Musing on the concept of Good Environmental Status:

the complexity of the status & the status of complexity

Abstract Booklet

Joint Workshop

2-4 December 2020

Cover photo: Juanma Clemente-Alloza on Unsplash

Contributions:

S. Azaele, A. Vulpiani, A. Maritan, S. Granum Carson, P.F. Moretti, L. Dubroca, D. Eveillard, F. Falcini, T. van Rossum, M.J. Sanz, G. Masciandaro, C. Gaucherel, P. Mariani, M. Ribera d'Alcala, J. Tronczynski, W. Bonne, T. Hema, I. Boujmil, H. Jaziri, C. Sammari, M. Snoussi, A. Hamsa Chaffai, A. Borja.

Publication editing:

Lavinia Giulia Pomarico & Willem de Moor

Suggested reference:

JPI Oceans & BlueMed Initiative (eds.) (2020). Musing on the concept of Good Environmental Status: the complexity of the status and the status of complexity - Abstract Booklet. Brussels, Belgium.

Photo credit frontpage:

Juanma Clemente-Alloza on Unsplash

Table of Contents

Musing on the concept of Good Environmental Status:

the complexity of the status & the status of complexity

Introduction 4

DAY I 6

Session I: Dealing with Complex Systems - Concepts 6

Session II: Dealing with Complex Systems - Methods 9

DAY II 10

Session III: Success Stories 10

Session IV: The Ocean Domain 13

DAY III 14

Session V: How to manage MSFD and enhance science-policy interface 14

Mankind is facing grand challenges to deal with the complexity of eco-socio-economic systems which entail a paradigmatic shift to a new way to design and tackle the process towards possible solutions: research and innovation can and will play a fundamental role in this regard.

The good marine environmental status (GES) fostered by the MSFD is one of these challenges, addressing a diversity and complexity of systems in terms of social, economic, environmental and political aspects, as well as, of the related stakeholders. Human activities and protection of the marine ecosystem have to be integrated in the concept of shared values, towards a sustainable and feasible economic and environmental framework.

To maximize the impact of investments and make the contribution of science relevant, the interface between science, funds and policy is crucial to adopt efficient and effective interventions. In this context, the EU directive MSFD has provided a fundamental milestone towards the cooperation and integration of national efforts in addressing the good environmental status of the marine environment, whose potential is still to be fully exploited.

The Joint Programme Initiative Healthy and Productive Seas and Oceans (JPI Oceans) is an intergovernmental strategic platform open to all EU Member States and Associated Countries.

JPI Oceans coordinates and integrates research programmes for tackling marine and maritime challenges. In November 2019, JPI Oceans launched the Joint Action "Science for Good Environmental Status (S4GES)" to better understand marine ecosystems, how multiple activities impact the environment and how to fulfill the requests of MSFD.

BlueMed is an intergovernmental initiative launched in 2014 during the Italian Presidency of the European Union, aiming to advance a shared vision for a more healthy, productive, resilient, better known and valued Mediterranean Sea.

BlueMed addresses research and innovation through a multi-disciplinary approach, linking economy, environment and humans, to build sustainable Blue Growth by means of networks of actors and international science diplomacy efforts.

Effective linkages are needed between emerging knowledge, innovative approaches and techniques in marine science and its practical understanding, and possible uses within the MSFD context. This means that criteria, including threshold values, methodological standards, and proper representation of the MSFD descriptors, should be periodically reviewed and amended in the light of scientific and technical progress.

The efficient mechanisms for such revisions should also be built and strengthened, including the development of new and innovative observational schemes and techniques, available for Member States. This will lead to a better consistency in the determination of the GES of different marine regions in the European Seas.

In such a context science can contribute revising or introducing criteria, apply risk-based approach, and provide rigorous definitions to sharpen and refine/specify the concept of thresholds and, in turn, of the Good Environmental Status (GES). Science has also the responsibility to foster data harmonization and interoperability, as well as integrations among MSFD Descriptors.

This workshop is officially part of the wide promotional action approved and supported by the Implementation plan of BlueMed "Understanding pollution impacts, mitigation and remediation in the Med Sea". Also, it is fully taking into account the recommendation to 'Support a better definition of GES and harmonize assessment criteria for priority contaminants', addressed in the framework of the Mediterranean Workshop preparing the UN Decade of Ocean Science for Sustainable Development (2021-2030).

The workshop aims at addressing the scientific contribution to design and structure a complementary path in addressing the Good Environmental Status, where individual and official positions are asked to confront within a scientific and interdisciplinary approach. Participants can contribute to launch a 'small world network' for the identification of the most relevant theoretical and operational aspects and paths to be considered.

Different aspects will be addressed and shared, in particular focusing on how science, governance and implementation can be integrated taking into account the state-of-the-art. The output of the workshop will be summarized into a document which will report the main aspects and recommendations for future developments.

Day I

Musing on the concept of Good Environmental Status: the complexity of the status & the status of complexity

Session I: Dealing with Complex Systems - Concepts

Sandro Azaele
Università degli Studi di Padova, Italy

Before addressing the problem of finding conditions which define a healthy ecosystem, we ought to understand how ecosystems work. Ecosystems are complex systems whose macroscopic states cannot be traced back to the elementary components only. The constituent parts dynamically interact with each other and as a result some patterns may emerge. The key to understanding lies in the elucidation of the mechanisms underlying observed patterns and without a robust mathematical or computational theory we cannot delve into the key driving forces which rule ecosystems across scales. Albeit we can search for regularities and calculate indicators of loads of empirical (marine) data, that is not enough to tell us whether a marine ecosystem is healthy or not. We might be biased by spurious effects, artefacts, finite size effects or sample correlations. On the contrary, quantitative approaches can help us making informed predictions, can tell us what we may or may not expect from the empirical data. The talks of this first session are going to show how complex system approaches can help understanding what a healthy ecosystem may look like.

