XXIV Congresso dell'Associazione Italiana di Oceanologia e Limnologia

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VOLUME DEI RIASSUNTI

BOOK OF ABSTRACTS

Il presente volume raccoglie i riassunti dei contributi presentati al XXIV Congresso Nazionale dell'Associazione Italiana di Oceanologia e Limnologia. I contributi sono riportati in ordine alfabetico, in base al cognome del relatore o del primo autore.

This volume is a collection of the abstracts of the scientific contributions presented at the XXIV Congress of the Italian Association of Oceanology and Limnology (A.I.O.L.). Abstracts are reported following the alphabetical order, according to the speaker's or first author's surname.

RELAZIONI AD INVITO

INVITED LECTURES

The use of environmental samples for High-Throughput Biodiversity monitoring: Current knowledge and future perspectives

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Obtaining accurate inventories of species biodiversity is fundamental to gain a better understanding of ecological processes and to mitigate the impact of biotic and abiotic stressors. A diverse array of monitoring tools is available for biodiversity monitoring but conventional tools all require the physical capture of species and are often unsuitable for rare and cryptic species. In recent years, research has shown that by applying High-Throughput Sequencing technologies to DNA extracts from environmental samples (eDNA) highly detailed biodiversity inventories can be obtained. This approach, often referred to as eDNA metabarcoding, is highly suitable for the detection of rare and cryptic species and workflows allow for rapid processing of samples thus reducing labour and cost requirement. For aquatic biodiversity in particular metabarcoding has become a highly popular monitoring tool with current studies focusing on a wide range of taxa (i.e. ranging from plants to vertebrates). During this presentation I will outline the current knowledge and applications of eDNA metabarcoding. In particular, some of the activities undertaken within the EU Interreg project 'Eco-AlpsWater' will be highlighted which specifically aims to promote the implementation of these technologies into traditional monitoring surveys. Finally, I will discuss some of the current challenges and future perspectives.

Key positions and additive effects in food webs

FERENC JORDÁN

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Some organisms have disproportionately large effects on ecosystem functioning, while others play less important roles. Since species are coevolving in richly connected interspecific interaction networks (e.g. trophic networks), importance can be related to network position: central food web positions may indicate more important species. This means that network analysis offers quantitative tools to identify key species. Testing structural predictions by experiments is not easy but simulation models can help to understand their predictive power. We constructed food web simulation models and performed sensitivity analysis in order to measure the community response after disturbing single species as well as pairwise combinations of species. Comparing these results, we could identify the additivity of disturbance effects. Pairwise perturbations resulted in additive (i + j = ij) and non-additive effects, the latter were either synergestic (i + j > ij) or dampening (i + j < ij). We quantified the food web positions species pairs and tested how additivity depends on combined food web position. This kind of research can contribute to systems-based conservation and support multi-species maximum sustainable yield assessment in the future.

Voices from the water: how experience, knowledge, emotions link past, present and future, through long-term ecosystem research

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As human beings we realize our living immersed in networks of conversations, which represent both a great treasure and a great danger. It is through the voices that we are listening to and through the narratives we embrace that we learn and reflect about the natural world and that we perceive our deep interconnections with or separation from it. In long-term ecosystem research (LTER) conversations occur among multiple actors. Based on the last decade activities of the LTER networks, in particular at the national (LTER-Italy) and European (LTER-Europe) level, we try here to describe and highlight the major outcomes and challenges, by imagining them as different voices, which we are listening to and we are talking with. Organisms, ecosystems, methodologies, data, researchers, stakeholders and citizens: their "voices", which we receive, interpret and express, create our experience and knowledge, which we share with and convey to our contemporaries and future generations. At the same time, these voices shape, and are influenced by, our "inner world" (our emotions, thoughts, identities and beliefs), which is the main responsible of generating shifts in behaviors and values, enabling actions in uncertain or unprecedented situation. In the presentation, one of the main narrator's voices will be that of phytoplankton: how we "listen" to them, describe and share long-term data and researches, also with the wide public. Through the "voices from the water" we will report and discuss experiences, recently carried out within the LTER-Italy network, which have been relevant also to open up our views on the role that science is challenged to play in a world of rapid change, characterized by complexity and contradictions.

Long-term changes and short-term variations of land use and nutrient loadings in the Po river basin: old problems and new challenges

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This contribution aims at presenting and discussing reconstructed long term data series in order to elucidate relationships between land uses and anthropogenic pressures, and nutrient loadings in the Po river basin, an example of heavily exploited watershed. The main goal is to disentangle permanent changes or shifts which occurred in the last half century from slow or transient processes and episodic or infrequent events. Moreover, processes or events with multiple causality and major time lags are considered in order to assess possible legacies and their impact on environmental policies and current management practices. Four main points are addressed through time series from 1960s to date: 1) spatial distribution and time evolution of land uses and associated N and P budgets; 2) long-term trajectories of reactive N and P loadings exported from the Po river; 3) responses of the coastal sea to loadings and their changes; 4) impact of environmental policies either on successful management or unsolved problems.

In addition to unsolved problems, emerging issues, especially related to climate changes, are discussed as challenges for research and management. Examples on the main issues will be handled based on the Po river case study. Nutrient stoichiometry and budgets, including silica, are expected to be impacted by hydrological constraints in a different way in the Apennine (e.g. river intermittency) and Alpine (e.g. lake oligomixis and meromixis) sides of the watershed. The nitrogen legacy, namely the accumulated nitrate in groundwater, and complex relationships between rivers and groundwater are supposed to delay solutions aiming to reduce nitrogen contamination. The impact of wet deposition on sewer overflows and wastewater processing, and the management of sludge disposal may further cause phosphorus pollution. To contrast these recurrent problems, nature based solution have been tested and can be applied, at present mainly for managing nitrogen contamination. They exploit different management options of neglected aquatic ecosystem of the secondary hydrographic network, i.e. ditched and canals and gravel pit lakes. Furthermore, the hydraulic and ecological restoration of such waterbodies can offer solutions, not only for managing the nutrient excess, but also for storing water and mitigate storm-water events.

Finally, problem analyses on the one hand and possible solutions on the other have to take into account the temporal and spatial scales on which issues have to be dealt with in order to preserve and restore river basins, set sustainable management goals and, ultimately, harmonize environmental policies.

COMUNICAZIONI ORALI

ORAL PRESENTATIONS

Environmental migration, climate changes, geology and natural resources: a long complex history

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The link between environmental changes and migration is often the complex result of a series of more or less related causes: economic reasons, social reasons and political reasons. These can at various levels be influenced by changes in environmental and demographic conditions. Also the ways in which the populations, which migrate due to environmental causes, move can be of various types: internal or international, voluntary or forced and temporary or permanent. These typologies depend on both the times and the ways in which the environmental changes occur (sudden or gradual, temporary or permanent, periodic or occasional) as well as the intrinsic characteristics of the territory in which they live and the spatial-temporal evolution of this also with respect to the neighbouring territories. A recent experience of collaboration between human and natural research scientists on these issues will be presented and discussed by way of some real examples from past and recent history. We try to understand how and why the relationship between the physical characteristics of the territories (geography and geology) and the migratory phenomena, as a result of a long complex natural and cultural history, can (re) question human rights and democracy.

The perspective of the AIOL scientific community on aquatic science future

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During the last AIOL Congress held in Cagliari in September 2017, the President Antonio Pusceddu proposed that the AIOL community draw up a position paper on the state of the art of aquatic sciences in Italy. The idea was to represent the authoritative voice of an important part of the Italian scientific community dealing with aquatic ecosystems (seas and oceans, lakes and rivers, transitional environments, etc.) from different and multi-colored points of view, taking into account the current knowledge on these issues, analyzing their strengths and weaknesses, shortcomings, problems and future perspectives.
For this purpose, a dedicated workshop was organized as part of the Cagliari 2017 AIOL congress in order to gather the first inputs, suggestions and criticisms. This first exchange served to capture the feeling of the present AIOL community and to begin to understand what were the current strengths and the burning issues, the investment and commitment needs in the coming years by the scientific community as well as the decision-making system.
Then we also liked to involve the rest of the AIOL scientific community along this path and therefore we decided to build a survey that could give us more useful information to set up the document, as well as being a tool to inform them of this initiative.
Today, we will present the publication recently published on the AIOL Journal (Advanced in Oceanology and Limnology) where the contribution of the AIOL scientific community on the future of aquatic sciences was gathered, presented and discussed.

A metabarcoding survey of planktonic protistan community in two Mediterranean LTER sites, the Lagoon of Venice and the adjacent gulf

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Two adjacent coastal LTER-Italy sites, the Lagoon of Venice (LoV) and the Gulf of Venice (GoV), were sampled seasonally for environmental DNA and relevant abiotic variables with the aim of assessing the relative importance of environmental factors in structuring the protist community.
The analysis of 56 samples taken at 7 stations from April 2016 to February 2017 targeted the V4-18S rDNA fragment, of which ca 6 million reads were obtained. Reads were grouped into 97% OTUs, and their presence in both marine and lagoon sites (generalists) or in one of the two environments only (specialists) was assessed. Different statistical, multivariate and network analyses were performed to identify temporal and spatial variations in community structure and their driving factors.
The 4,535 OTUs obtained were affiliated to 35 taxonomic protist groups. The community of the whole area was dominated by Bacillariophyta, especially in spring-summer and in the LoV, and by Dinophyta, mainly in the GoV. Ciliophora, Syndiniales and Cryptophyceae were the next more abundant groups. The protistan community composition was different in the two ecosystems, which shared only 25% of the OTUs. The network analysis showed different degrees of complexity in the community structure, separating LoV and GoV in two different sub-networks. The protistan variation related to environmental variables was quite low (16,7%), suggesting that biotic factors and inter-taxa relationships may be the main drivers in structuring the communities. This was particularly evident in the LoV, where OTUs' connections were stronger than in the GoV.
Overall, the metabarcoding approach allowed to depict for the first time the composition of the whole protist community in the lagoon and adjacent coastal waters with high resolution and provide an assessment of the relatedness of these communities and of the main factors shaping their structure.

