was recorded in Malanza, which is possibly related to its higher area and wider habitat diversity. This preliminary approach indicates that the Malanza lagoon plays a central role in the maintenance of fish species and ecological functions of mangroves and coastal systems in São Tomé.

PIGMENT ANALYZES WITH HPLC IN ALGERIAN COASTAL LAGOON (EL MALLAH)

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Presentation type: POSTER

Wetlands in Algeria, particularly El Mellah, the only brackish coastal lagoon in Algeria, constitute an important natural site, rich in biocoenosis, with its transitional spaces, they perform very complex roles in maintaining the natural balance of the region. The lagoon receives intermittent fresh water supplies from the Reguibet, Melha and El Arougwadis. The channel which allows the intrusion of marine waters also ensures the exchange between the sea and the lake due to tides, the movements of the sea and the variations in the level of the lake related to atmospheric precipitation.
We have been interested in the pigment identification of the biomass that characterizes the El Malleh lagoon, we have opted to draw up a floristic and faunistic inventory that characterizes the shore of the lagoon, followed by extraction of lagoon water with outlets regular from February to May 2017, two different sites were chosen as reference and sampling points, pigment analyzes in HPLC were carried out in the MARBREC laboratory of the "University of Montpellier, this technique had shown a phytoplankton biomass, dominated by a component of the green line. The high concentration of chlorophyll_a observed on the two sites of the El Malleh lagoon is concomitant with a high concentration of chlorophyll b (Chl b). Chlorophyll_a shows the dominance of diatoms in coastal areas. This correlation with biomass is suggesting a development of green algae. Since we do not have the nutrient data on the El Malleh lagoon, chlorophyll_a is considered a pressure indicator.
In perspective, we intend to calculate the concentration of chlorophyll to draw graphs and publish our results.

MICROORGANISMS COMMUNITIES ON PLASTIC MEDITERRANEAN LAGOONS DEBRIS

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Presentation type: POSTER

There is more and more information on the impact of plastics pollution on the ocean's ecosystems. Knowledge about their deleterious impacts on wildlife, habitats, humans and the economic health of coastal communities are increasing. 80% of marine pollution, therefore litter, arises from land-based sources. , the influence of plastic on lagoons ecosystems is, however, poorly understood particularly for microorganisms communities.
Surfaces of plastics debris provide an attractive and alternative substrate for a number of opportunistic species, such as harmful microalgae, that favors their dissemination. Located at the interface between land and sea, the Mediterranean lagoons are severely impacted by anthropization. Because of their environmental, social and economic roles, it appears essential to assess the importance and role of plastic debris in the dispersal of toxic species in these coastal lagoons.
The present study used scanning electron microscopy to characterize the phytoplanktonic organisms colonizing plastic debris collected in lagoons. Samples were collected from plastic debris during spring, summer and winter in three contrasting Mediterranean lagoons. One lagoon of the Gulf of Aigues-Mortes very anthropized (Prevost), the Biguglia lagoon in Corsica very degraded by an increasing human pressure and the Diana lagoon in Corsica less impacted. A total of 27 fragments of plastic were sampled.
The results showed that diatoms were the most abundant, widespread and diverse group of plastic (frequency of occurrence=100%). Two orders, belong to diatom, are frequently observed on plastics: Achnanthales and Naviculales. The genera *Cocconeis*, *Navicula* and *Amphora* are commonly substrate-associated. The potential toxic dinoflagellate, *Prorocentrum minimum*, is encountered in spring on Corsica lagoons plastics debris. In summer, several cyanobacteria were identified in all samples.
The results of the present work highlighted the need to better understand harm caused by the colonization of plastics and the dispersal of toxic species in a coastal lagoon, and the need to raise awareness of the potential impacts of debris accumulation on biodiversity of lagoons.

AURELIA SPP. ECOLOGY IN THE MEDITERRANEAN SEA

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Presentation type: POSTER

Aurelia spp. are cosmopolitan scyphozoan species and probably the most studied jellyfish in the world. They inhabit nearshore waters, especially closed basins, such as coastal embayments, fjords and estuaries, occupying a great variety of habitats worldwide. Recent studies have addressed the biogeography of the genus *Aurelia* and reported that it constitutes a species-complex embracing numerous locally adapted species.
The Mediterranean Sea is a hotspot of biodiversity threatened by climate change, which is expected to have a significant influence on the biodiversity and biogeography of marine populations. Here we compiled a comprehensive data set on *Aurelia* spp. occurrence in the Mediterranean Sea and assessed the thermal niches as well as the phenology of the various populations.
Our results indicate that the species biogeography is restricted to temperate areas of the Mediterranean basin, whereas the seasonal pattern generally displayed an unimodal peak that occurs earlier in warmer systems. Our results highlight that the thermal niche of the species, where the bulk of the population (90%) is present, shows a temperature window from 12 to 20°C, although it is further constrained when accounting only for the northern populations of the western and Adriatic basins. Hence, while global warming has been claimed as one of the most important triggers for jellyfish outbreaks, the projected temperature increase of the Mediterranean Sea warns on the shrinking of favorable environmental conditions for the species with the concomitant risk of its potential decline and perhaps extinction in the Mediterranean Sea.

MACROBENTHIC BIODIVERSITY AND COMMUNITY STRUCTURE IN APULIAN TRANSITIONAL WATERS ECOSYSTEMS: WHAT'S GOING ON?

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Presentation type: POSTER

The present work aims to supplement an overview of faunistic data from nine transitional waters ecosystems of the south-eastern Italian coast over eight years. This study is the first to compare the taxonomic biodiversity and ecological composition of the macrobenthos within transitional waters ecosystems of Apulia region.
Water Framework Directive (WFD) requires the classification of the ecological quality status of benthic macroinvertebrates in coastal and transitional waters through several structural parameters of benthic invertebrate assemblages (i.e. diversity, abundance and proportion of disturbance-sensitive taxa). According to WFD the analysis of the ecological role of functional groups has been implemented.
Samples were collected from 14 stations (three replicates at each station) in nine lagoons since 2010 to 2016. A total of 189 species from 17 taxa was collected and identified. Overall, Mollusca was the most abundance taxon (90%), followed by Annelida and Arthropoda. This check list of macrobenthic species provided important information on functional groups as tool to assess the ecological state of the environment.
The temporal trend of the abundance (ind/m^2) showed a general increase, statistically significant, over the years; in Lesina, Salpi and Cesine lagoons were found the highest values of abundance, however the results were not related to a specific geographic gradient. Overall, the biodiversity indices showed a temporal negative trend in all lagoons.
The observed inverse relation between abundance and biodiversity could be explained by the dominance of the *Ecrobia ventrosa*, a gastropod species tolerating to the high spatio-temporal variability occurring in transitional waters ecosystems. As a result, the dominance of *E. ventrosa*, as well as other tolerant species, could affect the structure and biodiversity of lagoon macrobenthic communities.

DETERMINING *OBELIA* SP DIVERSITY AND POPULATION DYNAMICS IN THAU LAGOON (NORTHWESTERN MEDITERRANEAN SEA, FRANCE).

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The jellyfish *Obelia* belongs to the family Campanulariidae (Hydrozoa, Leptomedusae), an important and widely distributed family of hydrozoans. *Obelia* is a very popular and widespread medusa, however first report on its complete life cycle was only published in the late nineties in Northern Japan. This is probably due to its size, as the medusa umbrella diameter is lower than 1mm. This Hydrozoa presents a bentho-pelagic life cycle with both polyp and medusa stages.
In Thau lagoon, Northwestern Mediterranean Sea, populations of *Obelia* occur each year. Some polyps colonies were identified and sampled in the lagoon on *Zostera noltii* leaves, indicating that the populations realise their full development cycle within the lagoon. Morphological and genetical (COI) approaches, on both polyps and medusae, have revealed that main populations are composed by *O. dichotoma* individuals(side branches typically irregular in length; hydroteca bell-shaped, usually not very deep, thin walled, often thrown into fine longitudinal folds; hydrotecal rim with smooth or with shallow cusps –crenate, slightly flared; diaphragm transverse to oblique) but that *O. bidentata* (lateral branches roughly in right angles pairs are given on both sides; slightly oblique diaphragm; hydrotecal rim with bimucronate cusps) is also present in lower abundances. An *in situ* pelagic monitoring every two weeks since 2008 have allowed understanding the populations dynamics of the genus and the environmental factors that seemed to be particularly appropriated for promoting optimum growth conditions.
Baseline information regarding seasonal cycles and historical abundances were provided from a 8 years monitoring, which has allowed detecting blooms. Indeed, the medusae were found at very low densities during the study period with main abundances under 5 ind.m^{-3}, in accordance to previous reports for *Obelia* spp. medusae around the world. Nevertheless, 2 exceptional events took place in June 2008 and May 2013 were blooms reached 1232 and 660 ind.m^{-3} respectively. Such data raise questions regarding the potential importance of this small and understudied hydrozoa in the pelagic community of Thau lagoon.
Consequently, it is necessary to improve the available databases documenting medusae blooms, as this will provide baseline information about these little-studied events.