Understanding the dynamics of a complex system: theory, models and data

Angelo Vulpiani
Università Sapienza, Italy

The goal of Science is to understand phenomena and systems in order to predict their development and gain control over them. In the scientic process of knowledge elaboration, a crucial role is played by models which, in the language of quantitative sciences, mean abstract mathematical or algorithmical representations.
This talk discusses some example representing paradigmatic procedures to build models and predictions from available data.
In particular it is discussed the limits of the approach to the problem of the predictions with just data using the methods of analogues.
In cases of multiscale systems, where the complexity is challenging, I stress the necessity to include part of the empirical knowledge in the models to gain the minimal amount of realism.

From single individual body mass - metabolic rate scaling to community patterns

Amos Maritan
Università degli Studi di Padova, Italy

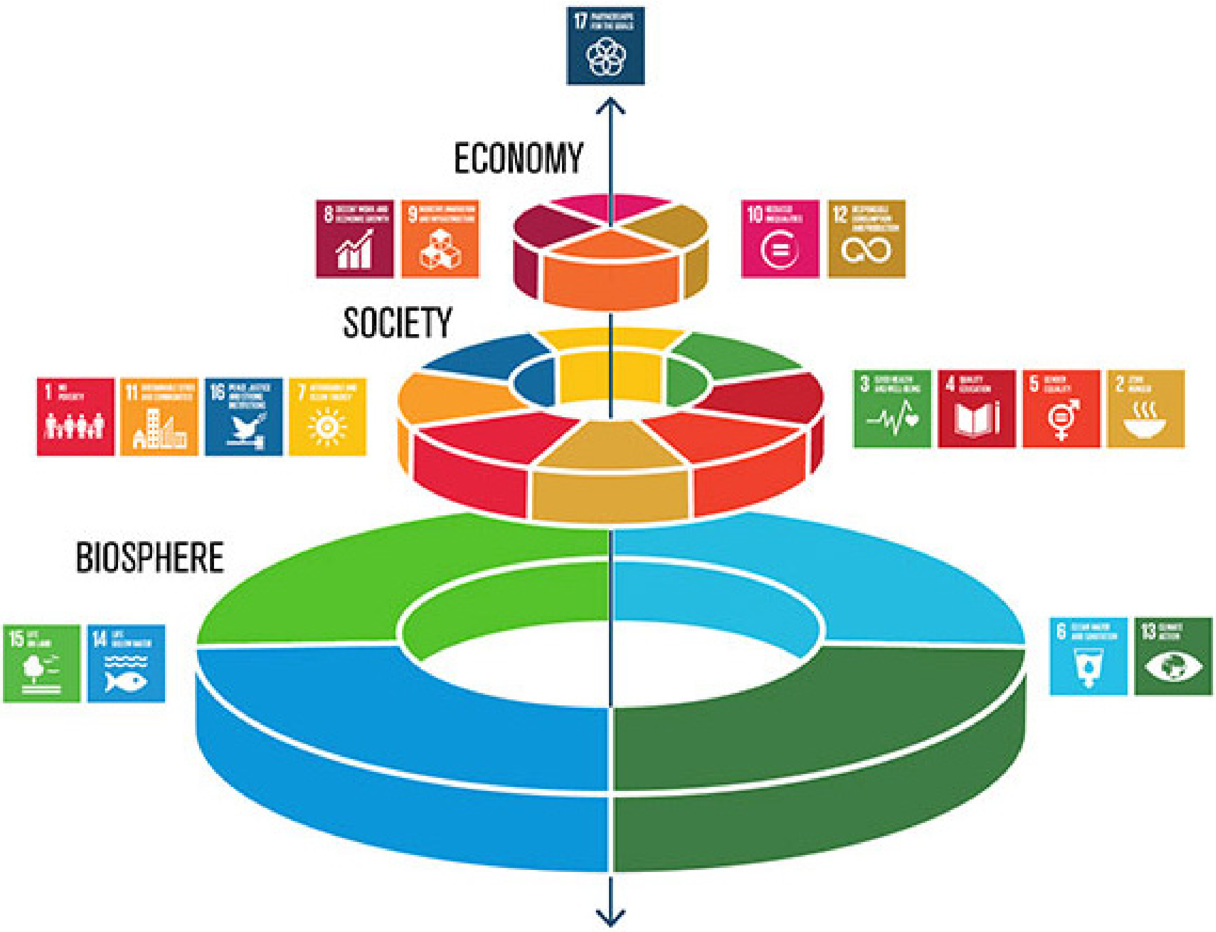
Living systems are characterized by the recurrent emergence of patterns/regularities independent of their biological/ physiological details. Approximate power-law distributions and long-range correlations are pervasive and can be found both at the level of single organisms and at the community level. The challenge is to grasp how general trends and behaviors emerge and how single individual traits scaling impact on community assembly.
We consider the case of forests representing one of the most complex systems with a high degree of structural and functional diversity. We demonstrate an astounding simplicity underlying the apparent bewildering complexity of forests. Our starting point is based on optimization/variational principle which predicts the body mass-metabolic scaling, size distributions in plant communities and pair correlation function vs distance. Predictions are tested in forests at various latitudes. Deviations from the predictions are used to quantify degrees of disturbances.

Balancing ecological, social and economic concerns – an ethical perspective

Siri Granum Carson
NTNU Oceans, Norway

Sustainability originally referred to environmental questions, specifically the responsible use of renewable and non-renewable natural resources. In Our common Future, the Brundtland commission's 1987 report, sustainable development was defined as "a development which meets today's needs without destroying the future generation's ability to satisfy their needs", outlining a development uniting two goals: Respect for nature and securing human values. This was further conceptualized as the balancing of three basic concerns: Environmental, social and economic values. This is in line with the 2017 Marine Directive, where Good Environmental Status (GES) means "that the different uses made of the marine resources are conducted at a sustainable level, ensuring their continuity for future generations." However, the question is whether this concept of sustainability should be interpreted as "weak" sustainability – based on a traditional, neoclassic framework of economics where natural capital and human-made capital may be substituted for each other as the total outcome is what matters – or as "strong" sustainability – based on ecological economics prescribing that no acts may reduce or harm the environmental capital of the world.

In my presentation, I argue that sustainability is a normative concept concerning how to balance basic human values, and as such it is well suited to address complex issues such as the environmental status of marine waters. However, to turn the concept into efficient policy, it is vital to recognize the ambiguities in terms of who and what matters most. Is sustainability basically about sustaining a safe existence for human beings, or do other species or ecosystems have an independent value? And what about future generations, are their rights truly recognized, e.g. in the Marine Directive and the corresponding SDG 14, or are these policy goals ultimately limited to maintaining a safe existence for today's generations?