Studio dei principali proxies oceanografici, geochimici e radiometrici sui siti osservativi S1-GB e E1 del Macrosito Alto Adriatico (A.A.IT12-000-M) della rete LTER e RITMARE

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I sistemi osservativi Meda S1-GB e Boa E1 costituiscono un patrimonio scientifico di informazioni meteo-marine acquisitine gli anni nell'area costiera Emiliano Romagnola e rappresentano un record storico a disposizione per il miglioramento delle politiche ambientali per la gestione, l'uso, la conservazione e il ripristino delle risorse degli ecosistemi acquatici.
In questo lavoro vengono presentatii dati di 6 carote di sedimento prelevate durante le crociere oceanografiche EL14, LTER-ANOC16 e INTERNOS17 nelle aree marine in cui sono ancorati due sistemi osservativi Meda S1-GB e Boa E1(sito LTER Alto Adriatico)ed alcune serie temporali relative ai principali parametri meteo-oceanografici (direzione e intensità del vento, salinità, torbidità,portate fluviali) acquisiti tramite le due stazioni negli anni 2014 - 2017.
I dati ottenuti attraverso l'integrazione di diversi proxies oceanografici, sedimentologici, geochimici e radiometrici permettono di ottenere informazioni sulle relazioni tra le portate fluviali e i forzanti meteo-marini e sull'influenza delle portate sulla colonna sedimentaria.
Il controllo cronologico dei sedimenti campionati, effettuato tramite l'utilizzo dei radionuclidi, e la caratterizzazione geochimica degli stessi ha evidenziato che il sito S1- Delta del Po è principalmente influenzato dagli apporti fluviali del Po e risente meno dello stato del sistema marino; il sito E1- Costa Romagnola, invece, è rappresentativo di apporti appenninici e risulta maggiormente influenzato dalle condizioni meteo-marine che possono alterare il record sedimentario.
I dati raccolti contribuiscono ad ampliare le conoscenze inerenti la caratterizzazione oceanografica e ambientale del Nord Adriatico.

Hot moments and hot spots of benthic nitrogen cycling along a gradient of complexity

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Benthic nitrogen (N) cycling consists of microbially-mediated processes, strongly affected by physical factors and by the presence of macrofauna and primary producers. N cycling was studied in detail in benthic ecosystems characterized by low species and functional diversity, often by means of oversimplified experimental set up. Such approach does not allow to disentangle all the various interactions within a community, and often leads to large, unidirectional fluxes of energy and matter. Aim of this work is to analyze how three interplaying factors (light, background nutrient levels and biodiversity) regulate the coupling of benthic N transformations. This was tackled along a gradient of increasing complexity, taking into account emerging properties associated to the interactions among species as well as hot moments and hot spots where key N-processes occur. Measurements are based on paired light and dark incubations of microcosms collected from a freshwater water body, including sediments and different primary producer growth forms and macrofauna functional groups,. N-related process (uptake, denitrification, DNRA, ANAMMOX, N-fixation) were quantified by addition of 15N stable isotopes to the microcosms. Results from this work suggest that in healthy benthic ecosystems N paths are scattered in a wide array of multiple processes regulated by trophic and community interactions. Complex communities tend to minimize both N imports (i.e. fixation) and optimize N recycling. The outcomes of this work add to the international literature a new generation of holistic experiments targeting the relationships among benthic diversity and N cycling in aquatic environments. A deeper knowledge of these relationships may help to understand how anthropogenic pressures and species loss affect N turnover in benthic ecosystems.

Time series, knowledge and experiences from the aquatic sites of the Italian Long Term Ecological Research Network (LTER-Italy)

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The Italian LTER Network (LTER-Italy) includes 79 research sites, operated by approximately 55 institutions, where ecological researches are carried out over decades. More than half of the LTER-Italy sites are in aquatic systems, representing the main freshwater, transitional and marine ecosystems across the national territory.
In this session, results from long-term ecological observations gathered at a number of aquatic freshwater and marine LTER sites will be presented. Furthermore, visions and practices towards an open science approach applied to long-term research will be discussed and the main public engagement initiatives within LTER-Italy will be illustrated.

Ecosystem functioning and efficiency loss in degraded coastal ecosystems: a case study from *Cystoseira spp.* meadows and barrens in the Mediterranean Sea

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Habitat loss, fragmentation and degradation have been recognized as major threats for biodiversity worldwide. This particularly affects ecosystems based on habitat-forming species, which are considered as ecosystem engineers able to sustain high levels of associated biodiversity and ecosystem functioning, thus ensuring high levels of productivity. In the Mediterranean Sea canopy-forming algae form some of the most diverse, productive and valuable ecosystems along intertidal and shallow subtidal rocky coasts, as those formed by Cystoseira spp. The effects of Cystoseira spp. forests regression have been so far assessed mostly on biodiversity, but few studies have been conducted on the loss of ecosystem functioning and efficiency. Even fewer studies have been conducted on the smallest biotic components, prokaryotes and meiofauna, which have a prominent role in the biogeochemical cycles, matter recycling and the transfer of energy and organic matter along the food web. The aim of the present study was to investigate the relationships between biodiversity and ecosystem functioning and efficiency in macroalgal forests vs barren grounds in six areas of the Western-Central Mediterranean Sea, characterized by the co-occurrence of these alternative states. To test the null hypothesis that biodiversity, ecosystem functioning and efficiency did not vary between macroalgal forests and barren grounds, we investigated the organic matter degradation rates, prokaryotic abundance and biomass and their relationships with meiofaunal (at higher taxonomic level) and nematode diversity (in terms of structural and functional/trophic diversity and life-strategies). All of the investigate variables showed a significant and positive effect of the presence of algal forests and a strong relationship between biodiversity and ecosystem functioning. Our results indicate that the loss of Cystoseria spp. forests and their transformation into in barren grounds lead to the collapse of ecosystem functioning and efficiency. We provide evidence that the restoration of algal forests is essential to recover the ecosystem functioning of degraded hard bottoms.

The BLUEMED initiative in the Mediterranean sea

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Since 2014 nine European Countries (Croatia, Cyprus, France, Greece, Italy, Malta, Portugal, Slovenia, Spain) and the European Commission (EC) have been promoting and supporting the BLUEMED Research and Innovation Initiative for blue jobs and growth in the Mediterranean area (www.bluemed-initiative.eu). In 2017, through the Valletta Declaration, BLUEMED has been formally endorsed by all member countries of the European Union and of the Union for the Mediterranean (UfM), including non-EU countries. The 'soul' of the BLUEMED initiative is a Strategic Research and Innovation Agenda (SRIA), which identifies key challenges that need to be addressed and related actions and goals, according to three main pillars: enabling knowledge for the Mediterranean, sectorial enablers in the Mediterranean, and enabling technology and capacity creation for the Mediterranean. In order to promote the implementation of the BLUEMED SRIA, the EC funded the BLUEMED Coordination and Support Action (CSA), a project, coordinated by the CNR, that involves all the EU Member States supporting the BLUEMED Initiative. Its success will mostly depend on the ability to involve the relevant actors and stakeholders in the definition of knowledge driven shared strategies, to be implemented at national and international level. To support the participative process, while connecting the top-down and bottom-up approach and stimulating a dialogue among stakeholders, the BLUEMED project established four thematic working groups, the so-called BLUEMED platforms at Mediterranean level. Three of them reflect the three pillars on knowledge, economy, and technology clustering the SRIA key challenges; an additional cross-cutting platform is dedicated to policy. The BLUEMED platforms are conceived as fora where national representatives interact to convey the messages from their communities to consolidate the BLUEMED SRIA.
At Italian level, various initiatives have been developed for involving different stakeholders. One of the results of this continuous interaction is “The BLUEMED Italian White Paper”.

Microplastic ingestion in the *gourmet* crustacean *Aristeus antennatus* (Risso, 1816) in Sardinian sea

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The use of synthetic plastic literally exploded during 1950-60' and, nowadays, plays such an integral role in daily life that a mark can recorded in the timeline of human race: the "Plastic Era". Tons of plastic litter enter and persist in the marine environment through a number of pathways and this is globally recognized as one of the most concerning threats to oceans' wildlife. In particular, the ingestion of fragments of plastic smaller than 5 mm, known as microplastics (MPs), has been reported for a wide variety of organisms, covering all geographical and bathymetric boundaries. However, its spatial occurrence and effects on wild populations remain quite unknown. Present study targets an economically and ecologically key species dwelling in deep-sea habitats of the Mediterranean Sea: the deep-water shrimp *Aristeus antennatus* (Risso, 1816). This species is internationally appreciated as gourmet food and consist of some of the most valuable fisheries resource in European Atlantic and Mediterranean waters, with landings worth cumulatively hundreds of millions of Euros. *A. antennatus* is commercially trawled in Mediterranean deep waters at depths of 40 m down to over 800 m depth. Samples were collected in the framework of the MEDiterranean International Trawl Survey (MEDITS) scientific surveys conducted around the island of Sardinia (GSA11) in 2017. A total of 64 samples of stomachs were collected for *A. antennatus*, over a depth range comprised between 470 and 655 m depth, across 7 sites. Our survey, differently to the other data available in literature was based on an extraction protocol specifically devoted to MPs detection in biological tissues rather than visual inspection of stomach contents. Once extracted and sorted, the polymer composition was identified using Fourier transformed infrared (FT-IR) spectroscopy technique. In addition, n. 10 blank control samples were processed to detect eventual contamination throughout the steps of the protocol in different days, showing the absence of environmental contamination.