PESTICIDES MIXTURE TOXICITY ASSESSMENT IN TWO CONTRASTED FRENCH MEDITERRANEAN LAGOONS USING RISK QUOTIENTS (RQs) APPROACH

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The pesticides waters contamination of two Mediterranean lagoons (Thau and Or lagoons, France), was monitored by POCIS passive sampling during the year 2015-2016. POCIS were immersed in triplicates, in each lagoon, approximately every 3 weeks to integrate and report the water ambient contamination of these two transitional water bodies. 68 active substances from various chemical families (insecticides, herbicides, fungicides, biocides), and plenty of metabolites were systematically searched in samplers. Results showed Or lagoon is much more contaminated by pesticides than Thau lagoon: cumulated concentrations were in a range 4-5 times higher all over the year. In both lagoons, water contamination was characterized by mixtures of pesticides all over the year. These different mixtures were mainly composed of herbicides and biocides. They varied in the time and in each lagoon, according to the different uses on their watersheds. The chemical risk assessment proposed by the Water Framework Directive (WFD), compare individually each priority substance with its own Environmental Quality Standard (EQS). Using this method, both lagoons were considered as in a good chemical status during all the monitoring, considering pesticides only. Backhaus and Faust (2012) proposed a whole approach of the risk assessment using Risk Quotient (RQs), based on mixtures toxicity theory and concentration addition (CA) model. We applied this new approach on both lagoons. Even if the use of passive sampling smooth peak of contamination, pesticide risk was occasionally high in spring and summer 2015 in Thau lagoon and was high all over the monitoring in Or lagoon. High risks were sometimes due to some individual pesticides exceeding their thresholds values (but without EQS), and in the very large majority, high risks were due to effects of mixtures of pesticides simultaneously present in waters. This study point out the important gap between chemical risk assessment according to WFD or taking into account mixtures toxicity with simple models. We highlight the need to question the validity of the chemical status defined up to now by the WFD, in particular for lagoons, and the need to improve chemical indicators.

ASSESSMENT OF THE NUTRIENT LOAD FROM THE RUSSIAN PARTS OF THE VISTULA AND CURONIAN LAGOONS CATCHMENTS CONSIDERING NUTRIENT RETENTION

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Coastal lagoons (as well as lakes) play the role of biogeochemical filters reducing the nutrient load to the Baltic Sea. The estimates of retention of nutrients were made for the "lagoon-catchment" systems of the Curonian and Vistula lagoons of the Baltic Sea. Models of IL RAN and IEEP for the year of mean precipitation (220 mm/year) gave following values of the emission with river discharge to the lagoons from Russian parts of their catchments: 1780 tN/year и 90 tP/year for the Curonian Lagoon and 5970 tN/year and 560 tP/year for the Vistula lagoon, and the natural background emissions are 1030 tN/year and 30 tP/year, 2170 tN/year and 70 tP/year respectively. The first order estimates gave the equal retention for the catchments of the Curonian and Vistula lagoons: 45% for total nitrogen and 49% of total phosphorus. The retention capacities of the lagoon themselves are different, the Curonian lagoon is generally more "effective": the Vistula Lagoon is characterized by 28% and 31% of retention while the Curonian Lagoon by 41% and 49% for the total nitrogen and phosphorus respectively. In total, the retention after "consecutive filtering" of nutrients by a catchment and a lagoon for the Vistula and Curonian lagoons the retention capacities of the "lagoon-catchment" systems are 55% and 51%, 68% and 74% for total nitrogen and phosphorus respectively.
Authors were supported by State orders for their institutions.

SCENARIOS FOR SOCIO-ECONOMIC DEVELOPMENT AS DRIVERS FOR NUTRIENT LOAD FOR THE TRANSBOUNDARY PREGOLYA RIVER CATCHMENT (THE VISTULA LAGOON)

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The intensity of the nutrient load from the catchment area of the Pregolya River and its possible changes greatly depends on the socio-economic development scenarios of the region. A comparative assessment and analysis of the current agricultural status of the Pregolya River catchment area in the Kaliningrad Oblast of Russian Federation and the Warmian-Masurian Voivodeship of Republic of Poland was done. As well as the prospects for long-term development in accordance with the existing strategic planning documents of these countries were reviewed. Transboundary catchment position causes the diverse socio-economic situation in its different parts as in the two countries have developed different systems of management and decision-making. The area actually used for arable in Warmian-Masurian Voivodeship in 3 times more than in the Kaliningrad Oblast (which involved less than 50% of available land). Indicators in livestock are also higher here, for example the number of cattle in 7 times more. Further socio-economic development of Warmian-Masurian Voivodeship and environmental measures (including nutrients runoff prevention) significantly depends on the implementation of the European Union program "Operational Program Eastern Poland 2014-2020". A significant increase in agricultural production is not expected. Analysis of the "Strategy of socio-economic development of the Kaliningrad Oblast in the long term" showed the expected increase in the area of arable in 70%, cattle livestock in 3,5 times, the main crops harvest more than 2 times. In the case of the implementation of these plans nutrient load from the catchment area will increase significantly – diffuse from croplands, pastures and point sources from livestock complexes.
Data collection was supported by theme FASO 0149-2018-0012, comparative study for national areas was supported by the project RFBR BONUS 14-05-91730.

SPACE-TEMPORAL DISTRIBUTION OF THE INVASIVE CTENOPHORE *MNEMIOPSIS LEIDYI* IN TWO ADRIATIC LAGOONS (SOUTHERN ITALY)

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In recent years the growing anthropogenic impact on marine-coastal ecosystems, mainly maritime traffics and habitat modifications, promoted the increase of invasive species such as algae and gelatinous zooplankton. These species may colonize coastal lagoons through their tidal channels, determining a wide range of ecological and economic implications. Being Mediterranean lagoons transitory and unstable environments, they are important hotspots of invasion. In the last two years the Northern Adriatic Sea has been widely colonized by the ctenophore *Mnemiopsis leidyi,* a voracious planktivorous predator that has a strong impact on the pelagic community and fish resources; actually the presence of *M. leidyi* has become of concern also in the Lesina and Varano lagoons (Southern Adriatic Sea) as its blooms clog the nets for the artisanal fishing of eels; moreover, their massive presence seems to affect the population of the planktivorous fish *Atherina boyeri*. In this study the abundance, biomass, size spectrum and distribution of *M. leidyi* were investigated in the Lesina and Varano lagoons and in adjacent coastal marine areas. Zooplankton samples were collected bimonthly by horizontal tows of a WP2 net. Collected ctenophores were counted and their total length (oral-aboral length including lobes) was measured *in vivo*. At each sampling station surface temperature and salinity were measured by multiparametric probe and sub-surface (0.5 m) water samples were collected to determine the chlorophyll-*a* concentrations. Specimens of *Atherina boyeri,* caught in fyke nets located in the same sampling sites, were provided by local fishermen and immediately measured (total and standard length) and weighed. The *A. boyeri* condition index was determined by linear regression analysis of the weight-length relationship (log_{10} transformed), in order to evaluate their overall health.
Our study showed that, as previously reported for other Mediterranean lagoons, also in the Lesina and Varano lagoons the abundance and the size spectrum of *M. leidyi* depends on environmental and trophic variables, namely temperature, salinity and chlorophyll-*a*; moreover the increasing presence of ctenophores in the two lagoons leads to alterations in the zooplankton abundance and in the assemblages of zooplanktivorous fish.

ORIGIN AND POTENTIAL ECOLOGICAL RISK ASSESSMENT OF TRACE ELEMENTS IN THE WATERSHED TOPSOIL AND COASTAL SEDIMENT OF THE OUALIDIA LAGOON, MOROCCO

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The Oualidia lagoon provides important ecosystem services, such as fishing, aquaculture, tourism and high biological and ecological productivity. Many indices have been developed to evaluate environmental risks and to estimate the anthropogenic contribution of potentially toxic elements (PTE) in surficial sediments.
The results show that the concentrations of the PTE found in surface sediments due to the anthropogenic activities in the area (urban effluents, aquaculture and agricultural areas) are significantly higher than those from the local background and sediment quality guidelines (SQGs).
The potential ecological and biological risk index presents satisfactory results. However, the sites near to the areas where anthropogenic activities are developed present 49% probability of toxicity, while the rest of the lagoon, present 9% to 21% probability of toxicity and low potential ecological risk, except for Hg where the risk was considered to be significant.
The PTE are mainly originated from the anthropogenic activities; nevertheless, anthropogenic contributions represent up to 69% of the total sediment of content, but they depend on the PTE: Cd (16%), Ni (38%), Zn (41%), Cr (43%), Cu (56%), Hg (68%), Pb (69%). Compared with the Sub-basin soils, the PTE are higher than 80%, hence the sub-basin feeds the lagoon by these PTE.

ASSESSMENT OF THE PHYSICOCHEMICAL STATUS IN HELLENIC COASTAL LAGOONS

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A physicochemical quality classification method was applied on a coastal lagoons' dataset acquired through the WFD monitoring network in Greece. The method originally developed by Bald et al., 2005 from the Basque country (FA method) has been also applied in Hellenic coastal waters (PCQI index) (Simboura et al., 2016). The dataset included 17 coastal lagoons and 64 observations of physicochemical and biological data, covering three years and two sampling seasons. The method consists of a factor analysis using as physicochemical parameters: nutrients (nitrates, phosphates and ammonium), oxygen saturation, transparency defined by Secchi disk disappearance depth, standardized over lagoon depth. Reference conditions for high and bad physicochemical status were defined as the maxima or minima values over the sites' observations grouped according to average salinity ranges: mesohaline (5-18), polyhaline (18-30) and euhaline (>30). Within each salinity range various degrees of confinement may be observed (choked, leaky, restricted) corresponding to lagoon typology.

Overall results showed that the highest percentage of observations were classified as in good (61%), followed by high (23%) and moderate status (16%). In the mesohaline lagoons the highest (33%) incidence of moderate physicochemical status was recorded.

In the mesohaline lagoons the most significant factor accounting for the highest percentage of the variance of the data (factor 1) was represented by nitrates and ammonium; in the polyhaline lagoons by transparency and phosphates and in the euhaline lagoons by ammonium and nitrates. Of secondary importance (factor 2) was for the mesohaline lagoons the oxygen saturation, for polyhaline lagoons the nitrates and for euhaline lagoons the transparency.