Credit: Azote for Stockholm Resilience Centre, Stockholm University

Governance of complex systems: are Homines Sapiens ready to approach?

Pier Francesco Moretti
JPI Oceans, Belgium

The word governance was used by Greek philosophers to describe the process of steering a warship. Its Latin counterparts are gubernare and regere, which were used both for steering a ship as well as the state. English, French and German concepts "to govern", "gouverner" and "regieren" are derived from this.

Governing has traditionally mainly associated to a mechanistic process.

Literature associates the concept of governance to a wide variety of different phenomena, from decision-making processes to policy instruments, addressing different institutional structures and actor constellations. Literature on governance or organization of society, just limiting on social sciences, can show number of articles larger than two million! The ambiguity and vastness of the notion of governance may have contributed to its abundant popularity, and often to an abuse in many contexts.

Seas and oceans address a complex system, in terms of environmental aspects. Indeed, agents impacting on this system involve many different stakeholders which usually require a multi-level and multi-dimensional approach to governance. This approach has been implemented in different ways, and in the European Union (EU), "network governance" is assumed to be dominant with respect to other forms as "statism", "pluralism" and "corporatism".

Science has often been asked to support policy decisions and provide solutions to challenges. Rarely science has been used to design the process for managing complex systems.

Many clues can be identified looking at the behavior of organisms, network science and private organizations.

Addressing complexity suggests to limit the control and prediction of the system, which are mainly in contrast with the maintenance of privileges and of attitudes of humans.

Different options for new modes of governance can be investigated. No solution can be considered as a general effective one, but instead on focusing on communicating "what to do", it would be better to reflect on "why something is not working", "what not to do", "if the system is complex or complicated", "if assumptions are not compatible with objectives", "how many cognitive biases are affecting the process", "if the actors are able, or willing, to transform their mutual interconnections in adequate timescales and providing impacting interventions at different levels".

Session II: Dealing with Complex Systems - Methods

Analytical tools to deal with the real system

Laurent Dubroca
IFREMER, France

Good Environmental Status defined by the Marine Strategy Framework Directive (MSFD) or by scientific works relies on the combination of indicators into indices (Moriarty et al. 2018). An indicator involves a data stream representing the process of interest, and a numerical treatment summarizing the information variability into one single categorical value.
For example, the eutrophication descriptors D5C2 of the Marine Strategy Framework Directive can be based on a series of chlorophyll-a concentration (the data stream) and summarized using the 90th percentile (the numerical treatment) compared to a documented threshold (Borja et al. 2011). As simple as it seems, this task involves necessary steps of data gathering, extraction and processing. In 2020, in the age of the open marine data and the replication crisis, this task remains astonishingly complex and obfuscated. Data availability, analyses transparencies and replicability are the primary solutions to improve this fact. The analytical tools to deal with this issue exist for a long time and are used widely in other scientific fields. I will illustrate their uses based on my MSFD teaching experience and the difficulty I had to let students experiment the joy of good environmental status estimations using real data for the European seas.

References:

Borja et al. 2011
(https://doi.org/10.1016/B978-0-12-374711-2.00109-1)

Moriarty et al. 2018
(https://doi.org/10.1016/j.ecolind.2017.09.028)

Gathering and handling Big data

Damien Eveillard
Université de Nantes, France

Recent progress in metagenomics has promoted a change of paradigm to investigate microbial ecosystems. Today, these ecosystems are analyzed by their gene content that, in particular, allows to emphasize the microbial composition in terms of taxonomy (i.e., «who is there and who is not») or, more recently, their putative functions. However, understanding the interactions between microbial communities and their environment well enough to predict diversity based on physicochemical parameters is a fundamental pursuit of microbial ecology that still eludes us. This task requires deciphering the mechanistic rules that prevail at the molecular level. Such a task must be achieved by dedicated computational approaches or modeling, as inspired by Systems Biology. Nevertheless, the direct application of standard cellular systems biology approaches is a complicated task. Indeed, the metagenomic description of ecosystems shows a large number of variables to investigate. Furthermore, communities are complex, mostly described qualitatively, and the quantitative understanding of how communities interact with their surroundings remains incomplete. This research summary will illustrate how systems biology approaches must be adapted to overcome these points in different manners. First, we will present a bioinformatics protocol on metagenomics data, emphasizing network analysis. Second, we will describe how to integrate heterogeneous omics knowledge via constraints programming. Such integration will emphasize putative functional units at the meta-genome scale level. In particular, constraint-based modeling will predict microbial community structure and putative biogeochemical cycle involved.

Day II

Musing on the concept of Good Environmental Status: the complexity of the status & the status of complexity

Session III: Success Stories

Federico Falcini
ISMAR-CNR, Italy

Evidence is not enough: Assessing a "Good Environmental Status" needs knowledge. In a large variety of fields, science is invoked to tackle the difficult task of disentangling facts from perceptions. Environmental dynamics and resources range multiple spatial and temporal scales, the "use" of ecosystem service and products spans a huge variety of social and economic sectors, the understanding of those relationships that link physical, biological, geochemical, and ecological stressors with actual effects and feedbacks is not a trivial task. Although technology has made advancements, we still lack knowledge on the underlying change dynamics and future impacts of them, at appropriate spatial and temporal scales.

System vulnerability is assessed by evaluating the ability to meet specific targets and thus by extracting those effective processes that reduce the complexity of the system, allowing for suitable predictability. Ocean complexity, for instance, requires understanding effective environmental processes. Observing systems and methodologies need therefore to be planned by following a process-based design, aimed to solve the scientific challenges. In such a context it is worthwhile an upgrade that would introduce a breakthrough innovation in the sampling strategy.

The following talks show how knowledge can drive decisions on the design of the appropriate (process-based) strategy. Specific challenges of holistic understanding in complex system dynamics, along with cross-disciplinary expertise, provide examples on actions that can set effective and efficient use of data and meta-data in describing healthy state and functioning of ecosystems, as well as adaptation and mitigation options.