Overall, 275 particles have been identified in *A. antennatus* stomachs, of which 70 were identified as polymers. All sites showed the presence of at least one individual with MPs in the stomachs, thus, occurrence in sites was 100%. A total of 42 stomachs out of 63 were positive to MPs, with an occurrence of 60.7%. Average MPs abundance was: 1.11 ± 0.12 items stomach^{-1} (mean ± std. error). The maximum number of particles per stomach was 3 (observed in 15% of positive stomachs), while the majority of samples showed the presence of 1-2 particles (cumulatively 85%). Fibers of polyester were the most abundant category of MPs, followed by fragments of polyethylene and polypropylene.

Statistical analyses based on uni-variate PERMANOVA routine were conducted to test for significant differences in MPs frequency and abundance among different locations investigated, using the factors 'site' and 'geographical sub-area' singularly, as unique source of variation. The test showed no significant difference for both investigated factors. In addition, there wasn't any evidence of relation between individual size and the number of particles ingested. Overall, MP ingestion was confirmed to cover a wide spatial range over a deep bathymetry (470-655 m), pointing out the ubiquitous presence of these pollutants. *A. antennatus'* close trophic relation with the sea bottom might enhance MPs exposure and ultimately lead to accidental ingestion. Our results based, on an efficient and reliable extraction protocol shows higher occurrence values compared to the only study present in scientific literature based on visual sorting of stomachs contents. In addition, our results emphasize that MPs ingestion is not limited to polyester fibers balls but to a wider range of particles.

Linking lifestyle and foraging behaviour of microbial communities: do particle-attached microbes 'share' their goods?

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Prokaryotes are the leading actors of the marine carbon cycle, hydrolysing high molecular weight organic matter into smaller molecules by means of extracellular enzymes, which can be found both cell-bound or released in the surrounding waters (cell-free). Models and measurements with model substrates have so far depicted a scenario in which free-living 'selfish' microbes use cell-bound enzymes, whereas cell-free enzymes should be advantageous for particle-attached prokaryotes. However, no direct assessment of the 'social' vs. 'selfish' behaviour has been performed specifically on particle-attached microbes. Thus, in order to test the hypothesis that particle-attached prokaryotes are more prone to behave in a 'social' manner compared to free-living ones, we investigated the uptake of five fluorescently-labelled polysaccharides (FLA-PS) by microbial communities at the LTER station C1 in the northern Adriatic Sea. Furthermore, to test whether bacteria growing on particles are more prone to produce cell-free exoenzymes, we set up a controlled experiment, amending bacterial isolates with phytodetritus, in order to promote aggregates colonization. In this case the production of cell-bound and cell-free exoenzymes of both free-living and particle-attached bacteria was quantified by means of simpler artificial fluorogenic substrate analogues. Preliminary results obtained with FLA-PS indicate that prokaryotes that utilize complex polysaccharides according to a 'selfish' mechanism are both in the free-living and particle-attached form. On the other hand, the experiments performed with simpler model substrates, highlighted an increased contribution of cell-free proteases to the total hydrolytic pool in samples bearing aggregates and particle-attached bacteria. The continuation of these activities by testing the response of (i) natural communities in the productive season to FLA-PS amendments and (ii) the one of different bacterial isolates to other types of fluorogenic substrates will help to identify the conditions under which different uptake mechanisms predominate, deepening the current knowledge on the organic matter cycling in the ocean.

Toxigenic potential of cyanobacteria populations in the LTER subalpine lakes

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Deep Subalpine Lakes (DSL) are experiencing changes that are effecting, among others, also the phytoplankton communities. Alterations of cyanobacteria populations have important consequences on their toxigenic potential. For example, the increasing presence of Tychonema bourrellyi in DSL is accompanied by the increasing concentrations of anatoxins in the lakes water. In fact, in Lake Garda anatoxins are already found at levels higher than the other common toxins, microcystins. Anatoxins and microcystins have very different properties: besides the different target organs (the former are neurotoxins, the latter hepatotoxic), anatoxins are low molecular weight alkaloids with specific toxicological properties, specific distribution and excretion/detoxification mechanisms in living organisms, and specific degradation pathways in the environment. In order to assess the effects of the changes going on in the DSL on their toxigenic potential, in 2016 a survey was conducted in lakes Garda, Como and Iseo. To catch the seasonal variations of cyanobacteria diversity and abundance, a monthly sampling scheme was adopted, covering at least the spring-summer-autumn succession. In addition, in one occasion also Lake Lugano was sampled. Sampling and analysis protocols were uniform for all lakes. Analysis showed that, generally, anatoxins levels were always higher than microcystins' in lakes Garda and Como. In Lake Iseo, instead, alternate periods of anatoxins or microcystins dominance were observed. In Lake Lugano, finally, no anatoxins at all were found. In general, the most represented microcystins were a few demethylated variants; but, especially in late summer, minor quantities of standard variants were also found. The microcystins profiles were not homogeneous among lakes, as a result of the different composition of the cyanobacteria populations.

Model approaches to the study and management of lake ecosystems: the cases of Lake Como and Pusiano

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Lake are complex systems characterized by the interplay of physical, chemical and biological processes. The physical forcing in particular determines the degree of mixing of the water masses that in turn influences the distribution of both chemical and biological species. Coupled hydrodynamic-ecological models integrate the description of both physical and chemical-biological processes and they can be thus important tools for the study and the management of lacustrine environments. In recent years, the scientific community also developed open-source lake models, such as the one-dimensional General Lake Model (GLM) implemented within GLEON (Global Lake Ecological Observatory Network) with the main goal to integrate model simulations and real time measurements. One-dimensional models are “economical” computational solutions that simplify the system to the processes occurring on the vertical neglecting those occurring on the horizontal direction. Originally, these models were designed to study the dynamics of small or mid-sized lakes and resulted particularly efficient in long-term simulations (e.g. climate change impact studies). Recent researches demonstrated the applicability of one-dimensional models even to large and deep environments such as the deep south-alpine lakes. Different studies curried out in these environments however underlined a marked spatial heterogeneity induced by different physical features such as: complex morphometry, inflow intrusions and differential wind action. Such a spatial heterogeneity can be captured only using more complex models such as three-dimensional ones. These tools nevertheless present the disadvantages to be much more time consuming and computational demanding. In this contribution we will present some present and past experiences of 1D and 3D modelling on two subalpine lakes: the deep Lake Como and the mid-size Lake Pusiano.

30 years of multifaceted plankton research at the LTER-MC site in the Gulf of Naples (Italy)

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Plankton are a pivotal component of the diversity and functioning of coastal marine ecosystems. Long time series of observations are the best tool to trace their patterns and variability over multiple scales, ultimately providing a sound foundation for assessing, modelling and predicting the effects of anthropogenic and natural environmental changes on pelagic communities. At the same time, long time series constitute a formidable asset for different kinds of research on specific questions that emerge from the observations, whereby the results of these complementary studies provide precious interpretative tools that augment the informative value of the data collected. In this paper, we review more than 140 studies that have been developed around a Mediterranean plankton time series gathered in the Gulf of Naples at the station LTER-MC since 1984. These studies have addressed different topics concerning marine plankton, including: i) seasonal patterns and interannual trends; ii) taxonomic diversity, with a focus on key or harmful algal species and the discovery of many new taxa; iii) molecular diversity of selected species or of the whole planktonic community; iv) life cycles of several phyto- and zooplankton species; and v) trophic relationships, parasites and viruses. Overall the products of these researches demonstrate the great value of time series besides the record of fluctuations and trends and highlight their primary role in the development of the scientific knowledge of plankton much beyond the local scale. The research conducted so far at LTER-MC has paved the way to the 'augmented' marine observatory NEREA, which is taking its first steps exploiting the full range of advanced analytical tools (including omics) set up for the oceanographic environmental research. For the future, plans are made to increase the links to societal issues by providing stakeholders with knowledge-based directions and through citizen science projects, with the aim of increasing the involvement of citizens in the coastal systems' management.