Results indicate that eutrophication related to riverine inputs and agricultural runoff influences most of the lagoons studied.

Overall, the PCQI index showed a statistically significant correlation with the M-AMBI index (Muxica et al., 2007) used for the classification of benthic macroinvertebrates, although M-AMBI gave a more severe classification with 47% of sites in poor, 35% in moderate and 18% in good status. Results also indicated a relation between PCQI and phytoplankton index MPI index (Facca et al., 2014), which is expected to show a statistical significance with the acquisition of more data.

SEASONAL CHANGE OF THE ALIEN BIVALVE *ARCUATULA SENHOUSIA* (Benson in Cantor, 1842) POPULATION OF THE VARANO LAGOON (GARGANO CENTRAL ADRIATIC SEA, ITALY)

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Presentation type: POSTER

In this paper the seasonal observations on the abundance, wet weight and frequency classes of non indigenous bivalve *Arcuatula senhousia* (Benson in Cantor, 1842) carried out in 2015 are presented in the Varano lagoon, Gargano National Park (Central Adriatic Sea, Apulia, Gargano, Italy), during a survey carried within the framework of the Regional Project FEP Apulia 2007/2013.

Samples were collected in 12 stations arranged along three transepts perpendicular to the coastline. The sampling was carried out by professional hydraulic dredge. Collected samples were screened in situ by sieve with mesh of 1 mm. For each transept, random specimen were collected by *A. senhousia* and on which the length (mm) and the wet weight (gr) were measured and length-wet weight correlations by the ratio of the minimum squares regression and distribution of length classes were calculated. Spatial and temporal variability of abundance and size classes (length) were evaluated by the ANOSIM test. In addition to biological sampling, in two stations CTD profiles were detected. Environmental data (T°C, Salinity, O%) showed a typical seasonal pattern. The average abundance and wet weight ranged by a minimum (67±146 ind/m^2; 16±44 gr/m^2) in October to a maximum (1266±1416 ind/m^2; 411±423 gr/m^2) in July, respectively. The highest average lenght (820±5.34mm) was found in July, instead the smallest average lenght (12.82±5.41 mm) in October. One-way analysis of similarity (ANOSIM) on abundance ($R=0.250$; $p<0.001$) and lenght ($R=0.261$; $p<0.001$) data highlighted a significant difference between sampling months. The lenght showed significant differences (ANOSIM) both between transepts ($R=0.082$; $p<0.001$) and stations ($R=0.11$; $p<0.001$). Significantly positive correlations length-wet weight were found for all sampling periods ($R^2=0.9087$; $R^2=0.8508$; $R^2=0.8964$). The population growth in the Varano lagoon was extremely rapid, providing yet another example of the explosive potential of Asian date mussel populations in a Mediterranean lagoon.

LAGOON LITTER: PRELIMINARY APPROACH AND PROPOSAL OF SAMPLING METHODS FOR THE FUTURE IMPLEMENTATION OF WFD

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Presentation type: POSTER

Lagoons are one of the most productive ecosystems in the world, with unique hydrodynamic and ecological conditions. They provide many goods and services, otherwise they are located along coastal areas in which the anthropogenic pressures are very high, especially for what concerns plastic pollution. These transitional water ecosystems act as a trap for litter; in particular the impact of plastics could be higher with respect to marine litter because of the "trapping effect" of the lagoons. For this reason, the aims of this research are to analyze the methods for sampling plastics in respect to the dimension of the particles, sedimentation and suspension processes, and water circulation. Up to now, implementation methods for sampling plastics in order to measure their abundance and distribution are not well investigated, more efforts should be addressed in achieving consistency of the sampling techniques as well as standardization.
The research was carried out in the Aquatina Lagoon (South Adriatic Sea, Apulia, Italy).
The investigated plastics were divided in 3 main categories: microplastics (smaller than 5 mm), mesoplastics (between 5 mm and 2.5 cm) and macroplastics (bigger than 2.5 cm).
The lagoon has been divided in different compartments that were separately considered and sampled: water surface, bottom and banks.
Each compartment was sampled with different sampling methods such as: i) plankton net (200 μm) for the water surface, in order to have a better precision about the abundance and distribution of microplastic; ii) square method was applied for sampling bottom and banks. Bottom samples were collected using a grab while bank samples were collected by hand.
Since the quantifying of the plastics is the first step to analyze the consequences of this anthropogenic impact on human-health, food chain, supply natural and goods and services of lagoons, here we propose and applied sampling methods for collecting plastics in different compartments and in order to catch the most common dimensional categories of plastic particles.

MONITORING ECOLOGICAL STATUS IN THE VOURKARI COASTAL LAGOON (ATTICA, GREECE)

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Coastal lagoons are highly dynamic ecosystems and significant for their biological diversity while they provide precious services such as nutrient recycling, fish nursery and removal of pollutants. However, many of these coastal systems are also characterized by intense human influence, frequently leading to their transformation and degradation. The main anthropogenic pressures threatening coastal lagoons in Greece are agriculture, livestock, dam constructions, water level abstractions and overfishing. This study aims to monitor and estimate the ecological status of Vourkari Lagoon, a shallow paralic wetland and -one of the four lagoons located in Attica- based on physicho-chemical parameters, nutrients and biological indicators, accompanied by the collateral monitoring of heavy metals, total organic carbon, total lipids and oils concentrations. Three sampling campaigns have been conducted at two sampling sites on November 2016 and January and February 2017, indicating well oxygenated salty water with high nutrient concentrations and great temporal and spatial variations. Furthermore, the ecological quality assessment based on benthos has been conducted according to the Bentix biotic and the M-AMBI indices and in particular according to M-AMBI, ecological quality at both stations was moderate for both November and February while Bentix fluctuated between moderate and poor ecological quality in all months and sites. Moreover, several other activities are proposed in order to improve the ecological status of the Vourkari lagoon while further studying of biological and other key ecological parameters will result in a better understanding of its ecological structure and functioning that will facilitate the optimal management, protection and restoration of this ecosystem.

Goods and services, Conservation, Management & Sustainable Use

KEYNOTE LECTURE

Prof. MIKE ELLIOTT

HOW TO RECONCILE CONFLICTS USING A DECISION FRAMEWORK FOR MANAGING THE SOCIO-ECOLOGICAL SYSTEM IN LAGOONS

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ZEBRA-MUSSEL (*DREISSENA*) CULTIVATION IN THE SZCZECIN LAGOON: AN ECOLOGICAL-SOCIAL-ECONOMIC ASSESSMENT

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Presentation type: ORAL

The Szczecin (Oder) Lagoon at the German/Polish border in the southern Baltic Sea region is subject to heavy eutrophication. High riverine nutrient loads with the Oder/Odra River cause poor water quality, low transparency, an insufficient ecological status in the Szczecin lagoon and hamper the socio-economic development.
A comprehensive Integrated Coastal Area - River Basin Management (ICARM) approach including integrated modelling has been carried out, to solve the problems (e.g. Behrendt et al. 2008, Schernewski et al. 2008). Conclusions were that even maximum realistic riverine nutrient loads reductions in the Odra river basin seemed not be sufficient to transfer the lagoon into a non-eutrophic state. Ina follow-up approach, we analyzed to what extent a comprehensive eutrophication management approach should also include internal nutrient retention and removal measures in the lagoon. The focus was on the potential of Zebra mussel (*Dreissena polymorpha*) farming for removing nutrients and improving water transparency in the Szczecin Lagoon. Previous studies indicated Zebra mussels were abundant in the lagoon and possess a high cleaning potential (e.g. Radziejewska et al. 2009). For this purpose, an ecological model was extended by a mussel module and an economic model. The model simulations showed that mussel farming in the lagoon could only be considered as supporting measure to improve water quality (Schernewski et al. 2012).
In this presentation, we introduce and show socio-economic, ecological and modelling results for three concrete scenarios on mussel cultivation:
Scenario 1: A mussel farm that induces a self-reinforcing cycle with increasing environmental quality, nature restoration and supports the implementation of the Water Framework Directive implementation. Idea is that increasing local water transparency enables the extension of submerged macrophyte belts, which in turn stabilize the sediments and further increase water transparency.
Scenario 2: A mussel farm that removes nutrients, increases water transparency, provides feed in the most efficient way and can be maintained as a profitable business.
Scenario 3: A mussel farm close to beaches to increase water transparency in bathing areas as well as to support the extension of emerged and submerged macrophyte belts, which in turn stabilize the sediments and further increase water transparency.

BLUE CARBON CONCENTRATIONS, FLUXES AND STOCKS IN SEAGRASS MEADOWS FROM AN ANTHROPIZED TROPICAL LAGOON, IN SOUTHERN GULF OF MEXICO

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Coastal ecosystems such as mangroves, tidal marshes and seagrass meadows, known as “blue carbon” reservoirs, sequester and store large quantities of carbon in sediments, contributing to recent climate change mitigation. Therefore, degradation of these ecosystems may cause significant releases of CO_2back to the atmosphere and the oceans. However, the importance of blue carbon stocks has not been appropriately recognized worldwide, and is not yet included in coastal zone management nor in climate change mitigation plans. This is, to a great extent, due to the scarce knowledge on the distribution and the conservation state of these valuable ecosystems around the world, as well as the lack of scientific information on carbon fluxes and long term storage capacities, especially in seagrass meadows. Here, we present preliminary results of a comparative study on carbon fluxes and stocks of three seagrass species, by using ^{210}Pb dated sediment cores from Terminos Lagoon, an anthropized tropical lagoon in the southern Gulf of Mexico.