The Human Microbiome: success stories and challenges

Thea van Rossum
EMBL, Germany

The bacteria, viruses, and micro-eukaryotes that live in and on us are critical to our health. Their presence not only can cause disease but can also be required to maintain good health. After a dozen years of human microbiome research, the field has yielded important successes but significant challenges remain. Early work focused on gut bacteria sampled from faeces using observational surveys. In many of these studies, the aim was to identify associations between microbial community members and disease states, with the major end goal to develop diagnostic biomarkers. In some cases, this has produced actionable outcomes, such as diagnostics for colorectal cancer, in many other cases, it has not. This can be due to many factors, such as a misprediction of the role of the microbiome, inadequately considered confounding factors, or using sample sizes that are too small to account for biological variability. To satisfy the requirement for large sample sizes, meta-analysis of shared public data has proven indispensable. This has been supported by centralised databases for microbiome DNA sequencing data and by studies revealing the importance of specific experimental steps. However, the consistent and complete collection and storage of associated metadata remains a challenge. Despite this, a benefit of the meta-analysis of tens of thousands of samples is the opportunity to better describe the healthy state of the human microbiome, which has been revealed to contain much variability.

Translating these descriptions of healthy states into usage in disease studies has been challenging due to population and individual level differences and variability in the effective definition of health based on the disease context. Human microbiome research has had great successes from studying health at the population level. This work will surely continue, but it has also opened up opportunities to consider personalised medicine approaches in the future and to consider health more specifically.

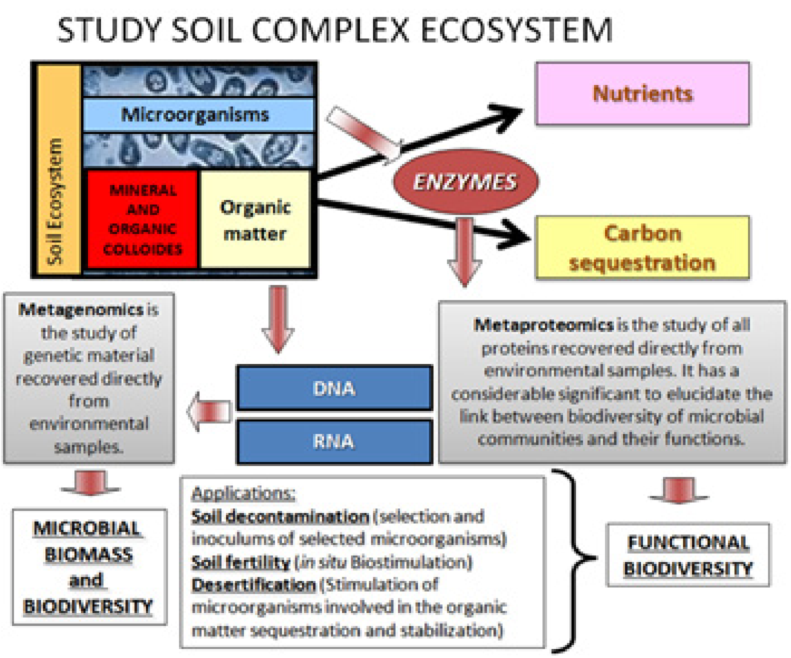
Forests as complex adoptive systems

Maria José Sanz
Basque Centre for Climate Change, Spain

Forest ecosystems are sensitive to global warming. IPCC SR1.5 indicates that at the present global anthropogenic warming of 1.0oC above preindustrial levels, forest ecosystems' dynamics are already changing. Ecosystems are projected to undergo transformation from one type to another. On the other hand, forest "negative emissions" or "natural climate solutions" are expected to fulfill a substantial share of the mitigation gap of present nationally determined contributions (NDCs) in the 1.5°C and 2°C pathways. Whether or not the present sink will persist in the future and how the technical potential could be materialized are the greatest uncertainties in the future carbon cycle. Evidence of this can be found in the recent vigorous debate among scientists, with some foreseeing great potential for carbon sinks and others expressing considerable doubt. We know more about forest today due to the expansion of monitoring efforts in the last decades. There are growing evidences that they are suffering worldwide of impacts of climate change, and therefore they are expected to naturally adapt. But we also see that direct or indirect impacts of climate change are contributing to complex decay phenomena. And that actions to mitigate climate change are rarely evaluated in relation to their impact on adaptation, sustainable development goals, and trade-offs with food security. Considering benefits other than mitigation (resiliency to climate change, improved biodiversity and soil quality, etc.) when the options are selected and their implementation is designed could help overcome some of the constraints indicated above. Some of the most promising adaptation options for land and ecosystems include mitigation options such as ecosystem restoration, deforestation reduction, and coastal protection with natural based solutions. Despite that, the land-use sector represents an enormous opportunity, if the forest and land sector is to contribute to achievement of the Paris Agreement goals, and compliance with the SDGs, this will require to understand that they are complex systems that also respond to climate change themselves.

The soil and cognitive control

Grazia Masciandaro
CNR-IRET, Italy



Credit: Masciandro (2020)

Soil is a complex system which provides a wide range of ecosystem goods and services that support ecosystem functioning and human well-being. The cognitive processes involved in the relationship between man and soil go from perception to learning. Man's perception of the soil evolved in relation to his cognitive and technological development. The conscious man-soil relationship passed from the perception of the soil as a source of products necessary for food (agricultural conception) to the recognition of establishing a balance in the coexistence between man and soil, to the knowledge of the limits of the soil as a non-renewable resource (environmental conception). This is the perception of the soil as a vital substrate that works but also needs rest. In this context, it is necessary to learn to know the limits of the soil beyond which degradation situations could happen. The main soil mark is the fertility which provides us with nutritious food and other products as well as with clean water and flourishing habitats for biodiversity. In order to have healthy food it is necessary to have healthy soil.

The European Commission in the "Soil Mission 2020", in line with the Sustainable Development Goals and the Green Deal, defined the soil health as "the continued capacity of soils to support ecosystem services". In particular, soil biodiversity provides a range of different ecosystem services such as keeping disease-causing organisms in check, recycling and storing nutrients and making them available to plants, allowing healthy root growth, and providing a highway for air and water to pass through. In addition, soil biological community composition and activity, strictly interacting with physical-chemical structure, indirectly governs soil resistance and resilience. For this reason, the more diverse the soil food web, the healthier the soil ecosystem.