Sea Futuring Tours (SFT): imagining the future of the sea in Napoli and Taranto

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Over the last century, deep transformations have changed the Italian landscape, subtracting coastal area to their marine vocation in favor to a massive industrialization, which has left many traces in the urban, social and natural environment. Although the sea remains at the center of many relationships between humans and the environment (fishing, tourism, bathing, research, etc.), its natural dimension, its richness and complexity have been suffocated and neglected. Is it possible, today, to imagine a future in which the sea return to be the protagonist of these areas and where the vital and intimate link between man and the environment be restored?
Starting from these questions, a group of researchers from the LTER Italia network promoted a series of workshops on new ways of imagining the future of the sea in two Italian coastal areas strongly affected by the anthropogenic impact, Bagnoli and Taranto, as well as LTER sites dedicated to the study of marine biodiversity. The workshops called "Sea Futuring Tours" were proposed as part of the program of the 2017 "Cammini LTER", a travelling event organized by LTER Italia every year in order to inform a wide public about activities of the LTER network. The Tours involved students from local high schools with the aim to produce visions on the future of their area not only based on expertise but also on sensorial and perceptive experience, on local and indigenous knowledge and collecting the perspectives of citizens living and working in the area.

ResponSEAble – Protecting the ocean: our collective responsibility, our common interest

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ResponSEAble is funded by the European Commission's Horizon 2020 program and has 15 partners from around the European Union. For the last four years, the project has been looking at ways to connect people to their seas so that they treat oceans with greater respect, by helping them to better understand the complex human-ocean relationship. The starting idea is simple: if people have better knowledge they will make responsible decisions – in other words, they will become "ocean literate".

But who needs to know what? What are the target audiences? What kind of information is needed? What are the best channels or methods to transmit information to these audiences? How do we encourage people to become more knowledgeable, to make responsible decisions and change their behavior? And why, sometimes, don't we act even if we have the right information?

Answers to these questions served as a basis for the development of several innovative ocean literacy tools targeting different audiences. The effectiveness of these tools was also tested as part of project activities. Project findings were consolidated and shared through a series of ResponSEAble webinars. A knowledge base for marine key challenges was built, an interactive guidance for practitioners is under development.

As a last step, the project organized Ocean Dialogues event together with the H2020 project MARINA, and in cooperation with IOC-UNESCO and SERICA group of the European Parliament, on the role of Ocean Literacy and Responsible Research and Innovation in supporting effective Ocean Governance to ensure the sea matters to all, resulting in a final manifesto on how to make RRI and OL effective and successful including in seizing opportunities that the policy framework offers.

The presentation at the AIOL Congress will focus on ResponSEAble experiences with targeting key stakeholders along the value chain of marine key issues.

Fishermen-scientists-institutions partnership to combat marine litter through Fishing for Litter: the Adriatic Sea (Mediterranean) experience

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Fishing for Litter (FFL) is an initiative that aims to reduce marine litter by involving the fishing industry. Fishing boats are given large bags to collect the litter that gathers in their nets during normal fishing activities. Once in the port, they can unload the bags free of charge. FFL initiative started in Scotland at the beginning of the 21st century, but it was almost an unknown practice in Italy until a few years ago.

Between 2012 and 2015, ISPRA researchers and fishermen from Chioggia (Italy) established a strong partnership in the framework of the EU project GAP2 (Bridging the gap between science, stakeholders and policymakers). The Chioggia case study aimed at stimulating a bottom-up approach for the inclusion of fishers' proposals into the management discourse. Through a constant dialogue between researchers and fishermen, the need to manage the high amounts of waste that fishermen daily found in their nets strongly emerged. In the absence of clear instruction on how to dispose of the litter, fishermen had no alternative other than throwing it back to the sea.

The occasion to face this problem came with EU projects DEFISHGEAR (Derelict fishing gear management system in the Adriatic Region) and ML-REPAIR (Reducing and preventing, an integrated approach to marine litter management in the Adriatic Sea) that put together scientists, fishermen, policy-makers and stakeholders to combat marine litter in the Adriatic-Ionian macroregion. Chioggia fishermen contributed to define the project aims and shape the proposal. Between 2014 and 2019, FFL pilot projects were implemented in Adriatic ports, including Chioggia. Municipalities, port authorities and waste management companies significantly contributed to solving the obstacles created by the lack of legislation and obscure bureaucracy. Here we reflect on the value of the partnerships between scientists, stakeholders and institutions and their contribution to achieving better ocean governance.

Effects of salt wedge intrusion on macrobenthic communities in the river Po delta

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Salt wedge intrusion lead to the salinization of water bodies in deltaic areas thus impacting aquatic ecosystems. The responses of macrozoobenthic communities to such environmental stress was investigated in four arms of river Po delta (Northern Italy) along a salinity gradient. Macrobenthic communities were sampled on 14 sites from 0 to about 22 km distance from the river mouth, in two different dates (march and july) corresponding to different seasonal levels of salt water intrusion. Eight environmental descriptors were measured (distance from the sea, temperature, dissolved oxygen, oxygen saturation, salinity, water depth, conductivity and pH). The impacts on macrobenthic communities were assessed both in terms of structural and functional diversity, by means of taxonomic diversity indices and trophic groups and biological traits, respectively.

The results showed that distance from the sea, salinity and temperature were the most relevant environmental factors shaping the macrobenthic communities. The salt wedge intrusion during summer lead to significant community simplifications both in terms of structural and functional diversity. Higher values of taxonomic diversity indices were found in the most distant sampling sites, while no clear patterns were observed at mid and short distances to the river mouth.

The analysis of functional and biological traits revealed that epifaunal k-strategist species with relative long life cycle and gathering collectors were more abundant in upstream sites. Increasing abundance of infaunal and opportunist r-strategist species with relative short life cycle increased were observed moving towards the river mouth. The comparison of different seasonal results highlighted that macrobenthic communities cannot recovery completely after disturbance.

The study demonstrates that salt wedge intrusion is a serious threat to the conservation of aquatic biodiversity. As salt wedge intrusion is expected to increase its magnitude as a consequence of climate change, management measures are urgently needed.

Time series of organic matter and nutrients in the Gulf of Trieste

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In the northern Adriatic Sea the variations in the riverine discharges are influencing the trend of dissolved and particulate organic matter and of nutrients. A nineteen years' time series was analysed, from January 1999 to December 2017, in the Gulf of Trieste, where a long term ecological monitoring has been conducted since 1970. The LTER-C1 site is located in the shallow Gulf of Trieste (maximum depth 25 m), which is the north-easternmost edge of the Adriatic Sea. The Gulf is strongly affected by the highly variable riverine discharges, mainly from Isonzo River, controlling salinity and nutrients supply. Higher riverine inputs generally characterize late spring and autumn while drought periods occur in winter and summer.
Depth profiles of salinity and temperature were determined using CTD probes and discrete water samples were collected monthly at four depths in order to measure dissolved oxygen, dissolved organic carbon (DOC), particulate organic carbon (POC), chlorophyll a and nutrients (nitrates, phosphates and silicates).
The study area seems to be affected by increasing riverine discharges in the period investigated, as shown by the negative linear trend of salinity both in surface and in deep waters. As a consequence of the higher riverine inputs, a significant increase in nitrates and silicates surface concentrations was observed. On the contrary, a decrease of phosphate concentration in the investigated period was detected, in agreement with the oligotrophication trend already observed in the Gulf of Trieste and in the open northern Adriatic Sea. Similarly to nitrates and silicates, DOC concentration seems to be affected by the increased freshwater discharges and by the temperature rise. Overall the trophic status, as described by the TRIX index, shows a decreasing trend.

What is blue growth? And how does it relate to the sustainable development of marine environments? The experience of the IMC Foundation in aquaculture in Sardinia.

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Sardegna Ricerche (SR) is the Sardinian institution for research and technological development, which assists the regional government in political decisions concerning research, innovation and technological development. SR manages the Science and Technology Park of Sardinia, of which the IMC Foundation, in Oristano, is a site.
If we read from the SR website, the IMC “carries out applied scientific research in the marine, lagoon and coastal areas, with particular regard to environmental management. He also deals with scientific dissemination in the same fields. The main objective of the IMC Foundation is to promote scientific research, international cooperation, training and dissemination, aimed at the correct management of bio-resources and the Mediterranean marine environment, thus contributing to policies for sustainable development of the territory ".
In these few lines we find all the slogans of blue growth, but in practice the sharing of data between research institutions is normally lacking, and the involvement of the interested actors (politicians, entrepreneurs, non-experts) in the definition of the themes and contents of the research itself is missing.
The experience of the IMC on aquaculture and sustainable fisheries management in Sardinia is a good example of the lack of coordination and the frequent overlap between the various institutions involved in the sector. How do you pass in a few (5-10) years from a research institute in the Sardinia research system, with the introduction of new tasks related to technology transfer? Secondly, what should be the relationship between such different institutions as Universities, CNR, MPA, FLAG, regional technical services, etc., especially considering the diversity of skills of those who have a role to play in blue growth and sustainable development. ?
Finally, we will ask ourselves: is the current organization of science able to take up this challenge, or is it also necessary to rethink the roles of the different actors in defining the priorities and the most important topics of blue growth?