THE SYSTEMS APPROACH FRAMEWORK FOR COLLABORATIVE, SCIENCE-BASED MANAGEMENT OF COMPLEX SYSTEMS

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The Systems Approach Framework (SAF) provides a structure for an effective science-policy interface that integrates the three pillars of sustainable development; environmental protection, social progress and economic growth. Policy decision embedded in scientific evidence is likely to be more effective. The SAF embraces the challenge of assessing complex systems for scenario simulations to support potential policy decisions, which can be discussed with and among stakeholders.
The SAF provides a coherent approach to public participation that is timely, iterative and genuinely inclusive. Stakeholders have a direct interest in the outcome of decision-making, as they are often the most affected by these decisions. Furthermore, it is up to them, in many instances, to ensure that legislative changes are sustainable. Stakeholder engagement throughout the process increases social capital, as all those participating become aware of the complexity of the system, and gain more knowledge on the processes involved.
A SAF process often begins with a comprehensive identification of Issues. Listing all associated human activities and mapping of institutions and stakeholders provides an overview of the power and influence as well as potential interests in the Issue(s). Following the various Steps of the SAF, one proceeds to develop a conceptual model and, if required, a numerical model of the biological, economic and social components related to the Issue(s) to enable scenario simulation of potential management options. When carried out in collaboration with stakeholders, the SAF ensures a transparent and participatory process that may be more efficient for implementation and strengthen compliance among citizens.

SUSTAINABLE MANAGEMENT OF DANISH COASTAL FISHERIES BALANCING RESOURCE USE AND PRODUCTION UNDER CHANGING CLIMATE CONDITIONS

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In response to outcries from Danish commercial coastal fishermen claiming offshore migration of fish in recent years, the Systems Approach Framework(SAF) was implemented to formulate and address the policy issue(s). An interview study with 74 fishermen from 30 Danish harbours was conducted to elucidate the spatial and temporal magnitude of the problem. It appeared that the primary target species, cod and plaice, had moved offshore and were no longer available in several coastal areas. Following collapse of coastal fisheries, fishermen were forced to leave the industry and find alternative vocations with negative cascade effects on harbour activities and local economies. Applying the SAF in the BONUS BaltCoast project, we examined if offshore fish migration could be detected from existing survey data for the period from 1991 to 2015. The results showed a grand mean decline of target sized cod and an increase of target sized plaice. Using a Log Gaussian Cox Process (LGCP) modeling approach, inter-annual changes of cod and plaice distributions and their centres of gravity were identified, but no clear patterns of movement offshore were detected. Causal relationships between changes in cod distribution and potential environmental drivers were further addressed using Data Storage Tagged (DST) cod in the Western Baltic and a high resolution hydrodynamic model (a Cox numerical ocean circulation model) of temperature and oxygen changes for the entire Baltic Sea Region. This revealed a depth related shrinkage of potential cod habitats limiting target sized individuals to deeper, offshore waters during spring and summer probably linked to climate change. The results highlighted a misalignment with the Individual Transferable Quotas (ITQ) system which restricts individual fishermen to specific target species in allotted areas (ICES fishing zones). The combination of changed cod distribution and the ITQ system would benefit offshores fisheries from larger vessels and negatively impact coastal, small vessel fisheries. The SAF, thus, proved useful in highlighting a potential conflict which needs to be proactively addressed with stakeholders and managers at local, national and international levels.

COMPARING THE PROVISION OF ECOSYSTEM SERVICES OF DIFFERENT COASTAL LAGOONS IN THE SOUTHERN BALTIC SEA

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Coastal lagoons are one of the most important ecological systems worldwide, contributing to anthropogenic development in coastal zones. The ability of marine and coastal ecosystems to contribute to human well-being, through processes and functions is called marine and coastal ecosystem services (MCES). Transitional water bodies such as coastal lagoons provide an array of ecosystem goods and services which directly and indirectly contribute to human well-being. Hence, despite its importance these are also areas which are often fustigated by anthropogenic impacts, affecting nature's ability to provide MCES. To ensure the importance of nature and preserve those services for future generations, multidisciplinary and holistic management approaches are necessary. In the marine environment MCES concept became an integrative part of such approaches, as a good tool to raise awareness about nature's importance.
The main objective of this study is to assess and compare MCES provision over time for different coastal lagoon in the Southern Baltic Sea. The methodology chosen was the "Ecosystem Services Assessment Tool" (ESAT). This tool builds on the Common International Classification of Ecosystem Services, and addresses 31 ecosystem services assessed by 54 indicators, covering Provisioning, Regulating & Maintenance and Cultural services sections. It assesses two points in time (initial and present status) representing the different ecological status of a water body. The difference between the two statuses is classified according to a scale, representing an increase or decrease of MCES provision. The tool also incorporates the Water Framework Directive (WFD) typology to define water bodies spatially.
The coastal lagoons chosen for this study were the Curonian Lagoon (Lithuania), Darss-Zingst (Germany), Schlei (Germany) and the Szczecin Lagoon (Germany/Poland). The lagoons represent different WFD water body types. Regarding the results for sections of MCES (aggregated classes of change), for almost all locations the Provisioning Regulating & Maintenance services decreased its provision over time. On the contrary, for Cultural services all locations showed an increase in their provision over time.
Understanding how services provision changed over time is of great importance for decision makers and government when defining new management strategies for future, ensuring sustainability of MCES.

CREATING SUSTAINABLE OUTCOMES: THE NEED FOR COMMUNITY ENGAGEMENT

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A civil society is about people, and people therefore need to be at the centre of any initiative or project. Whilst the integration of the social, environmental and economic goals lead to more balanced outcomes, sustainability requires that these should be embedded in robust governance with openness and transparency on the one hand, and public participation on the other. This paper sets out the paradigm shift in government-citizen interaction that moves from a management outcomes based approach to a more collaborative partnership approach focussed on outcomes and what this means in terms of engaging with community and stakeholders. It outlines how this has been embedded into the Systems Approach Framework (SAF) for an effective science-policy interface that embraces the challenge of simulating management scenarios in complex systems and encapsulates citizen and stakeholder involvement from the onset and throughout the process for outcomes that are more successful and that lead to greater compliance, sustainability and improved social capital.

A STAKEHOLDER PREFERENCE AND PLANNING TOOL FOR COASTAL MANAGEMENT AND ITS APPLICATION FOR AN EVALUATION OF INTERNAL MEASURES WITHIN BALTIC LAGOONS

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Stakeholder involvement plays a crucial role within Integrated Coastal Management (ICM) and is considered beneficial for gaining trust and knowledge and reducing conflicts. Nevertheless, stakeholder involvement processes are still often insufficiently developed or too late within the process, and have caused public outcries and delays in decision-making and implementation of solutions to coastal problems. Hence, decision-support tools that allow a systematic and balanced involvement of stakeholders are needed. Within the scope of the BONUS BaltCoast project a stakeholder preference and planning tool was developed that can be adjusted to local specificities and used to support stakeholder involvement and decision-making processes. Based on applications within coastal management initiatives along the German Baltic Seacoast, we show how the tool can be used in combinations with ecosystem services or sustainability assessments as an awareness-raising and decision-support tool. For this, the System Approach Framework (SAF) for coastal management, with its stepwise approach from the identification of a problem to the implementation of a solution and evaluation of success, was found to serve as a suitable frame. Hence, we illustrate how the stakeholder preference and planning tool can guide stakeholder discussions within ICM initiatives systematically from generating a general view of an area and problems therein, down to the selection and evaluation of a concrete measure to tackle the problem, as well as its effects on a larger level and contribution to a sustainable coastal development. For this, the issue of using internal measures, such as mussel farms, for water quality improvement within German Baltic lagoons, is used as an example.

NEW BATHING SITES AT THE CURONIAN LAGOON COAST: APPLICATION OF THE SYSTEMS APPROACH FRAMEWORK

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The increasing tourism in Baltic Sea coastal areas gives new opportunities for region socio-economic development. Currently marine beaches attract most of the tourist in coastal area and inner coastal waters, like lagoons, due to poorer water quality remains neglected for bathing tourism. Despite past microbiological pollution events resulting in increased concerns for bathing water quality, new beach opening in the Curonian lagoon (South-eastern Baltic Sea region) is expected to favor more sustainable tourism development in the area and region.

This was the first time in Lithuania when the Integrated Coastal Management case was assessed using the stepwise, user-friendly System Approach Framework (SAF) during the BONUS BaltCoast project. The Ecological-Social-Economic aspect of the case study were assessed in a close cooperation with stakeholders. For this accurate knowledge and experimental information on microbial water pollution, its distribution, effect of new bathing place establishment to social-economic development, and certain scenarios modelling were needed.

In this presentation we will introduce the SAF application for new beach establishment from the Issue identification to the Implementation step. The issue was identified through DPSIR and CATWOE schemes. The main governance (people or institutions that make or implement laws or policy) and stakeholders (that cause the problem, are affected by the problem or affected by the solution) groups were identified and involved through the participation in meetings.

In the System Design step, we developed a conceptual model that visualised the dependencies within and between the economic and the natural scientific models. Modeling of *E. coli* bacteria (one of the two parameters according to Bathing Water Directive) distribution in the Curonian Lagoon was performed along Curonian spit and as an outcome the sinks and sources and the risks for establishing new beaches were provided.

The simulated ecological model and socio-economical model scenarios were presented for stakeholders. In close cooperation with municipality and authorities we provided a new bathing water quality evaluation system in the Curonian Lagoon with high practical relevance for end-users.