In view of the remarkably complex biological, chemical and physical constitution of soil, it is evident the necessity and urgency of cross-disciplinary expertise for improved understanding of soil system health and functioning.

"By 2030, at least 75% of soils in each EU Member State are healthy, or show a significant improvement towards meeting accepted thresholds of indicators, to support ecosystem services.": this is the main goal of the proposed "Soil Mission 2020".

Characterizing integrated ecosystems: understanding the complexity via application of a process-based state space rather than a potential

Cédric Gaucherel (with F. Pommereau and C. Hély)
AMAP Laboratory, France

Ecosystems are complex objects, simultaneously combining biotic, abiotic, and human components and processes. Ecologists still struggle to understand ecosystems, and one main method for achieving an understanding consists in computing potential surfaces based on physical dynamical systems (Scheffer et al. 2015). We argue in this conceptual talk that the foundations of this analogy between physical and ecological systems are inappropriate, and aim to propose a new method that better reflects the properties of ecosystems, especially complex, historical non-ergodic systems, to which physical concepts are not well suited (Gaucherel 2019, Gaucherel et al. 2020). As an alternative proposition, we have developed rigorous possibilistic, process-based models inspired by the discrete-event systems found in computer science, and produced a panel of outputs and tools to analyze the system dynamics under examination (Gaucherel and Pommereau 2019). The state space computed by these kinds of discrete ecosystem models provides a relevant concept for a holistic understanding of the dynamics of an ecosystem and its above-mentioned properties. Taking as a specific example an ecosystem simplified to its process interaction network, we show here how to proceed and why a state space is more appropriate than a corresponding potential surface.

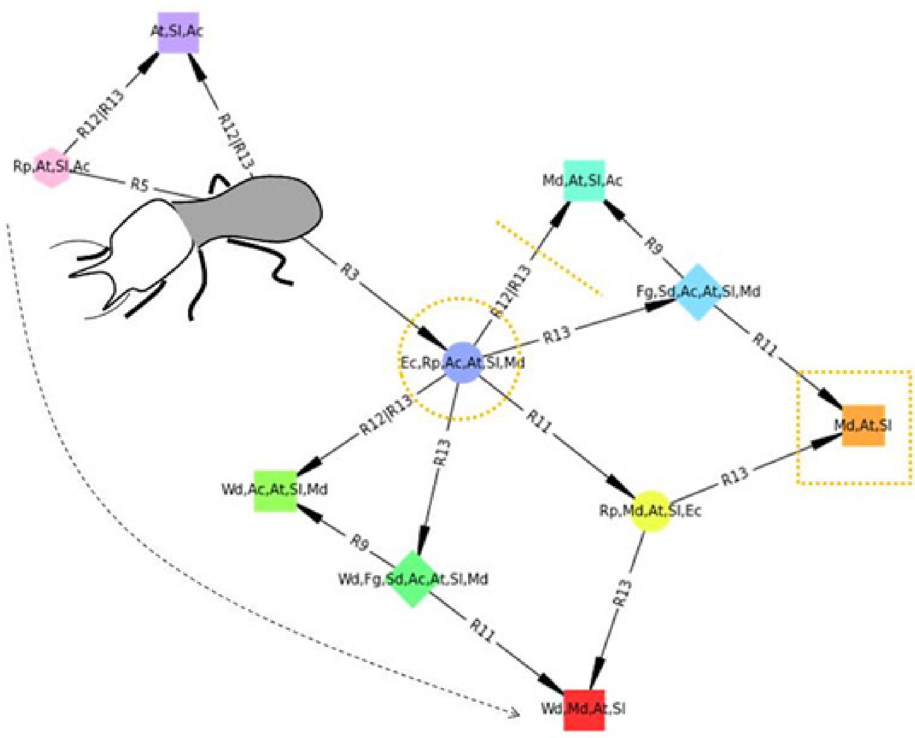
References:

Gaucherel, C. 2019. The Languages of Nature. When nature writes to itself. Lulu editions, Paris, France.

Gaucherel, C. and F. Pommereau. 2019. Using discrete systems to exhaustively characterize the dynamics of an integrated ecosystem. Methods in Ecology and Evolution 00:1–13.

Gaucherel, C., F. Pommereau, and C. Hély. 2020. Understanding ecosystem complexity via application of a process-based state space rather than a potential. Complexity In Press.

Scheffer, M., S. R. Carpenter, V. Dakos, and E. H. van Nes. 2015. Generic Indicators of Ecological Resilience: Inferring the Chance of a Critical Transition. The Annual Review of Ecology, Evolution, and Systematics 46:145-167.



Credit: Gaucherel

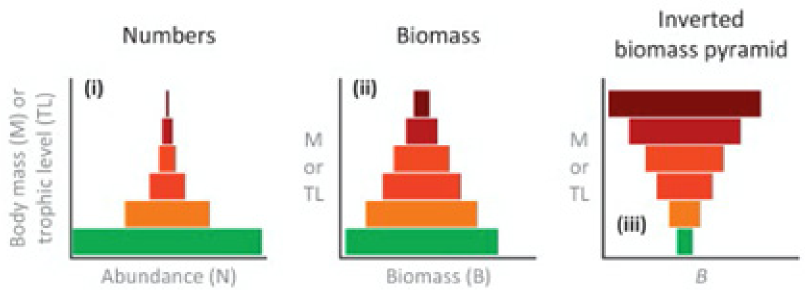
Session IV: The Ocean Domain

Patrizio Mariani
Technical University of Denmark, Denmark

A limited number of resources can fuel the huge diversity of marine organisms and support ecosystem functions and services that are essential to life on Earth. Generally considered as a paradox in all aquatic systems, we now know that the strong environmental gradients, the complex life history traits and trophic interactions, and three-dimensional nature of the oceans allow for the diversity of life forms to be develop and maintained. Nonetheless, increasing pressures acting across scales can have large impacts on marine ecosystems, putting some of those functions and services at risk. Hence, present initiatives towards the restoration of functional, compositional and structural biodiversity at different organizational levels, should include the management of those impacts. The Good Environmental Status of our oceans can be then achieved within an improved understanding of the socio-ecological non-linear interactions in marine ecosystems which can enable moving towards a systemic framework for ecosystem assessments. Decisions under deep uncertainties, optimal control and complex adaptive system theory are the key ingredients for this transformative change, and they have to be supported by developing new technologies and models able to provide information and data on the changing marine ecosystems.