The importance of the dialogue for a shared governance of the ocean: theories and experiences

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The Mediterranean Sea has been a crucial crossroad for the history, economy and culture of Europe, Middle East and North African countries. However, until very recently, past and current impacts of human activities on the basin have been largely neglected, nor has a coordinated plan for a coherent and sustainable use of its resources been developed.
The concept of sustainable marine and maritime economic development, "Blue Growth", adopted by the European Union (EU) can be expressed as a knowledge driven quantum jump in the exploitation of marine resources, radically different from current practices and fundamentally aimed towards the improvement of the social wellbeing. Blue Growth implies a drastic change from how operators from marine and maritime sectors have traditionally addressed management of marine resources, towards a synergistic, non- conflicting and sustainable use of the sea, still allowing for a significant growth and prosperity.
The EU Blue Growth initiative represents a long-term strategy to support growth in the maritime sector as a whole by harnessing the untapped potential of Europe's oceans, seas and coasts for the creation of "blue" jobs and economic growth. To this aim, nine European Countries (Croatia, Cyprus, France, Greece, Italy, Malta, Portugal, Slovenia, Spain) and the European Commission (EC) have been promoting and supporting the BlueMed Research and Innovation initiative for blue jobs and growth in the Mediterranean area (www.bluemed-initiative.eu) since 2014. Since 2017, BlueMed has been formally endorsed by all member countries of the European Union (EU) and of the Union for the Mediterranean, including non-EU countries, through the undersigning of the Valletta Declaration. The EC also funded the BlueMed project (2016-2020), a Coordination and Support Action (CSA) to promote the implementation of the BlueMed Strategic Research and Innovation Agenda (SRIA).[1] The BlueMed SRIA is a shared reference for the Mediterranean countries, that addresses key challenges and identifies the main common priorities to foster Blue Growth.
The Italian BlueMed community has recently drafted a White Paper[2] illustrating the national position on Blue Growth. It builds on an overview of the status of different sectors and activities of marine and maritime economy, among which those considered pillars for Blue Growth due to their underexploited potential, with the scope to more specifically identify the impediments of sustainability and sketch possible roadmaps and scenarios to foster the Blue Growth in the Mediterranean area. This document condenses the results of targeted interactions within the Italian scientific community and several players and stakeholders, including the Italian Ministries involved in marine and maritime affairs.
Against this landscape, this session has the objective of collecting and exchanging theories and experiences on a sustainable governance of marine and maritime resources, basing – as BlueMed does – on the twin pillars of fostering relevant research and of engaging all concerned actors in order to promote solid and sustainable political choices.
Alongside projects or initiatives sharing the BlueMed focus on research and networking, contributions on international cooperation and science diplomacy in the Mediterranean area are also very welcome.
The first part of the session, hosting the speakers' contributions, will be followed by a second part devoted to a structured debate among the participants and with the public, with the final aim of producing a shared position paper summarizing the inputs emerged during the session.

[1] http://www.bluemed-initiative.eu/strategic-research-and-innovation-agenda/
[2] http://www.bluemed-initiative.eu/wp-content/uploads/2019/04/Bluemed_WP_Executive_ENG_Aprile2019. pdf

Long term ecological research in a coastal site: a focus on potentially toxic species

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Temporal modifications in the composition and relative abundance of different planktonic compartments are the result of the synergy of multiple environmental as well as anthropogenic drivers, which, in the case of abrupt and substantial changes, may determine sudden shifts in ecosystem status and possible important implications for the upper trophic levels and, ultimately, for ecosystem services.
In the present study, a 30-year (1986 – 2015) time series of data on phytoplankton abundance and community structure collected in the Long Term Ecological Research (LTER) site in the northernmost part of the Adriatic Sea (Gulf of Trieste), has been reanalysed, with particular focus on long–term dynamics of the blooming of potentially toxic species and on the possible effects on local economic activities based on marine living resources. Abrupt modifications in phytoplankton abundance and taxonomic compositions were observed and three main regime shifts were identified, involving biological as well as hydrological and meteo-climatic variables. In order to explore the possible effect of large-scale atmospheric oscillations on local ecosystem dynamics, we also address the link between atmospheric oscillations, oceanographic properties, inter - annual variability of phytoplankton abundance and the appearance of potentially toxic dinoflagellates (Dinophysis and Alexandrium taxa) as proxies. Results indicate that the long-term phytoplankton dynamics is mainly driven by large-scale meteorological drivers which affect seawater temperature, river inputs, precipitation and, to a lower extent, nutrient availability. Significant correlations between Dinophysis seasonality and long-term evolution and banning of mussel farming in the area indicate this taxon as the main threat to local economic activities.

Managing aquatic vegetation in shallow eutrophic lakes: lesson and challenges from Lake Fimon (Northern Italy)

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In most of shallow aquatic environments excessive nutrient load can generate a rapid growth of aquatic vegetation. The production and accumulation of macrophytes biomass can further induce anoxia and reducing conditions which deteriorate water quality and ecosystem status. In addition, dense vegetation biomass is also detrimental for human usage of lakes such as navigation, fishery and tourism.

To limit the excessive macrophyte growth various techniques are commonly used, such as mechanical or manual (by scuba diver) harvesting, which are expensive and often ineffective, while the causes of these abnormal growth are generally understudied.

Factors influencing growth and distribution of aquatic macrophytes are multiple and frequently depend on water and sediment characteristics, land use in the watershed and on the recreational activities themselves (i.e. fishing, boating).

The identification and quantification of these factors are critical for scientifically supporting decision making, in order to identify the best strategies to limit an excessive growth of macrophytes, to contrast the ecosystem deterioration, and allow a sustainable fruition.

In this study we estimated the external and internal loads of nutrients and factors affecting their patterns in a shallow eutrophic lake (Lake Fimon, Vicenza) which is greatly impacted by the excessive growth of *Myriophyllum spicatum*. The main aim was to identify the causes of the accelerated spreading of the macrophytes, in order to adopt measures for contrasting the lake filling and to restore an healthier status.

Benthic N pathways in illuminated and bioturbated sediments studied with network analysis

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The regulation of benthic nitrogen (N) cycling by multiple interactions among bacteria, macrofauna, and primary producers is poorly understood. We hypothesized that a biodiverse benthic system should better exploit the benthic N-availability and retain N than a simpler one. Retention occurs by avoiding losses both to the water column via increased recycling and to the atmosphere via decreased N_2 fluxes and by limiting energy-costly processes as N-fixation. We also hypothesized that primary producer-bacterial competition is reduced in the presence of macrofauna due to mobilization of refractory N pools. To this purpose, the effects of two bioturbators (the detritivorous *Sparganophilus tamesis* and the filter-feeding *Corbicula* spp.) and two primary producer growth forms (the rooted macrophyte *Vallisneria spiralis* and microphytobenthos) on benthic N cycling were studied. An array of N-processes were measured along a complexity gradient (from bare sediments to all combinations of the above mentioned organisms). Mass balance models were constructed for each treatment and then analysed via ecological network analysis (ENA). The suit of algorithms, applied to the microscale, revealed differential partitioning of N fluxes among bare sediments (highest denitrification rates), sediments with macrofauna (highest recycling), and sediments with rooted plants (highest N-fixation). N_2 losses and inputs were significantly reduced when all components were represented, and N requirements by primary producers were to a large extent supported by the activity of macrofauna. Ecological interactions in biodiverse benthic systems promoted an efficient exploitation of sedimentary N pools, increased the coupling between recycling and uptake, and maximized N use efficiency at the expenses of losses and imports.

Lake Maggiore (LTER_EU_IT_045) and the eLTER Transnational Access programme: a positive experience

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Lake Maggiore is a deep subalpine lake (surface area 212 km^2, max depth 370 m, volume 37 km^3) located in North Western Italy. The lake catchment (6600 km^2) is shared almost equally between Italy and Switzerland. Regular studies on Lake Maggiore have been established in 1938 with the foundation of the Istituto Italiano di Idrobiologia Dott. Marco De Marchi in Verbania Pallanza (since 1978, part of the National Research Council of Italy). From 1952, meteo-hydrological data are regularly collected by an automatic station in Verbania Pallanza and limnological survey are conducted regularly. These data contributed to describe the eutrophication of Lake Maggiore that occurred between the 1950s and 1970s. In the 1980s, a long-term monitoring program, still on going, was established, funded by the International Commission for the Protection of Waters between Italy and Switzerland (CIPAIS). Thank to this program, a long-term series of limnological data (meteorological, hydrological, physical, chemical and biological data) have been collected. Due to this extensive dataset, Lake Maggiore has been included as research site in the LTER Italy and LTER Europe networks. The main research topics considered at this site are the evolution of the trophic status, the dynamic of plankton and fish population, the microbial loop, the effects of climate change, including extreme events, on hydrology, thermal structure, water chemistry and biological communities, biodiversity, invasive species, micro and macro pollutants, paleolimnology, satellite data, hydrodynamic and ecological modelling. Recently, Lake Maggiore has been selected among the 18 Transnational Access site in the framework of the eLTER H2020 (Integrated European Long-Term Ecosystem & Socio-Ecological Research Infrastructure) and ranked as the highest applied site. Here we will briefly present the scientific activity and summarize the results obtained within this cooperation.

LTER marine data and Open Science: the experience of the "Ecological Northern Adriatic Open Science Observation System (EcoNAOS)"

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The Northern Adriatic Sea (NAS) is one of the 25 research parent sites belonging to the Italian Long Term Ecological Research Network (LTER-Italy). The NAS is undergoing a process, led by different research institutions and projects, of the establishment of a marine ecological observatory, building on the existing facilities and on long-term ecological data. This process requires the implementation of the Open Access and Open Science principles, by creating an open research/data lifecycle, which involves sharing results, data, metadata, methods, and software.

To this purposes, the Ecological Northern Adriatic Open Science Observation System (EcoNAOS), conceived within the RITMARE Flagship Project, was developed, with the aim to practically apply the Open Science principles to each step of the work for long term marine data valorisation: sharing papers on research ideas and outcomes, code, data and metadata. The database we refer to, recently made openly available on DEIMS-SDR (the metadata and site registry of LTER-International), consists of 50 years (1965-2015) of observations (more than 10 thousand) on abiotic parameters, and phyto- and zoo-plankton abundances.