PROPERTY REGIMES OF FRENCH COASTAL LAGOONS AND THEIR IMPLICATIONS FOR MANAGEMENT

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Presentation type: ORAL

In general, coastal lagoon management puts a lot of emphasis on participatory approaches with stakeholders. It is, however, also of importance to consider the "stockholders", i.e. to consider who owns the lagoon. In this contribution we discuss the property regimes of coastal lagoons in S France and discuss the implications for management. French public law (Code généralde la propriété des persones publiques) makes a clear difference for public property between "Public Domain" and private property of the different public entities. Public domain property is imprescriptible and inalienable, i.e. the property rights cannot be changed in the future and neither transferred nor sold to somebody else. In contrast, private properties of public entities can be sold or transferred to other owners. Coastal lagoons are, in principle, included in the Maritime Public Domain owned by the French State following the definition used as "salty ponds (étangs) with a direct, natural and permanent connection with the sea". This definition may, however, create a conflict between the actual features of a coastal lagoon, which are often brackish and not really salty (e.g., oligohaline and mesohaline lagoons), while the connection with the sea can often be temporary or artificial. In practice, many of the larger coastal lagoons (e.g., Salses-Leucate, many lagoons close to Narbonne, Thau lagoon) are Maritime Public Domain. Human, exploitation as e.g. salt extraction, shellfish farming, is not excluded, but regulated by temporary concession to private actors. In contrast, large parts of the lagoon surface in the Palavas lagoon complex, in the Camargue and in Corsica are either privately owned or owned by the municipalities, departments etc. This is mainly explained by historic reasons, either because property rights were well established before the Edit of Moulins in 1566, or because private owners acquired the properties of the Crown or the Clergy (vente de biens nationaux) after the French revolution. Fragmented ownership is a clear difficulty for the integrated management of coastal lagoons and even the private ownership by public entities often creates uncertainties. Since 1975, the Conservatoire du Littoral is active to acquire coastal lagoons to cope with these difficulties.

COASTAL LAGOONS IN NORTH AFRICA: A DPSIR ANALYSIS FOR MANAGEMENT

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Coastal lagoons fringe the coastline of North Africa, from Morocco to Egypt (Atlantic Ocean and Mediterranean Sea). Theses lagoons are important both from the ecological and the socio-economic perspective. They provide many valuable ecosystem services, goods and natural resources to people living around their margins.
Nevertheless, anthropogenic pressures on the lagoon ecosystems for fisheries, freshwater, agriculture and even tourism has often lead to unsustainable resource use. Land-use changes in the catchment of the coastal lagoons results in additional pressures. As a result, many of the coastal lagoons of North Africa are disturbed, which affects the status of the environmental conditions, the ecology and hence the delivery of valuable ecosystem services. The degradation and loss of ecosystem services impacts human welfare, however society at present has failed to recognize the value and function of the coastal lagoon ecosystems.
The aim of the study is to provide the scientific knowledge base for the appropriate management of coastal lagoon (as socio-ecological systems) in North Africa. Successful water resource and aquatic ecosystem management can only be achieved if integrated, basin-wide approaches are adopted. A modified and expanded DPSIR (**D**rivers - Activities - **P**ressures - **S**tate changes - **I**mpacts (on welfare)- **R**esponses (as Measures) analysis of several lagoons in North Africa (Morocco, Algeria, Tunisia, Libya and Egypt) was used to as an interdisciplinary (natural science, social science and economics) tool to construct an adaptive management framework.

INDICATOR SYSTEM TO SUPPORT SUSTAINABLE COASTAL AND MARINE MANAGEMENT

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Many Integrated Coastal Zone Management (ICZM) initiatives have been implemented around Europe, but in general this approach failed and as a consequence Directive 2014/89 on "Maritime Spatial Planning" (MSP) was set on agenda. The main drawbacks of ICZM implementation were the lack of application of the broad holistic and long-term approach, and the lack of an adaptive management. Following the System Approach Framework (SAF) steps is considered to be an efficient way of structuring coastal and marine management processes. SAF contributes to better management in terms of sustainability priorities, which requires an iterative process using a multidisciplinary approach that integrates the three pillars of sustainable development: environmental protection, social progress and economic growth. To assess them and in the context of ICZM, indicators are used as a tool for evaluating the state and progress of sustainable development of coastal zones, whereas process indicators are intended to measure the success of ICZM implementation. Indicators are popular because of their ability to provide a simplified view of complex phenomena, quantify information and make it comparable. However, in practice indicator systems are hardly applied and there is no universal existing set of indicators that would be applicable to all coastal and marine regions.
Therefore, a joint definition of success criteria and sustainability indicators that allows a comprehensive assessment of the situation before and after the measure is needed. An indicator based pre- and post- assessment allows a systematic compilation of lessons learnt for future studies and avoids repeating mistakes. Indicator-based tools may help users, including managers, scientists, industry, or NGOs, and support decision making.
We present a set of indicators and how the appropriate use of indicators can be a powerful tool in addressing the sustainability of coastal and marine management. We compare the environmental, economic and social well-being impacts of different management alternatives for achieving more sustainable solutions, presenting application results and indicating what progress has been made towards sustainability and to which extent targets of coastal and marine initiatives have been met.

IDENTIFYING DRIVING AND FEEDBACK MECHANISMS FOR THE EVOLUTION OF THE SOCIO-ECOLOGICAL SYSTEM OF A MEDITERRANEAN ISLAND: A BACK-CASTING MODELLING EXPERIMENT

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Islands and coastal areas are complex dynamic systems with interconnected socioeconomic and ecological components. Managerial approaches for sustainable development, use of resources and conservation have to be based on the full understanding of the various drivers and feedback mechanisms defining the evolution of the dynamic system. In the current study a dynamic model is proposed aiming to quantitatively describe key variables and processes, structured along a flexible framework able to be adapted to the different socio-ecological characteristics of Mediterranean islands and coastal areas. The main economic sectors are identified for the area under consideration (e.g. agriculture, stock breeding, fisheries, tourism, industry, services) and quantitative information is collected for a recent decade. Possible relations between sectors are tested using univariate and multivariate statistics, aiming to identify a common driver (e.g. change in GDP). The economic activities are used as drivers for the evolution of the insular or coastal system and a number of indices is calculated expressing environmental quality and resource use intensity (e.g. water and energy consumption, pollution, biodiversity loss), financial growth (income, employment) and social well-being (human development index, population evolution). Feedback mechanisms are also included in the model describing both positive and negative effects. Information has been compiled and the model has been tested in the island of Lesvos, Eastern Aegean, Greece. Effects of uncertainties in the compiled data are quantified and the robustness of the model to the initial conditions is assessed. Understanding of the key-processes driving the evolution of the socio-ecological system of an island or coastal area is essential for sustainable management and in this sense the proposed model can be further used for the development of scenarios, either short-term for a decade, or long-term including global changes.

THE EFFECTS OF DREDGING THE INLETS IN A HIGHLY ENCLOSED COASTAL LAGOON: GLOBAL REGIME, WATER EXCHANGE AND ENVIRONMENTAL HETEROGENEITY

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Coastal lagoons are areas of great socio-economic importance for their surrounding regions and for this reason they are usually subject to high environmental pressures from human activities. Their functioning is strongly related to the more or less restricted communication with the adjacent sea and closing or opening of the inlets is a common practice for managing fisheries or navigation with different consequences depending on the lagoon.
During recent years, the Mar Menor has experienced severe events of eutrophication, mainly due to large amounts of nutrients from agricultural uses, with consequences for biodiversity, water quality and tourism. As a potential solution, mitigation measures consisting of dredging the channels that connect the lagoon with the Mediterranean Sea have been proposed.
However, the channels dredging have to be considered carefully as it can have important consequences, not only in the environmental ranges, but also in the spatial and temporal scales of variability and hydrological heterogeneity of the lagoons. All these aspects are crucial for the species composition and ecological complexity and functioning of these ecosystems. This study aims to provide further insights about the changes induced by the dredging of the channels on the environmental conditions of the lagoon.
The analysis is undertaken through a numerical model that allows simulating the hydrodynamic conditions of the lagoon as well as the salinity and temperature fields. Different dredging scenarios have been applied to the shallower inlets and the results have been compared between the cases with and without the dredging. Seasonal variations of the salinity and temperature, water circulation inside the lagoon and exchange with the open sea have been assessed as they are thought to be crucial for the lagoon ecosystem.
It has been found that some of the scenarios could lead to not negligible impacts in terms of homogenisation of the physical gradients and high reduction of the confinement. Nevertheless, the scenarios with a lesser or localised impact could be initially regarded as feasible approaches. Finally, this study also demonstrates that numerical models provide a suitable tool for decision makers involved in the management of highly sensitive areas of this kind.

ALTERNATIVE APPROACH AND TOOLKITS FOR THE ECONOMIC VALUATION OF ECOSYSTEM GOODS AND SERVICES OF WETLANDS: AN APPLICATION TO FARLINGTON MARSHES, UK

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Wetlands offer a wide variety of ecosystem goods and services (EGS), such as fisheries, agriculture, tourism and regulatory functions that benefit human society. Despite this relevance, there are no generally acceptable methodologies for the economic valuation of EGS of wetlands. The lack market price for most of these services makes the assessment difficult anddrives existing methodologies to rely on revealed preference approaches (willingness to pay and travel cost). Hence,value assessmentcould be compromised because it is indirectly inferred from users' opinion and willingness rather than the actual benefit or services derived from the ecosystem. In addition, current methods lack of simple resources and tools in order to make them user friendly for surveyors and researchers assessing ecosystem services value. This paper attempts to develop an alternative holistic approach for the valuation of ecosystem good and services, which is based on integrated characterisation, appraisal of EGS and an opportunity cost approach for the economic valuation of the EGS. The methodology includes fieldwork, case study in a local wetland (Farlington Marshes) and assessment of actual market values for each ecosystem goods and services, and application of opportunity cost where market values could not be ascertained.The results provide a realistic and evidence-based value to inform sustainable exploitation and management of wetlands. The outcome revealed the total economic value of the EGS offered by Farlington Marshes to be about £7,754,495, compromising support-regulation functions (£5.13 million, e.g. carbon sequestration, protection against floods and storms, formation of habitats and services for migratory species etc.), the cultural-logistic services (£2.49, e.g. landscape and aesthetic features, tourism and touristic infrastructure, etc.), and the supply-exploitation benefits (£ 0.15 million, e.g. agriculture and fodder-pasture). The paper concludes by advocating for the acceptance of this evidence-based valuation methodology for the economic valuation of ecosystem goods and service.