The bottom-up view of marine ecosystems

Maurizio Ribera d'Alcalá
Stazione Zoologica Anton Dohm, Italy



Credit: Triblinco et al. 2013

Terrestrial food webs have a prevailing shape of bottom-heavy trophic pyramids, with top consumers displaying much lower abundance and biomass than primary producers. This pattern would hold true even if the crucial contribution of the structural biomass of terrestrial primary producers would be accounted for. By contrast, marine ecosystems display a full suite of trophic organizations. Bottom-heavy, even, and top-heavy layering of throphic levels are all present in marine ecosystems. Despite this evidence the most frequent approach in dealing with marine food webs, especially the pelagic ones, that are strongly based on plankton microbiome, is bottom-up, meaning that there is a lot of detail in formulating the modulation of primary producers activity by their essential resources, e.g., nutrients, light, trace elements, while less attention is invested in detailing the mechanisms by which consumers, and their dynamics, ultimately determine the shape of trophic marine trophic pyramids. As a consequence, in simplified biogeochemical models, consumers are more a closure term than an active, crucial component in determining the fate of matter and energy flows in the communities. Furthermore, the bottom-up approach tends to represent primary producers as passive transducers of energy and matter as long as they are available, overlooking the role that species-specific biological traits and life strategies may play in those flows.

Descriptor 5 of MSFD specifically addresses the problems derived by the increased flux of essential resources for marine primary producers provided by anthropogenic activity, which leads to an accumulation of primary producers biomass, usually referred to as "eutrophication". This term, even though with caveats, is considered a sign of a not-Good Environmental Status. However, observations show that the increase in the availability of resources, i.e., of the bottom-up driver, produces a large suite of responses, both quantitative and qualitative, and that reversing the supply of those resources very seldom restore the previous state and structure of the food web. This, in turn, links to the evidence that planktonic food web are complex systems which demand for a more in depth understanding of their functioning in order to design restoring strategies or even assessing the health of the ecosystem, also when dealing with an apparently simple process as an increase in the carrying capacity of the system.

Day III

Musing on the concept of Good Environmental Status: the complexity of the status & the status of complexity

Session V: How to manage MSFD and enhance science-policy interface

Jacek Tronczynski
IFREMER, France

The MSFD as relatively "young" but complex socio-ecological legislation has by now generated a broad scientific community response and interests. Many research projects were and are conducted within Europe and beyond its borders, aiming to enhance science background of the MSFD assessments. But questions on how to manage the MSFD including better and enhanced science-policy interfaces or what practical mechanisms exist allowing suitable introduction of technical and scientific innovations are still not answered sufficiently.
The last session will focus on some examples on how to tackle potential problems connected to the implementation of MSFD approaches for reaching an actual GES in the Mediterranean basin wide regional and sub-regional scales. The different experiences and point of views are given (scientific and policy makers) on the approaches including the South and North of the Mediterranean Sea. These examples will also schowcase progresses in the ecological and environmental sciences that we have focused on in the previous sessions (about models, new concepts, approaches, tools and methods…) and on how these improvements can be introduce into MSFD as well as in the Regional Sea Conventions in order to maintain, observe, assess and understand good environment-ecological status of the marine ecosystems.

The challenging Marine Strategy Framework Directive as catalyst for marine research

Wendy Bonne (with Alice Belin, Ivan Conesa Alcolea (EC DG RTD) & Jacques Delsalle (EC DG ENV))
EC DG RTD, Belgium

First evaluation on the implementation of the Marine Strategy Framework Directive:

In June 2020 the European Commission published a first evaluation report on the first implementation cycle of the Marine Strategy Framework Directive (MSFD) covering Member State obligations from 2008 until 2018. These obligations included the reporting on the status of their marine waters, the setting of targets to achieve good environmental status based on the 11 'descriptors' (objectives) defined by the MSFD and the establishment of monitoring programmes and programmes of measures.
Despite the tremendous positive efforts that scientists and policy officers of Member States at national and regional level made, the report also revealed that there are significant weaknesses in adequacy, consistency and coherence in the determination of Good Environmental Status. The report* states that "There is no shared EU understanding of what constitutes GES, even at a (sub)regional level. There are 23 different GES determinations across the EU, and therefore no common or comparable goals. It will be challenging not only to achieve GES by 2020, but even to know how far we are from meeting the objective. This may also deprive economic operators of a level-playing field across the EU and its marine regions. The Commission observed during the first cycle of implementation that much more progress needed to be made to avoid an insufficient, inefficient, piecemeal and unnecessarily costly approach to the protection of the marine environment." A more thorough review of the MSFD, in line with better regulation requirements, will also be developed as soon as possible, and no later than 2023.

Scientific knowledge contributing to the implementation of the Marine Strategy Framework Directive:

The same report also recognises that the MSFD triggered applied research initiatives that informed experts, managers and policy makers**: "Some examples come from the assessment of marine litter and underwater noise, two topics that were very poorly understood before the MSFD. Based on the monitoring and knowledge generated on marine litter under the MSFD, the EU adopted new legislation to curb single-use plastics and lost fishing gear, which account for some 70% of all beach litter. The MSFD was an incentive to develop underwater noise monitoring surveys and to establish a number of registers for impulsive underwater sound. In addition, analysing seabed integrity and analysing entire food webs are novel approaches that are largely driven by the requirements of the MSFD.

The MSFD assessments, monitoring networks and programmes of measures do not only channel efforts into new fields of research, but also into improving management and policy coherence."