In this presentation, we briefly discuss the actions concerning the whole Open Science process and those required to operate on the NAS database. We then report some significant or innovating experiences, discussing as well strength points and shortcomings encountered. Finally, we point out optimal solutions and we evidence the main obstacles (afforded and/or possible) to achieve them.

Implementation of the EU environmental flow policy and requirements: a review with a special emphasis on Italy

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Environmental degradation and habitat loss caused by increasing anthropogenic pressures affect freshwater aquatic ecosystems worldwide. River ecosystems, though characterized by naturally high levels of hydrodynamic perturbation, include many different essential aquatic-terrestrial habitats, which, as a whole, represent an important component of the human beings' welfare. Disturbance caused by anthropogenic activities, worsened by global change, has progressively caused changes in freshwater flow regimes, channels' morphology, flow capacity and habitat availability, thereby causing severe degradation of rivers' ecological integrity. The ecological flow (e-flow) is commonly intended as the quantity, timing, duration, frequency and quality of water flows required to sustain freshwater, estuarine and nearshore ecosystems. Maintaining the e-flow represents a necessary option for the preservation of autochthonous communities, environmental services and cultural/societal values, and also a reliable tool for managing river ecosystems. The European Water Framework Directive (WFD; 2000/60/CE), requires all Member States to implement and integrate, in the River Basin Management Plans (RBMP), a national methodology for the assessment of e-flows that ensures the achievement of a good ecological status for water bodies. We reviewed the approaches adopted so far for the e-flows assessment in different basin contexts at the European and Italian scale. Our survey points out that, in the last decade, a wide array of methods has been proposed and adopted for the e-flow assessment. These span from methods based only on hydrologic approaches to others based on a more accurate appraisal of the connections between the hydrological regime and the ecological status of the water bodies, using complex combinations of biological and eco-hydraulic indicators. We conclude that each of the methods appears reliable within the basin-scale context, out of which their application is difficult if not, even, unreliable.

Building key competences and methodologies to involve knowledgeable and reflexive citizens in policy making process

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The active involvement of citizens in the policy making process, when facing to complex issues such as ethical, environmental and social, is becoming more and more relevant all across Europe.

Indeed, in a shared perspective of the governance, facing with social and innovation issues and fully understanding its perspective through an inclusive process entails to deal with inclusive, reflexive and resilient decision making process, as suggested by the RRI approach[1].

However, according to Fishkin[2], an active and informed participation of citizens in the policy making process, implies that they are able to express a responsible and conscious point of view: so they become human beings that do not behave just as "users" and "producers" but emerge as key "knowledgeable"[3] and "reflexive"[4] actors, able to manage knowledge and to take an active part in decision-making processes being aware of their impact in the socio-political sphere[5].

In the framework of the special session "Blue Med" the IRPPS-CNR research team "Studi Sociali sulla Scienza, Educazione, Comunicazione (COMESE)" will introduce some considerations on the different methodological approaches, on the role of competences, evaluation and analysis to promote an active, conscious and responsible involvement of citizens in the decision making process.

The considerations will be lead from studies and experiences realized by the research group through the last years. In these studies, some models (ETHICs AND POLEMICS, REPOPA[6]) and a set of key competences needed to promote participatory, reflexive and inclusive policy making processes were identified (Ethics and Polemics[7], Projects DESCI[8] and Diypes[9]).

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[6] http://form-it.eu/goodpractice/projects/ethics_and_polemics.shtml

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Food addicted fish: impact of the invasive alien algae *Caulerpa cylindracea* Sonder on the central nervous system of *Diplodus sargus*

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The non-native clonal macroalga Caulerpa cylindracea Sonder is widely distributed across the NW Mediterranean. This seaweed can alter the structure and functioning of benthic assemblages as well as sedimentary organic matter attributes. Recent studies revealed that the seabream Diplodus sargus has included C. cylindracea in its diet. This results in altered physiological characteristics of the fish and potentially detrimental consequences on its population dynamics. Mechanisms that lead this species to maintain this algae among its preferred food items is unknown. To shed light on this issue, we exposed D. sargus to a mixed diet made of shrimps and fragments of C. cylindracea for 30 days in mesocosm. Controls were fed with shrimps only. At end of the conditioning period, fish were suppressed, after having being anesthetized. Before suppression, a group (n=3) was left fasting from the mixed diet for 12h. Brains were sectioned with a vibrating microtome and the sections, preserved in a cryogenic liquid, stored at -20°c until analysis. Sections were incubated with a monoclonal antibody for Tyrosine hydroxylase and inspected under epifluorescence confocal laser microscope to measure neurons' area, perimeter and soma circularity. We report here that only specimens left fasting from C. cylindracea were characterized by a significant decrease of neurons' soma area and perimeter. The decrease of neurons soma area is a typical response to withdrawal which occurs also in drug-addicted mammals, including humans. Our results demonstrate for the first time ever that the reason by which D. sargus, once occasionally ingested the algae, maintains it among its preferred food items is the result of a typical addiction mechanism that involves the central nervous system.
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River-groundwater mixing: how irrigation and N excess drive N dynamics in Po Plain watersheds

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From global to local scales, N budgets performed to investigate and manage anthropogenic pressures generally hypothesize but do not quantify N accumulation in soils and groundwater. This is a key issue for river basins like the Po River and its sub-basins (Northern Italy), which drain a heavily fertilized and irrigated agricultural land and are characterized by springs. We hypothesize widespread river- nitrate-polluted groundwater interactions during irrigation periods. Large fractions of river discharge are diverted to irrigate permeable soils by flooding, a practice that enhances nitrate transfer from soils to groundwater and from groundwater to rivers via springs and river-groudwater interaction. As a result, nitrate display sharp increase in stretches without point N inputs and crossing areas with springs. Aim of the work, part of the INTEGRON project supported by Fondazione Cariplo, is to integrate N budget at watershed scale with the role of groundwater as N source, quantifying N-rich groundwater input to rivers. Soil N budgets were calculated for Oglio, Adda and Ticino watersheds and were integrated with experimental N mass budgets. During 2017 we performed reach-scale N balances by seasonal samplings of river water in segments crossing the springs area. For all basins a soil N surplus and water contamination risk emerged, as N inputs (mostly livestock manure and synthetic fertilizers) largely exceeded outputs (mostly crop uptake). Reach-scale N and conservative parameters balances suggested diffuse contamination of nitrate-rich groundwater into the river. Similar outcomes were found for the Oglio River using a water quality model (QUAL2Kw). The combination of basin level budgets, experimental balances and QUAL2Kw modelling represents an effective tool for the evaluation of diffuse N pollution and for optimal water quality management.

Beyond the rhetoric of dialogue at the science-policy-society interface: lessons learnt from working with fishers in the Northern Adriatic Sea (Mediterranean)

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Ensuring the establishment of an effective dialogue and a direct collaboration of societal actors at the science-policy-society interface is considered as one of the preconditions to succeed in defining and enforcing adequate policy measures in support of ocean governance and the development of a "blue society". This is the case of fisheries where the engagement of fishermen and fisheries stakeholders, in the generation of knowledge-base used for setting fisheries management is now an emerging practice. Such approach can be extended even towards the inclusion of fishermen and their representatives in the context of co-management schemes, where fishermen may directly contribute (among others) to setting rules and to monitoring, control and surveillance activities.

We reflect on the attributes, effectiveness, barriers, needs, pros and cons that such a participatory approach entails when applied in the real world. To this end, we critically reflect on the merits and limitation of the process we established through a series of international projects enforced in the context of the Northern Adriatic Sea fisheries (GAP1, GAP2), identifying key issues that practitioners should consider when willing to act in practice at the science-policy–society interface.

In particular, we focus on the implications for scientists, policy makers and stakeholders of establishing effective dialogues in context of i) knowledge generation in fisheries science and ii) policy making in fisheries management, and we compare our experience with current practices.

We argue that shifting from the mere consultation towards the actual engagement of stakeholders can be seen as one of the key needs to make such participatory approaches to be really effective and prevent the rhetorical representation of the business as usual approach that tends to claim that stakeholders are already involved in fisheries management.

Effects of local and global stressors on a large and deep lake south of the Alps: Present status and perspectives of LTER investigations in Lake Garda

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The limnological investigations of the LTER research site of Lake Garda (Macrosite IT08-Subalpine lakes) are based on a wide multidisciplinary approach aimed at understanding the long-term temporal effects of climate change and anthropogenic pressures on biotic communities and ecosystem functionality. Specific activities include the assessment of the nutrient impacts (P, N, Si) and climatic fluctuations; the identification of factors favouring the development of cyanobacteria, the genetic characterization of toxigenic strains, the measurement of several toxins classes (e.g. hepato-and neurotoxins), and the evaluation of their impact on the use of water resources for drinking and recreational purposes; the reconstruction of the lake secular evolution based on the paleolimnological study of plankton remains in deep sediments; the identification and impact of alien and cryptogenic species. Over the last few years, investigations have been complemented by additional research lines including metagenomics and metabolomic profiling. Microbial and cyanobacterial communities have been and are studied using High Throughput Sequencing techniques and massive amplification of 16S rRNA genes with MiSEq Illumina technologies. Related approaches are underway for the characterization of heterotrophic and photosynthetic protists based on the analysis of 18S rRNA genes. The characterization of bioactive molecules in cyanobacterial species isolated from Lake Garda is performed using semi-untargeted metabolomic analysis with LC-MS. The general significance and value originating from the introduction of these new tools in the completion of data collected with traditional methods and in the understanding of the long-term changes of large lakes will be evaluated and discussed with a selection of results obtained from the investigations carried out in recent years in Lake Garda. The vitality and progress of scientific research in Lake Garda and in the other LTER large lakes should be founded not only on the adoption and updating of new conceptual models, but also on the opening towards new technologies.