APPLICATION OF BAYESIAN BELIEF NETWORKS TO EVALUATE COMMERCIAL FISH STOCK RESPONSE TO FISH MANAGEMENT AND ENVIRONMENTAL CHANGES: CURONIAN LAGOON CASE

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Presentation type: ORAL

Understanding and predicting reaction of fish resources to environmental changes and changes in fisheries and fishery management decisions are essential for rational and long-term use of fish resources. Therefore, Bayesian belief networks (BBN's) can be used as effective tools for modeling ecological predictions and aiding resources-management decision-making. BBN's can be proven helpful when representing existing influence of uncertainties in ecosystem at the same time understanding variability response of the ecosystem itself. As a tool BBN also can be adapted in fisheries management system by providing testable management hypotheses and adding new knowledge to asses existing management guidelines also can facilitate in communication with non experts about making natural resource management decisions. We developed BBN to assess the Curonian lagoon most important commercial fish species. In the BBN model we incorporated several fish life stages and adult year cycles when fish occupy different habitat and the environmental requirements and fisheries pressures are different. When constructing BBN model, we combined both the actual time series data of riverine loads, temperature, ice cover, nutrient related parameters and phytoplankton to relate to CPUE and commercial fish catches in the lagoon and expert's opinion. As different fishes occupy specific habitats and have different lifecycles and environmental preferences, the BBNs were built for separate fish species. We did find well-founded relationships between the environmental parameters and fish populations related both to the climatic and fishery related parameters. We foresee that development of such BBN's models realistically represent fish stocks dynamics and provide reliable basis for evaluating impact of proposed management strategies, environmental changes and shift in exploitation of the fish resource, such model would be a valuable tool not only for fisheries management but also for better understanding of ecosystem itself.

ASSESSMENT OF THE HUMAN AND ENVIRONMENTAL VULNERABILITY OF COASTAL LAGOON HAZARD USING A MULTI-CRITERIA DECISION ANALYSIS

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This study provides an integrated approach using geographical information system (GIS) based on a multi-criteria approach (MCDA) to assess coastal vulnerability, resulting from human activity, population density, erosion and climate change-induced sea level rise. A coastal vulnerability index for erosion and floods was calculated and mapped (~24 km in length; ~400m in width, and 11.47 km² in surface) for the Nador lagoon barrier located on the Mediterranean coast of Morocco. Results suggest that 54 % (~13 km) of the shoreline is moderately vulnerable, whilst 42 % (~10 km) is highly vulnerable and only 4 % (1 km) present a low vulnerability. The vulnerability map of the socio-economic activities indicates that most wetlands and forest areas 83% (~31 ha) and 50 % (~440 ha) respectively, present low vulnerability. Fifty two percent of artificial areas (~23 ha), 73% of agricultural land (~128 ha), and 41% of natural areas (~363 ha) have moderate vulnerability. However, the level of vulnerability of the remaining artificial and agricultural areas classify from high to very high. The north-western sector was classified as the most vulnerable area, characterized by an erosion of 0.6 m/yr to 1.20 m/yr for 70% of this area while the south-eastern part shows a low to moderate vulnerability to erosion (~0.1 m/yr to ~1m/yr) for 40% of this area. Coastal vulnerability maps have potential as decision tools to identify the most exposed coastal zones to sea level rise, and to contribute to national climate change adaptation and disaster risk reduction to achieve the sustainable development goals (respectively goal 13 and 11).

THE IMPORTANCE OF PROVISIONING ECOSYSTEM SERVICES IN MANGROVE LAGOONS OF SÃO TOMÉ ISLAND (CENTRAL AFRICA): RESOURCE ASSESSMENT AND COMMUNITY PERCEPTION

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Mangrove lagoon ecosystems provide a range of goods and services with high value for local communities. These systems provide several resources, such as food (e.g. fish and shellfish), as well as raw materials such as wood and coal. In general terms, they can also be very relevant as a tourist attraction, especially for boat tours and wildlife observation. These are crucial assets for the conservation and management of mangrove lagoons, but much is still to be done, as ecosystem services are frequently overlooked and understudied. Moreover, although mangroves are some of the most threatened coastal ecosystems and their decline may jeopardize their capacity of providing benefits to the human population, they are often weakly valued by local communities.

The main aim of this study was to evaluate the importance of provisioning ecosystem services and how they are perceived by local communities. Two mangrove lagoons (Malanza and São João dos Angulares) in São Tomé Island (Gulf of Guinea, Central Africa) were selected as study sites. Food resources (fish and invertebrates) were assessed during three field campaigns in August 2017 and approximately 200 questionnaires were applied in the nearby communities.

The results obtained emphasize that despite being able to identify a mangrove tree, local communities struggle to identify these ecosystems and to understand their boundaries. Results revealed that half of the respondents acknowledge the benefits their family received from the mangrove, especially from provisioning ecosystem services. The communities that live in the surroundings of Malanza tended to recognize a higher value for these ecosystems, and were also more aware of the need to protect them. This may be associated with the touristic activities that have been developed in this lagoon, focusing on nature and directing profits to the local communities. This study shows that raising awareness about the benefits of mangroves is important to enhance their conservation and management.

MUSSEL FARMING IN THE BALTIC SEA – STAKEHOLDER INVOLVEMENT AND ACCEPTANCE

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Mussel farming in the Baltic Sea is becoming increasingly important with regard to its potential for nutrient removal as well as the accompanying 'Blue Growth' opportunities. However, regional particularities and differences exist and need to be considered. While in Denmark the main focus is on human consumption of mussels, the removal of nutrients from eutrophicated waters is the main priority in Sweden. Choices where farming sites are installed and which species are used vary accordingly. In Germany, the potential of mussel aquaculture is still being investigated. First pilot installations exist in the Bay of Kiel and Greifswald, previously also in the Szczecin Lagoon. Parallel to the technical testing at these study sites, relevant stakeholders were identified and involved from the beginning of the process in order to strengthen awareness and knowledge regarding mussel farming. Furthermore, it is of paramount importance to determine potential conflicts of use and develop strategies to prevent or mitigate them in order to guarantee a socially, ecologically and economically sustainable shellfish aquaculture on the long-term.
Our stakeholder questionnaires offer new insights how mussel farming is perceived and how it has to be adopted to the local conditions and consumption patterns. Whereas in the Bay of Kiel mussel farming is conceivable as an additional income source of fishermen, fishermen in the Szczecin Lagoon fear ecological changes potentially caused by mussel filtration and improved water quality. In several Baltic lagoons along the German coast a 'good ecological status' as requested by the Water Framework Directive cannot be reached without additional internal measures. Mussels such as *Dreissena* or *Mytilidae* have the potential to remove nutrients out of the water and offer therefore a valuable option for internal nutrient reduction and enhancements in the local water quality. Due to currently low market values for mussels in Germany it is necessary to find ways to connect the nutrient removal by mussels with financing schemes such as nutrient quota trading mechanisms or the acceptance as compensation measure.

Our stakeholder surveys are parts of the EU funded projects Baltic Blue Growth, BONUS BaltCoast and BONUS Optimus.

ZOOPLANKTON FAST RESPONSE TO RESTORATION IN NEWLY CREATED SALT MARSH LAGOONS

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Presentation type: POSTER

We analysed the zooplankton composition of six confined coastal lagoons located in La Pletera salt marshes (NE Iberian Peninsula). These salt marshes were altered and filled during the 80s by building works for a residential estate and recently restored. We sampled the zooplankton community from April 2016 to May 2017 to study the effect of restoration, hydrology and some environmental variables on community structure. Two of the lagoons are natural and other one, created in 2002, together formed the old lagoons, while the other three were created, in 2016, in the framework of a Life Nature restoration project (Life Pletera). Results showed, higher nutrient and organic matter content in old lagoons suggesting accumulation processes which may be related to lagoon age and confinement. On the other hand, we did not found significant differences in the zooplankton community suggesting that dispersal, sediment egg bank and colonization processes allow a quick homogenization (less than one year) in zooplankton composition and structure, mainly due to the small distance between water bodies in the study area (less than 2 km). However, the zooplankton temporal pattern was influenced by the hydrology: calanoids dominate during flooding conditions and *Brachionus plicatilis* during confinement. Results show a close relationship among environmental parameters and zooplankton composition, but suggest a slight delay in this relationship probably due to unpredictable conditions typically found in the Mediterranean salt marshes as La Pletera.

EVALUATION OF THE RESTORATION EFFECTS IN THE MEDITERRANEAN SALT MARSHES OF LA PLETERA (NE IBERIAN PENINSULA)

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La Pletera salt marsh, located at the mouth of the Ter river (NE Iberian Peninsula), includes a set of coastal wetlands that were partially urbanized in the decade of the 90's, leaving the salt marshes interrupted by levees, accesses, a promenade and piles of rubble. Since 2014 we are developing a LIFE Nature project (LIFE-Pletera, LIFE13 NAT/ES/001001) that aims to carry out a comprehensive and definitive restoration in order to recover their ecological functions that were altered by the building works. LIFE-Pletera main actions include the excavation and removal of the man-made elements currently covering the wetlands and their replacement by a coastal lagoon system with flooded zones surrounded by their corresponding wetland flood belts and a well-preserved dune front.