Funding was channelled from the European Maritime and Fisheries Fund (EMFF) and the LIFE regulation specifically to help Member States achieve GES and implement the MSFD, with LIFE calls in 2012 and EMFF calls in 2014, 2016 and 2018, resulting in 20 supporting projects. The COLUMBUS project also mapped hundreds of FP7 projects according to relevance for different MSFD descriptors or implementation steps, with the most well known projects DEVOTES and STAGES.

This talk will further elaborate on the strenghts, weaknesses, opportunities and threats of scientific contributions to policy making, which need to be taken into account in order to boost further scientific successes to overcome remaining challenges as highlighted in the first evaluation report on the implementation of the Marine Strategy Framework Directive.

References:

* European Commission, 2020. COM (2020) 259 final. Report from the Commission to the European Parliament and the Council on the implementation of the Marine Strategy Framework Directive (Directive 2008/56/EC)

** See for instance 'LIFE and the marine environment' (https://doi.org/10.2779/942085), projects funded by EU framework programmes for research and innovation such as https://cordis.europa.eu/article/id/400695-better-marine-stewardship-through-research-and-innovation, DEVOTES and STAGES projects (http://www.devotes-project.eu/, http://www.stagesproject.eu/) or the list of projects in SWD(2020) 60.

Marine Strategy beyond borders, Part I

Tatjana Hema
UNEP/MAP

In 2008, the Contracting Parties to the Barcelona Convention and its Protocols decided to progressively apply the ecosystem approach to the management of human activities that may affect the Mediterranean marine and coastal environment for the promotion of sustainable development. This refers not only to an overarching principle cutting across all Mediterranean Action Plan (MAP) operations, but also to a specific process with an adopted implementation roadmap, including the definition of an ecological vision for the Mediterranean, the setting of common strategic goals and of a set of corresponding ecological objectives and indicators. The vision is for "a healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse contributing to sustainable development for the benefit of present and future generations".

In line with this vision, the overall objective of the implementation of the Ecosystem Approach roadmap is to achieve and/or maintain Good Environmental Status (GES) of the Mediterranean Sea and coasts.

Contracting Parties adopted a list of 11 Ecological Objectives (EOs), addressing all key elements of the Mediterranean marine and coastal environment, further broken down into Operational Objectives, as well as GES definitions and associated targets.

In view of establishing a coherent region-wide framework, the Contracting Parties adopted in 2016 the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (IMAP, Decision IG.22/7). The IMAP is articulated along 23 regionally-agreed Common Indicators and 4 Candidate Common Indicators, covering for the moment 9 out of 11 EOs.

In this context, UNEP/MAP delivered in 2017 the first ever Quality Status Report for the Mediterranean (2017 MED QSR). IMAP implementation has since progressed with the establishment of national IMAPs, development of a centralized data collection and management infrastructure (IMAP Info System), refinement of technical specifications on IMAP common indicators, building of knowledge on candidate indicators, and development of methodologies for integrated assessment. A specific Roadmap (endorsed at COP 21 with Decision IG.24/4) is currently under implementation for the preparation of a fully-data based Quality Status Report in 2023 (2023 MED QSR).

This Roadmap is articulated along the following processes:

1. Timely negotiation and agreement of Contracting Parties through the Ecosystem Approach Governance Structure at regional (and as appropriate at sub-regional) level on the scale(s) of **monitoring, assessment and reporting;**

2. Development and agreement on necessary methodological tools and assessment criteria to allow and promote **integrated assessment of GES** at the level of EOs and to the extent possible, across relevant EOs;

3. Full **implementation of IMAP-based national monitoring programmes** throughout the Mediterranean to enable the region to generate quality assured and real time data during 2020-2022;

4. Delivery and operationalization of a user-friendly and SEIS-based **IMAP Info System** to collect and process data produced by IMAP-based national monitoring programmes;

5. Development and implementation of **Monitoring Protocols and Data Quality Assurance and Quality Control** for IMAP Common Indicators;

6. Continuous **support and technical assistance** to the Contracting Parties in relation to all the above areas;

7. **Outreach** to regional partners to provide inputs to the 2023 MED QSR, establishment of solid partnerships and development of a communication and visibility strategy for the 2023 MED QSR

8. Regular and **effective regional cooperation** and coordination with the Contracting Parties, through Correspondence Monitoring Groups (CORMONs), under the guidance of the Ecosystem Approach Coordination Group.

Marine Strategy beyond borders, Part II

Inès Boujmil, Hela Jaziri, Cherif Sammari
National Institute of Marine Science and Technologies, Tunisia

The growing awareness of the intense pressures causing environmental degradation of the Mediterranean's natural wealth signals the need for a sustainable approach. Scientific knowledge, Maritime strategies and citizen science applied to our shared Mediterranean Sea are the basis for understanding and protecting it. Science, Society and policy need to be accurately linked in Tunisia in order to effectively protect the marine resources and efficiently maintain the Good Environmental Status in the Southern basin.
In the light of the MSFD descriptors, Tunisia have developed marine strategies and scientific observational systems and studies in order to evaluate the GES of the Mediterranean Sea through criteria and methodological standards. One should consider as examples, the Ferrybox system including the sampled Sea parameters in real time, CTD sensors, auto-sampler, filtration system to collect microplastic samples, dynamic web-application related to Ferrybox data to insure a long-term follow-up. A special consideration is dedicated to enhancing the science-policy interface, for that aim, a National Hub will ensure building a shared information system, based on trustworthy, science-based data, from all parts of the Tunisian society, outreach activities about citizen science, implementation of BlueMed priorities in Tunisia based on National and International projects, etc.
The competence of the marine scientific community should thus be made available to the policy implementation process, and a long-term networking should be taken into account in order to bridge the gap between scientists, decision makers and stakeholders, with a special interest to citizens who are the main actors of change.

How could non-EU countries contribute to a better understanding of Mediterranean dynamics and cross-border connections? Examples from Morocco

Maria Snoussi
Mohammed V University, Morocco

Over the last decades, human-induced pressures, exacerbated by climate change, have increasingly affected the Mediterranean region. The riparian countries are increasingly aware of these growing risks and recognize the need for regular and adaptive monitoring to anticipate these adverse phenomena. They also recognize that good policy decisions rely on sound knowledge, targeted research and innovation, and dissemination of this knowledge to all stakeholders. The challenge is that the Mediterranean is a single large socio-ecosystem and its northern and southern shores cannot be treated separately. This is why cooperation and partnership are keys to successful implementation of the Mediterranean GES. So, how could a non-EU country, like Morocco, contribute to a better understanding of Mediterranean dynamics and cross-border connections?