Silica regulation and nutrients stoichiometry in a subalpine lake: from external loads to in lake processes

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Silica (Si) is an essential nutrient and the molar ratio of Si relative to nitrogen and phosphorous is relevant in the eutrophication process of aquatic ecosystems because it determines species composition. Lakes and reservoirs are biogeochemical reactors that recycle, store, remobilize and transform material. However, related to the well-studied N and P, few works have examined factors controlling Si loads, retention and stoichiometry in lakes.
In the frame of the project ISEO (Improving the lake Status from Eutrophy towards Oligotrophy - Fondazione Cariplo 2015 - 0241) we analyzed Si, N and P loads and recycling in Lake Iseo. The purpose of this work were: 1) estimation of Si loads and fate and the relation with N and P; 2) evaluation of Si accumulation and recycling in the littoral zone in relation to primary producers activity.
Quantification of incoming (3175 ton TSi y^{-1}) and outcoming Si loads (1178 ton TSi y^{-1}) suggest that Lake Iseo is a net Si sink and retains 63% of total load, causing a different stoichiometry alteration in summer and winter period. Intact core incubations of different substrates collected from the littoral zone during the summer vegetative period indicate that the littoral zone mainly recycles DSi to the water column, but the intensity of Si regeneration differs among investigated microhabitats. Bare sediment colonized by benthic microalgae and rooted macrophytes show the highest release (121 µmol m^{-2} h^{-1}) while rocky shores colonized by epilithon have the capacity to store Si during the all period (-29 µmol m^{-2} h^{-1}). Considering also the sedimentation rates, littoral zone result a net sink of Si, with a sedimentation (365±41 ton BSi y^{-1}) stronger than regeneration (146±45 ton DSi y^{-1}) in water and the Si retained mainly goes to the bottom of the lake (1634 ton Si y^{-1}) trapped into the monimolimnion.

Bringing back aquatic vegetation in agricultural ditches to bridge the WFD missing goals on eutrophication

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The interest on agricultural ditches as effective filters to buffer nitrate pollution has been raised only recently. Although ubiquitous elements of human-impacted watersheds, they still remain largely understudied and rarely included in restoration programs compared to wetlands and vegetated buffer strips. Here, we summarize recent findings about nitrogen removal via denitrification in the capillary ditch network of the Po River lowland (Northern Italy), a worldwide hotspot of eutrophication and nitrate contamination. Several experimental approaches (laboratory incubations, open-channel methods, GIS-based upscaling models) at multiple spatial scales (mesocosm, whole-reach, watershed) were applied to parameterize denitrification in relation to biotic (e.g. presence of macrophytes and biofilms) and abiotic drivers (e.g. nitrate availability, water velocity, temperature) and evaluate its relevance at the entire drainage network scale and in the context of agricultural nitrogen excess.

Outcomes demonstrate the pivotal role of emergent vegetation in sustaining the ecosystem function of denitrification thanks to its complex synergistic action with bacteria. Vegetated ditches express the highest mitigation potential in summer when macrophytes act as ecosystem engineers by favoring the development of denitrification hotspots and elevated water temperature enhances microbial activity. However, biofilms on senescent stems maintain the ditch depuration capacity also in winter with a positive response of denitrification along a wide range of nitrate availability. Nitrogen dissipation in slow-flow waterways is also regulated by hydrodynamic transport conditions (i.e. water velocity) that affect the nitrate supply to bioactive surfaces. Simulated scenarios of vegetation restoration suggest that ditches may offer new management opportunities for effectively buffering agricultural nitrogen excess and decreasing nitrate loads in surface waters. Maintenance of aquatic vegetation could be an effective low-cost tool to be incorporated into the implementation strategies of the EU Water Framework Directive with potentially improved water quality at the watershed level and in the coastal zones.

Sediment records of Perialpine lakes anticipate the timing of lake responses to human impact and climate warming in the 20th century

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The majority of Perialpine lakes suffered on nutrient enrichment since the early 1960s, as a consequence of the economic boom that followed World War II. However, limnological surveys have been sparse and irregular for both large and small perialpine lakes during the early stage of nutrient enrichment, and regular monitoring programs started mainly during the most acute eutrophication or in concomitance with the launching of lake restoration measures. As a result, reconstruction of the early stage responses of Perilapine lakes to major human-related perturbations occurred during the Anthropocene can only be reconstructed based on information preserved in deep lake sediment records. The available paleolimnological surveys showed that lake biological responses to changes in lake nutrient availability was particularly rapid, especially for the phytoplanktonic compartments, and rather coherent for lakes belonging to homogeneous lake types north and south of the Alps. However, such studies suggest that first lake changes already occurred during the first half of the 20th century. Here we present results from sediment studies, which were conducted during the last ca. 10 years on six Perialpine and alpine lakes north and south of the Alps. Although the lakes differ in location, morphology (e.g. altitude, size, depth), and exposition to direct and indirect human impacts, the phytoplanktonic proxies of each sediment record indicate first relevant changes between the 1930s and 1940, i.e. well before the beginning of post war nutrient enrichment. These changes could be interpreted as lake responses to the first documented climate warming after the Little Ice Age, sometimes in combination with superimposed perturbations that ranged from early eutrophication to hydroelectric exploitation. These results underscore the importance of sediment studies for complementing and expanding decadal limnological surveys in predicting future lake ecological trends based on the understanding of past lake responses.

Interdecadal variability in phytoplankton community in the coastal area of the LTER-Senigallia transect (NW Adriatic Sea) over a 30 years period (1988-2016)

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The interannual variability of phytoplankton over a ~30-years period in the coastal site of LTER-Senigallia transect (NW Adriatic Sea) was investigated to document patterns potentially related to environmental/climatic drivers. Comparing 1988-2002 and 2007-2016 periods, we showed that phytoplankton abundance and biomass and inorganic nutrient concentrations increased in the last decade, and the P-limiting conditions typical of the N Adriatic Sea seem to have been attenuated in the study area. P levels were not explained by the P concentrations in the Po River waters, suggesting the possible influence of other local P sources that could be related to the anomalous meteorological events (intense rainfalls) that took place in the 2007-2016 period. In the last decade, the community structure and the seasonal cycle of phytoplankton markedly changed: the blooms of the diatom Skeletonema marinoi shifted from winter to spring and a significant decrease of coccolithophores was observed in winter months in the 2007-2016 period. Some indicator species among the most relevant in the 1988-2002 period (such as Emiliania huxleyi in winter, and Syracosphaera pulchra in spring) have lost this role in 2007-2016. Dinoflagellate abundances decreased, except in spring when the occasional proliferation of large sized species (Noctiluca scintillans) caused biomass peaks. The phytoplankton annual cycle became irregular with sudden diatom blooms, reflecting the variability of meteorological events in recent years. It is noteworthy that in the last decade, an allochthonous species, i.e. the diatom Pseudo-nitzschia multistriata, became a regular inhabitant of the autumn phytoplankton communities of the NW Adriatic Sea.

POSTER

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Innovative approaches for the evaluation of the ecological conditions and ecosystems functionality of alpine lakes and rivers: the Interreg Alpine Space project *Eco-AlpsWater*

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Eco-AlpsWater is a project co-financed by the European Regional Development Fund (ERDF) through the Interreg "Alpine Space" programme. The aim of the project is to improve the traditional water monitoring approaches utilized in the Alpine region (Water Framework Directive-WFD in EU countries and Water Protection Ordinance-WPO in Switzerland) with innovative technologies, providing solid knowledge to support lake and river management plans. The new approach will make use of Next Generation Sequencing (NGS) techniques to analyse environmental DNA (eDNA) extracted from samples collected in lakes and rivers. These new techniques, based on the amplification and analysis of millions of DNA sequences, allow rapid and low cost identification of aquatic organisms. The new generation monitoring will permit to carry out one of the most extensive census of lakes and rivers biodiversity of the Alpine region based on the analysis of hundreds of samples collected in over 50 water bodies. The investigations will focus on the study of bacteria and cyanobacteria, phytoplankton, periphytic communities (including diatoms) and fish. The collected data will allow to identify the areas at risk of toxic cyanobacteria, pathogenic bacteria and alien or potentially invasive organisms. The project, started in 2018 and operational until April 2021, involves 12 partners belonging to 6 countries in the Alpine region (Austria, France, Germany, Italy, Slovenia and Switzerland). The research, started in the first months of 2019, in the Italian context will in particular evaluate the ecological quality of two key environments representative of the great lakes (Garda) and rivers (Adige) south of the Alps. During the summer months, the survey will be extended to a greater number of lakes and rivers, including other great lakes of the network LTER IT08-Subalpine lakes, small lakes (for example Ledro, Caldaro, Ragogna) and rivers.