To check the effects of the restoration actions on the lagoons, two biotic indexes were used: *QAELS* (to check water quality) and *ECELS* (to assess habitat condition). Six permanent coastal lagoons were analysed quarterly (*QAELS*) and annually (*ECELS*): three natural lagoons (old lagoons) and three newly created lagoons (new lagoons). Additionally, two old lagoons were partially modified. We compared the water quality and habitat condition before (1 year), during (1 year) and after (2 years) restoration works.

The results of the evaluation show that after restoration works all lagoons had a natural variation of water quality along the year: in winter and spring the water quality was good in all lagoons (flooding period) while in summer and autumn was poor (confined period). Habitat condition was good in all lagoons (old and new) after restoration works, except in one new lagoon. The good habitat condition in old lagoons was caused by the decrease of human frequency due to regulation of access and the removal of promenade. In new lagoons, the habitat condition was good although the vegetation has not recovered. Only one new lagoon had poor habitat condition because this lagoon is located near the urban area.

COMMERCIAL AND RECREATIONAL FISHERIES AS ECOSYSTEM SERVICES IN THE CURONIAN LAGOON

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Presentation type: POSTER

Often fish resources understood directly as generated economic value by commercial catches, recreational fishing. However, the fact that such values originated from ecosystems with complex interactions, and that both economically and non-economically valuable fish populations play active roles in the maintaining and supporting ecosystems and in the provision of a range of ecosystem services, rarely taken into consideration. Ecosystem services defined by Daily (1997), ''conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life'', this includes the life-support functions of ecosystems and nature's capacity to provide aesthetic and cultural quality to human life. Fish, as an ecosystem resource is the one of the most important source of income and food protein for people communities in coastal and large fresh water body areas. In Curonian lagoon proportion and significant of small-scale and coastal fishery been decreasing due to decline in predatory and valuable wild fish stocks, which had impact to income of fishermen's. Increase in intensity and scope of recreational fishery causes confrontation between these two same fish resources using activities. Although commercial fishery has considerable impact to fish stocks and recreational fishing has its share to fish stocks and their capacity to recover, fish stocks are also influenced and dependable to biotic and abiotic environmental factors. Fish during its life cycle goes through complex ontogenesis and different life stages may often require different habitat and environmental parameters as temperature, water level, salinity. Fish larvae and juveniles often feed on different food but also occupies and requires (e.g. anadromous species) completely different habitats. Even adult fish during the year require different habitats for feeding, spawning, overwintering, therefore there is complex of factors and their interactions that affect fish stocks and the future benefits of ecosystem services provided by fish resources.

MUNICIPAL COASTAL GOVERNANCE: COLLABORATIVE SYSTEM

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Lack of reliable and in-time coastal information and understanding, and its transformation into decision making and planning-management process is the critical obstacle for coastal rural municipal governance in Latvia. EU BONUS BaltCoast project, in partnership with various municipal stakeholders, have been studying current coastal social-ecological system (SES) and, complementary, governance system situations in order to find governance process models and various complementary local innovative municipal governance instruments, which are adequate and well working in practice in case of sparsely populated rural coastal municipalities, actually representing at least 80% of national coastline municipal administration.

The case study area – Salacgriva municipality – is placed on 5-15 km in-land broad coastal strip of the Baltic sea, having bio-geo-culturally diverse and long shore line stretching for 55 km (above 10% of the whole Latvia coastline), being not at the real supervision and management, as having very limited human and administrative resources.

Case study is focused to collaboratively design and introduce on local/national and international best practice based municipal coastal governance system to be oriented towards real collaboration partnerships of the stakeholders as the key driving force for integrated and sustainable coastal management. During project, the complementary set of nationally innovative coastal governance instruments at the municipal level has been designed:

1. Coastal science-policy interface (module), including particular ICM instruments: (i) Municipal Coastal Outlook as coastal science and governance Source Book/Report/data for any ICM and other sectors decision making/planning; (ii) Municipal Coastal Monitoring Program, including, Coastal Indicators System and, importantly, Public Monitoring Program.
2. Coastal Governance System proposal for municipalities, based on governance cycle qualitative management development, particularly, on the set of all groups of governance instruments: political/legal, planning, institutional/administrative, infrastructure, financial/economic, communication.

Improvement of municipal Coastal Governance is, subsequently, based on modifying and better use of existing components, namely, (i) better application of existing municipal institutions capacities, (ii) adding new component, namely, opening space for new bottom-up stakeholders initiatives and organizing them in common package. Integrating these two components will lead to establishment of new approach for real and regular municipal assessment of coastal practice state, and, informed and collaborative governance decisions based on it.

SUSTAINABLE HARVEST OF EMERGENT MACROPHYTES AND INNOVATIVE FLOATING WETLAND ISLANDS AS AN OPTION FOR NUTRIENT REMOVAL IN EUTROPHICATED SOUTH BALTIC LAGOONS

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Lagoons with their vast wetlands along the South Baltic Sea have been heavily impacted by humans for decades and nutrients have accumulated in the sediments. During hypoxic conditions redox-sensitive elements such as phosphorus can be released again from the sediments and enhance eutrophication problems. Therefore internal measures are urgently needed in addition to mitigation measures at land in order to achieve the good ecological status required by the Water Framework Directive.
One option to tackle the internally accumulated nutrients is the harvest of emergent macrophytes. Phytoremediation is an environmentally friendly and cost-effective technology to remove nutrients as well as heavy metals from polluted soils. Fast growing macrophytes such as reed (*Phragmites australis)* are particularly suitable. Reed is one of the most dominant species of coastal wetlands along the South Baltic Sea and can store up to 8 g P m^{-2}in the above-ground biomass. Sustainably harvested biomass could then be used for a variety of products, inter alia as insulation material for walls or as roofing material, as energy source (combustion, biogas, biofuel) or as fodder when harvested in summer.
Within the *LiveLagoons* project (Interreg South Baltic) innovative floating macrophyte islands will be tested and installed in different lagoons along the South Baltic (Szczecin lagoon, Curonian lagoon, Puck Bay) to further increase the flexibility of phytoremediation. These "active barriers" can be placed in the lagoons where nutrient removal and improvements in water transparency are needed most urgently. Coastal municipalities are supported by our experts to find the best installation sites for the floating wetlands in order to maximize nutrient removal, gain additional aesthetics benefits to boost tourism and still prevent spatial conflicts of use. Ecosystem services supplied by floating wetlands are manifold and include the adsorption of nutrients by macrophytes, the reduction of water flow by the rhizome network, the enhancement of sedimentation process and thus sediment stability. This offers also a chance for submerged macrophytes to resettle and contribute to the internal nutrient reduction.
Besides the envisaged local improvements of water quality we aim at increasing the awareness of local stakeholders interested in 'green innovations for blue growth'. Furthermore, the installations of the floating islands will be linked to nutrient quota trading mechanisms for connecting effective nutrient abatement measures with voluntary financiers willing to acquire nutrient offset (EU funded NutriTrade project).

"A LOOK AT THE BENTHOS OF GREEK COASTAL LAGOONS: APPEARANCE AND IMPORTANCE" – A SHORT DOCUMENTARY VIDEO HIGHLIGHTING THE HIDDEN NATURE OF LAGOONAL BENTHOS, WITH THE AIM OF PROMOTING RESEARCH TO THE GENERAL PUBLIC

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Presentation type: POSTER

Coastal lagoons play an important environmental role supporting a variety of fauna and flora. In addition, they are of high economic value for local communities due to fishing, aquaculture and various recreational activities.
Almost all of the coastal lagoons in Greece were subjected to anthropogenic pressures in the past such as pollution, embankments, alterations of river inflow. Nowadays, however, most of them are protected existing within national protection sites and supervised by local management bodies. The presence of these regional authorities contributed to raising public awareness of the necessity for protecting the wetlands. Nevertheless, a major underwater component of them, the benthos, remains almost entirely invisible.
To highlight the environmental and social value of this habitat a compilation of motion pictures was created, depicting the benthic habitats of lagoons in Western Greece in the form of a "citizen science" informative video. Its aim is to promote the high significance of the benthic component of a lagoonal ecosystem to the general public, as well as, to demonstrate the means of researching the benthic habitat in its natural state. In addition, the benthic life captured is also of scientific use. The video shows the variety of soft bottom coastal lagoon habitats which are not typically visible during scientific sampling procedures (usually as a result of turbidity). In addition the behaviour of small epibenthic macrozoobenthos is also apparent from the footage.
The video targets audience of all ages focusing on an unusual yet innovative subject for the Greek public. Such videos are useful in depicting the macro-world of the benthos to younger audiences, and may help to inspire the next generation of lagoon ecology scientists.