I will discuss some examples of successful initiatives, but also highlight their limitations and barriers to implementation and long-term follow-up and monitoring. Joint successful programs and projects include: Integrated Coastal Zone Management (ICZM) with its different approaches (Ecosystem Approaches (Ecap), Integrated Monitoring and Assessment Program (IMAP)...), and more recently the BlueMed and Westmed initiatives. National and regional constraints and barriers include weaknesses in: (i) science-policy interface and mechanisms for dialogue to allow research projects and policy actors to interact more and regularly. Indeed, when collaboration between science and policy exists, it is often project-dependent and thus short-lived with limited capitalization over time; ii) sharing data and outputs produced by research and innovation projects through common platforms and observatories; (iii) capacity building formats, we need regional organizations to provide practices and solutions, not just guidelines and concepts. Education to complexity and building capacity in sustainability science, with their new sets of indicators are also needed.

Biomonitors and biomarkers in marine pollution monitoring: Possibilities and Limits

Amos Hamza-Chaffai
Tunisian Academy of Science, Tunisia

The Mediterranean Sea is exposed to various and complex pollution from both industrial and urban effluents. The molecules generated by this pollution are susceptible to alter the physiology the reproduction of marine organisms. To optimise without constraints, the exploitation of marine resources, one of the major challenges is to distinguish between "clean" and polluted ecosystems.

Considering the disadvantages of using sea water and sediments in pollution monitoring, marine organisms such as bivalves were shown to be successful Bioindicators of pollution. In fact, these organisms accumulate contaminants usually from water and food. The accumulation reflects only the bio-available fraction and gives us information about the health status of on considered ecosystem. Different monitoring programs such as RNO and Mussel Watch are based on Mollusc bivalve model.

Biomonitoring programs based on measuring contaminants in marine organisms are interesting from a human health point of view. However, it does not give information about the toxicological significance of pollutants accumulated and does not indicate the health status of the organisms particularly because xenobiotics can be stored in various forms such as insoluble precipitates and concretions. Consequently, biomonitoring programs are now involving biomarkers. These are measurable parameters at different levels of biological organisation, molecular, cellular, or physiological. They traduce changes in the metabolic regulatory processes resulting from the effect of anthropogenic stressors. We can detect and quantify the biochemical interactions between a contaminant and its biological receptor in the living organism. In such case we can determine pollution concentrations needed to initiate this response which is assumed to be lower than those required to provoke a life-threatening situation for the organism or a degradation of the ecosystem. These early warning systems are called a biomarker. In the last decades different research groups have focused on the validation of a battery of biomarkers and have been involved in biomonitoring program at the Mediterranean level. For that we need various and complementary approaches: in vitro, in vivo, in situ, in situ transplantations, and in vivo transplantation. They allow the validation of few Biomonitors and Biomarkers. Nevertheless, one of the crucial questions is about the variability of the response in relation with both biotic and abiotic factors. According to some researchers, the signal to noise ratio is a key issue allowing the validation or not of a considered biomarker.

More recently an innovative approach based on ex in vivo experiment was investigated, it has the advantage of limiting animal experimentation and could open new perspectives for pollution biomonitoring.

How to manage the MSFD machine: what are the keys

Angel Borja
AZTI, Spain

The Marine Strategy Framework Directive (MSFD) represents a challenge for science and management, since it is a complex socio-ecological legislation, requiring monitoring and assessment of 11 qualitative descriptors and multiple ecosystem components, from plankton to mammals. The assessment must be undertaken under the ecosystem-based management approach. However, there is only one big idea in marine management: How to maintain and protect the ecological structure and functioning (which is in the MSFD), while at the same time allowing the system to produce sustainable ecosystem services from which we derive societal benefits (which is in the Maritime Spatial Planning Directive (MSPD) and the Blue Growth).

The problem is how to reconcile both concepts, under a framework such as the DAPSI(W)R(M), in which the socio-economic Drivers promote human Activities, which produce Pressures and changes of State at sea, which result in Impacts on the environment and human Welfare (ecosystem services), needing Responses and management Measures, to reduce pressures and impacts. Taking into account this framework, my personal keys for a better management of the MSFD machine can be summarized into four blocks: (i) organization; (ii) monitoring (acting on the APSI(W) of the framework); (iii) assessment, on I(W); and (iv) management, on R(M)DA.

The keys of each block, which I will discuss, include: (i) Organization: take always knowledge-based decisions; use existing data as far as possible; practice flexibility; promote cooperation within and among states; establish strong links between research and policy; avoid endogamy; (ii) Monitoring: design adequate networks; use simple but effective methods; (iii) Assessment: use quantitative methods and thresholds; use expert judgment if necessary; use harmonized and calibrated methods; use integrative methods; make all data open access; and (iv) Management: design Programmes of Measures which can contribute to achieve Good Environmental Status (GES); use adaptive management; and use real ecosystem-based management.

To conclude with a positive message, we can achieve GES, within the MSFD, and reconcile it with the objectives of the MSPD (and Blue Growth), if: (i) monitoring is adequately designed, coordinated within the same eco-region and using adequate resources; (ii) any activity at sea is subjected to adequate evaluation of pressures and impacts produced, together with an investigation of its interaction with other activities; (iii) these activities are planned taking into account the assimilative capacity of the system; (iv) adequate targets are set for indicators of GES; (v) the programme of measures is designed to address the pressures preventing achieving GES; (vi) integrative assessments (ecosystem-based approaches) are undertaken regularly, based upon the best knowledge available; and (vii) marine ecosystems are considered in a holistic way, including humans as part of the system.

Published by:

JPI OCEANS

Rue du Trône 4 | 1000 Brussels | Belgium

Tel. +32 (0)2 626 16 60 | info@jpi-oceans.eu

www.jpi-oceans.eu

In collaboration with:

blueMed

Consiglio Nazionale delle Ricerche