Shift from nival to pluvial recharge of an aquifer-fed lake increases water temperature

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Global warming is affecting ecosystems worldwide, with mountainous regions particularly vulnerable. At mid-altitudes, changes in winter precipitation will have immediate effects on lake functioning. Lake Tovel (LTER site IT09–005-A; 46.261N, 10.949E; 1178 m a.s.l.), a deep (39 m) aquifer-fed lake in the Brenta Dolomites (Italy), showed unusually high water temperatures in 2017. As evidenced by a principal component analysis, monthly data from 2000 to 2016, including the hot European year 2003 and the locally warmest year 2015, did not show comparably high water temperatures. Volume weighted mean water temperature from June to September 2017 was 1.3–2.1 °C higher than long-term temperatures (mean 2000–2016: 6.6–8.8 °C). Warmer air temperatures in December 2016 and February and March 2017 led to a shift in winter precipitation from snow to mostly rain. The consequent lack of a spring snowmelt event resulted in whole-lake warming and increased stability of the water column, as evidenced by volume-weighted mean water temperature and Schmidt stability, respectively. Stable isotopes were used as tracers for the origin of lake water. The yearly mean δ18O of lake water in 2017 was more enriched (−10.9‰) with respect to the long-term mean (2009–2016: −11.9‰), supporting a pluvial instead of a nival origin in 2017. The temporary warming of Lake Tovel is an early sign of future changes in mountain hydrology, and we advocate for increasing attention to lake catchments considering their impact on many ecosystem services.

The LTER MareChiara station as a test site to assess the quality of coastal biogeochemical data

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While the overall quality of the biogeochemical data acquisition has improved with time, the comparability of the data is still a major issue and is particularly crucial for long-term time series, where different instrumentation and analytical methods are applied. Generating comparable and consistent results in environmental studies is a goal that can be achieved only through rigorous quality assurance (QA) and quality control (QC) procedures. In this study we aim at the development of ad hoc QC procedures to be applied to coastal biogeochemical data. To this end we used the biogeochemical dataset collected over 30 years at the LTER MareChiara station (LTER-MC, Gulf of Naples), addressing potential discrepancies in a long-term dataset. A serial step-wise procedure was developed in order to characterize the quality of the ~ 84,000 data-points included the dataset. The procedure combines statistical tests and expert knowledge and includes nine tests, each addressing potential problems in data generation and management. Quality flags assigned to individual data based on these tests revealed an overall good quality of the LTER-MC dataset, with only 2% of bad data. On the other hand, the QC highlighted some problems deriving from inaccuracies in data handling and storage during in the first years of the time-series, probably due to the alternation of different operators and to the limited informatics capabilities. The procedure was also applied to two other coastal datasets, confirming that the criteria and tests designed for the LTER-MC dataset could be extended to other biogeochemical coastal data. Overall these results contribute to bridge the gap between the need of objective QC criteria and the intrinsic noise of coastal datasets, promoting the discussion on this topic, and improving a proper management and sharing of coastal data.

Possible shifts in quantity and biochemical composition of sedimentary organic matter in the deep Ross Sea (Antarctica) 20 years after ROSSMIZE

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The Southern Ocean, the deepest ocean worldwide, covers 30% of the global ocean surface and plays a key role in global biogeochemical cycles. Thus, changes in the functioning of Antarctic deep-sea ecosystems would have a major impact at the global scale. Recent results indicate the presence of temperature shifts related to altered hydrodynamic regime in the Ross Sea. Nevertheless, the effects of these changes on Antarctic benthic ecosystems are mostly unknown, yet. To investigate the impacts of these changes on biodiversity and ecosystem functioning, the project BEDROSE revisited in 2017 the same sites investigated during the ROSSMIZE cruise (X Antarctic Expedition, 1994-1995). During the austral summer 2017, we collected sediment samples at ca. 500 m depth from two locations (namely site B and C), already visited in 1995, and analyzed them in terms of organic matter (OM) quantity, biochemical composition (protein, carbohydrate, lipid and phytopigment contents) and degradation rates (protein degradation). The two sites were characterized by the same differences observed in 1995, with OM contents in site B much higher than those observed in site C. The sediments of both sites showed OM contents higher than those observed 20 years ago, with biopolymeric C contents in 2017 ca. 2-3 folds and 2 folds higher (site B and C, respectively) than those in 1995. OM nutritional quality decreased in both sites as a possible consequence of the increased OM degradation rates in the sediment. Our results fit with a plausible scenery of a warming stimulated increase of primary production in the water column, associated with increased inputs of OM to the deep sea and a stimulation of the benthic activities.
This is a contribution to the project “BEnthic biodiversity and ecosystem functioning of the Deep ROss Sea in a changing Southern Ocean” funded by the PNRA.

Organic iron speciation in East Antarctic pack ice samples by a HPLC-MS/MS method

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Iron (Fe) is the most important trace element in the ocean, as it is necessary for photosynthetic processes related to the phytoplankton growth, playing a role of micronutrient. In particular, Fe plays a crucial role in the areas called High Nutrient Low Chlorophyll (including Antarctica), where the low Fe inputs limit marine productivity. In polar areas, sea ice is fundamental in the biogeochemical cycle of Fe, as it accumulates and stores Fe during winter months and releases it to surface waters after its melting during spring / summer months. This covers a high importance for the biotic component and for the triggering of primary production phenomena in the Southern Ocean.
In this study, a method was developed using High Performance Liquid Chromatography-Mass Spectrometry (HPLC-MS/MS) for the identification and characterization of organic Fe binding ligands in sea ice samples collected in the East Antarctic Region.
The organic complexation of Fe was primarily measured by the competitive ligand equilibration adsorptive stripping voltammetry (CLE-AdSV) technique. The results were considered together with other environmental and biological parameters (temperature, salinity, chlorophyll-a, particulate organic carbon (POC) and particulate organic nitrogen (PON) concentration), confirming that sea ice is an environmental matrix of accumulation of dFe and organic material, especially in the portion called “bottom ice”, that is the one closest to sea water.
Several Extracellular Polymeric Substances (EPS) have been identified in the same samples through the optimized HPLC-MS method. They differ in the number of glucose units making up the polysaccharide chain. The presence of these compounds is probably due to the production of mucilaginous substances originated by the phytoplankton and the bacteria associated to sea ice.

Long-term limnological research in the subalpine lake district: An Italian-Swiss collaboration extending the Italian LTER network

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The Macrosite "IT08 Subalpine Lakes" includes a group of lakes located at the southern border of the Alps. The lake typologies consist of large and deep lakes (Orta, Garda, Maggiore, Como and Iseo) and smaller and shallow lakes (Candia). Already active well before the creation of the LTER network in 2006, collaborations between IT08 research sites can refer to a long tradition. Although not formally part of this network, Lake Lugano was and is largely involved in the scientific collaborations carried out within the Subalpine Lakes macrosite. Common research topics in these lakes include the effects of eutrophication and climate change, structure and dynamics of biological communities (e.g. plankton, nekton, benthos), paleolimnology, ecotoxicology, ecological status and remote sensing. Scientific investigations can rely on the availability of numerous technological facilities located in the reference institutions. New technological infrastructures and methodological approaches allowed to uphold and update the classical approaches adopted in scientific monitoring, opening the way to new research fields especially e.g. in molecular ecology and metabolomic profiling, antibiotic resistance genes, high-frequency monitoring by sensor technology, remote sensing detection of cyanobacteria. The most recent data collected in the large and deep lakes allowed identifying the principal cardinal changes affecting their ecological status. These include the impact of eutrophication and global warming, decrease in the frequency of full mixing episodes and establishment of persistent meromixis in lakes Iseo and Lugano, variations in phytoplankton dynamics and identification of new toxigenic cyanobacteria and cyanotoxins, introduction and establishment of allochthonous species, and detection of numerous new emerging chemical pollutants. In this context, the scientific monitoring is only a key element of LTER research, which should include not only data collection, but also data interpretation and definition of new conceptual frameworks in order to identify the more significant environmental stressors affecting ecosystems, communities and populations.

The emerging issue of microplastics: ongoing investigation in water and sediments of Subalpine lakes

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Widespreading presence of microplastics in aquatic environments is of increasing ecological concern because of their chemical persistence and their potential effects in biota. Most studies have been focused on marine environments and only a few investigations have been performed on microplastics in freshwater ecosystems. The present work is addressed at identifying the different microplastic polymer types and to characterize their occurrence, features, fate, and the evolution of their abundance in four South-Alpine lakes (Iseo, Idro, Ledro, Garda) in Northern Italy. To achieve this goal, microplastics will be sampled from sediment cores collected from two different locations for each lake. In addition, water samples will be collected at different depth along the water column and analyzed for the presence of microplastics. As these lakes are characterized by different features in relation to watershed extension, hydrological characteristics and human impacts, their study can provide a useful framework to assess the occurrence of microplastics as related to environmental variability. This investigation will provide first insights on the role of lakes as possible “sink” of microplastics, through an accumulation and segregation in deep sediments, or as a “source”, due to a possible preferential distribution in the water column in relation to climate-related turnover patterns that could again bring large amounts of particles to the surface layers. The samples will be analyzed with innovative techniques (Raman spectroscopy and FTIR), which will allow the polymer identification of very small particles. This project will contribute to fill the knowledge gap regarding the abundance and distribution of microplastics in lake ecosystems, and will attempt relating types, occurrence and possible sources of microplastic in the watershed.