STATUS, TRENDS AND VALUES OF WINTERING AND MIGRATING WATERBIRDS IN GIALOVA LAGOON, MESSINA, GREECE

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In the EU all member countries have agreed to protect habitats supporting birds listed in the Annex I, forming the Natura 2000-network of protected areas. Such an area is the Gialova Lagoon (GL) wetland, (SW Peloponnese, Greece). GL is located at a unique location in southernmost Europe, in an important migration route along the west coast of Greece. During the last century many wetlands were lost along the west coast while the remaining are still degraded by human activities (e.g. increased irrigation, draining and infilling intending to expand cultivated fields) even being part of protected areas. Coastal wetlands in particular, face more threats coming from increased tourism activity.
In this study, we compare GL bird data obtained during two monitoring periods: 2010-2011 and 2016-2017 as well as previous available data from the area in order to (1) evaluate the GL wetland as a wintering area for waterbirds by compiling and analysing winter counting data for the last 30 years, and from this see if any long-term population trends are visible; (2) analyse the wetland's status as a migration stopover area with a focus on waterbirds and bird species with higher protection status; (3) analyse the status of the nesting activity compared to previous years and (4) map which parts of the lagoon hold the highest number of waterbirds and species with higher protection status throughout the year.
This information will be valuable when forming a management plan, something which the area is missing today. What is the status of GL compared to other wetlands around the Peloponnese? Could the bird conservation in a wetland like Gialova have other direct values for, and be supported by, the local community, easing the pressure coming from tourism? Which ecosystem services could be linked to bird conservation and how can this enhance the local community?

European networks and Projects in Transitional areas and Lagoons

THE INTERNATIONAL LAGOONS FOR LIFE INITIATIVE – UNDERSTANDING THE EFFECT OF ENVIRONMENTAL AND CLIMATE CHANGE ON COASTAL LAGOON MANAGEMENT

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Coastal lagoons are complex and dynamic ecosystems that form an interface between freshwater and marine waters, are resource rich and heavily influenced by human activities. Management of lagoon systems is not only complex because of the wide range of co-located activities and interests (e.g. economic *vs*. conservation), but also because the natural status of lagoons is affected by sea level and sediment supply. That means they exist within a naturally evolving lifecycle of bio-physical change. Providing a framework that informs lagoon management should address the challenges of (i) forecasting the bio-physical evolution of lagoon systems under both natural and anthropogenically altered conditions; (ii) monitoring processes of global environmental change; and (iii) monitoring consequences for current and future extractive and non-extractive resource utilisation. Such a framework requires data that is spatially and temporally explicit and measures, either directly or via a proxy, an indicator that reflects the link and association between the bio-physical components of lagoon systems with the resources and ecosystem services that underpin the utility of anthropogenic exploitation.

The purpose of this paper is to present how the recently established Lagoons for Life initiative aims to (i) characterise the features that render lagoon systems vulnerable to physical, ecological and associated societal disturbance from global environmental change, so that we can improve forecasts of future lagoon status and the societal consequences of change; (ii) define indices derived from Earth Observation Data (EOD) that can measure change at regional and global scales and in the long term; and (iii) propose an assessment regime that could be employed by managers to address the sustainable use of lagoon resources.

SYNCHRONOUS AND STANDARDIZED OBSERVATION OF THE BIOGEOGRAPHIC DISTRIBUTION OF MARINE WOODBORERS IN EUROPE: A NETWORKING ACTIVITY

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Presentation type: ORAL

Marine woodborers such as shipworms and gribbles, are common in European Transitional Coastal Ecosystems since ancient times. Their presence in Europe has risen from the Renaissance as a result of the opening of new navigation routes to the East and the Americas, settling mainly in the estuarine environments used as ports. Recently there has been a local increase in the attack on wooden artifacts and a progressive extending north of some species. These phenomena are probably due to a set of factors, including climatic change, acting on different scales and on various physiological and ecological mechanisms. Observations on the geographical distribution of species are, however, fragmentary. During the 7th Eurolag Congress in Murcia, the proposal for a European-level observation was advanced. Eurolag's colleagues, and the European network for the study of marine woodborers, responded enthusiastically to the call, on a voluntary basis. Sets of standard panels, obtained from the same lot of *Pinus sylvestris*, were therefore exposed simultaneously in lagoons, estuaries and harbors, at site equipped with systems for hydrological monitoring. The experiment was conducted in 21 sites spread over 13 Countries, covering a latitude range from 36°N to 58°N and longitudinal range from 1°W to 28°E, from the South Mediterranean to the Baltic and from the Black Sea to the Atlantic Ocean. The experiment is concluding, geographic distribution data, species and genetic characterization, invasive species diffusion, abundance and quantification of bioerosion will be presented at this Eurolag conference. A study on the fungal component is also in progress. This work is one of the results of Eurolag's networking activities.

THE INTEGRATED RIVER-DELTA-SEA SYSTEM INVESTIGATION: THE PAN-EUROPEAN RESEARCH INFRASTRUCTURE DANUBIUS-RI PHILOSOPHY

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The DANUBIUS Research Infrastructure (DANUBIUS-RI) is a new initiative to address the challenges and opportunities of research on large river- sea (RS) systems. DANUBIUS-RI is a distributed pan-European RI that will provide a platform for interdisciplinary research. It will deal with RS investigation through facilities and expertise from a large number of European institutions becoming a 'one-stop shop' for knowledge exchange in managing RS systems, ranging from freshwater to marine research.
Globally, RS systems are complex and dynamic, with huge environmental, social and economic value. They are poorly understood but under increasing pressure through pollution, hydraulic engineering, water supply, energy, flood control and erosion. RS systems in Europe are among the most impacted globally, after centuries of industrialization, urbanization and agricultural intensification. Improved understanding is essential to avoid irreversible degradation and for restoration.
DANUBIUS-RI will provide, among a number of other facilities concerning observations, analyses, impacts' evaluation, a modelling node that will provide integrated up-to-date tools, at locations of high scientific importance and opportunity, covering the RS systems – from source (upper parts of rivers – mountain lakes) to the transition with coastal seas. Modelling will be one of the major services provided by DANUBIUS-RI, relying on the inputs from the whole RI.

FROM IN BASIN TO IN LAGOON MEASURES: COULD BIOMANIPULATION IN BALTIC COASTAL LAGOONS IMPROVE THE WATER QUALITY

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Presentation type: ORAL

Three Baltic lagoons (Oder, Vistula and Curonian) are the largest coastal lagoons in Europe and characterized by a oligohaline salinity gradients and strong riverine influence. Despite differences in the external nutrient loads and water residence time (Vistula lagoon receives much less freshwater inputs than Curonian or Oder) the cyanobacteria blooms are common but not cyclic phenomena. The overall loads of phosphorus which is expected to be the limiting nutrient in most of the lagoons are estimated to be in the range of 2 to 10 tons per square km of the lagoon surface what is much higher than in most of the Mediterranean lagoons. However much of the nutrients are expected to pass through the coastal towards the sea during the spring flood period. Model calculations of the reduction in nutrient loads needed to improve the water quality at least to the "GOOD" status according to the Water Framework Directive proved that any sensible action in the drainage basin is likely to be economically irrelevant, especially taking into account the dominance of the nitrogen fixing cyanobacteria. We have considered other options including the cultivation of mussels and reed harvesting. However in the oligohaline waters of Baltic coastal lagoons only few species could be cultivated and ice cover could create additional difficulties for the cultivation. The reed harvesting could provide substantial removal of nutrients but is restricted by the conservation status of the lagoons which are mostly under habitat and bird protection directives.
However there are positive examples in application of phytoremediation which are, unfortunately, restricted mostly of areas outside the Baltic Sea. The introduction of the BioHaven technology extensively used in the USA and China is the one of the promising solutions to the Baltic lagoons as well. We plan to adapt it to the Baltic lagoons environment selecting regional tailored plant selection (see poster Karstens et al.) to achieve at least a local improvement in water quality which could be viewed as an economic improvement for local communities. The project LiveLagoons started in the Southern Baltic could possibly provide a tool attractive for both environmental authorities and local communities not only in the Baltic sea rea, but also in other regional seas.

QUALITATIVE AND QUANTITATIVE ANALYSIS TO ASSESS THE SYSTEMS APPROACH IN COASTAL LAGOON TOURIST DESTINATION PLANNING

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Presentation type: ORAL

Among the main objectives of the BaltCoast project of the EU BONUS (Baltic Sea Research) programme 2010-2017 is to develop a coherent and systematic approach to Integrated Coastal Zone Management (ICZM) in the Baltic Sea, which covers multiple impacts in a spatially varied context, including seaside tourism. The BaltCoast project to a large extent relies on application of the 'System Approach Framework' (SAF) methodology, which provides a structure for an ICZM process.

In the BaltCoast project, a re-analysis of selected 19 ICZM case studies from the previous EU OurCoast project has been implemented to check how much SAF was already applied in ICZM processes, and six case studies have been chosen for an in-depth pilot demonstration of a comprehensive SAF role to ICZM process.

In order to assess the effectiveness of coastal area planning processes in relation to sustainable tourism and SAF, a qualitative study (content analysis of planning documents) and a quantitative survey (mining and processing of visitors' needs expressed through online reviews via TripAdvisor) were applied for selected coastal tourist destinations that also are BaltCoast target territories. Four South Baltic case studies have been chosen from the 19 ICZM re-analysis case studies for our comparative survey: Timmendorfer Strand–Scharbeutz (DE), the Hel Peninsula (PL), Klaipėda-Palanga (LT), and Town of Liepaja (LV), and one (Curonian Lagoon, LT) was chosen from the six main SAF studies.

Content analysis of comprehensive plans and development strategies of the tourism-related target areas of BaltCoast was applied using a 'nuts-and-bolts' approach to get an insight into the planning of seaside tourism sustainability. The visitor needs were downloaded from TripAdvisor and submitted to KH Coder 2.0 software for quantitative content analysis. Using KH Coder 2.0, a hierarchical cluster analysis was undertaken to elicit topical co-occurrence networks for nouns, verbs, and adjectives occurring in the reviews.

The results of the comparative analysis of the two surveys show that the contents of the planning documents and the feedback from visitors are adequately related, which is a good first step towards the implementation of the SAF in tourism-related ICZM projects in coastal lagoons and transitional areas.