



Resumos das comunicações apresentadas na Conferência Internacional “Desenvolvimento Sustentável do Oceano: uma utopia útil”

Homenagem ao Professor Mário Ruivo
13 e 14 de novembro
Universidade do Algarve

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MESSAGE A LA MEMOIRE DE MARIO RUIVO

Jean-Pierre Levy

Je voudrais avant tout exprimer ma reconnaissance aux organisateurs de cette manifestation pour l'hommage rendu en ce jour à mon grand ami Mario Ruivo.

J'ai été sensible à leur invitation et je regrette sincèrement de ne pouvoir être parmi vous à cette occasion.

Je suis actuellement sur un autre continent cependant toutes mes pensées sont avec vous car le départ de Mario me prive d'un collègue et ami de plus de 40 ans. Tout au long de notre amitié, l'esprit d'entreprise de Mario, son dynamisme et son optimisme, que les ans n'ont pas su diminuer, m'ont constamment encouragé et impressionné. Il en a été ainsi en particulier lorsque nous avons eu le plaisir et l'honneur ensemble de seconder Mario Soares lors de sa présidence de la Commission Mondiale Indépendante des Océans qui a culminé lors de l'Exposition sur les Océans tenue à Lisbonne en 1998.

Au-delà de la perte d'un humaniste pour tous ses intimes, la communauté scientifique dans son ensemble et le monde politique intéressés au devenir de notre planète ont perdu un phare international qui les a éclairés pendant plus d'un demi-siècle.

La recherche scientifique marine, les pêcheries, le droit de la mer, la préservation du milieu marin, ainsi que la place et le rôle politique du Portugal dans ces domaines, sont des sujets dont l'évolution et les progrès accomplis doivent énormément à Mario. Ces sujets seront certainement longuement évoqués au cours de cette réunion, et je voudrais, quant à moi, plutôt vous rappeler, si besoin en était, que Mario, outre ses qualités professionnelles et sa défense permanente des valeurs démocratiques, était surtout un homme de cœur et d'esprit.

Mario a toujours su porter sur le monde et les personnalités qu'il fréquentait un regard objectif teinté de bienveillance qui lui a permis d'être grandement apprécié par tous ceux qui l'ont approché.

A ce propos, une brève anecdote illustrera cet aspect de sa personnalité : au cours des quelque 40 années qui ont vu nos routes professionnelles se croiser régulièrement il nous est arrivé de partir ensemble en mission dans des pays lointains. Lors de l'une de ces missions en Asie, nous avons été amenés à avoir des entretiens répétés avec des fonctionnaires du gouvernement local. C'était une époque de très grande chaleur et Mario et moi transpirions abondamment. Nos chemises étaient trempées et les bureaux des fonctionnaires étaient tous climatisés. Nous avons constaté à notre grande surprise que plus les fonctionnaires étaient haut-placés, plus forte était la climatisation. Et finalement, lorsque nous avons été reçus par le Ministre des affaires étrangères, nous nous sommes mis à frissonner. Le lendemain nous étions tous les deux malades et alors que moi je m'emportais contre ces personnalités qui utilisaient tous les moyens, y compris la réfrigération, pour manifester leur pouvoir, Mario, lui, se contenta de mentionner qu'il nous aurait appartenu de prévoir une telle situation et d'emporter veste et cache-nez.

Cette illustration de l'aptitude de Mario à faire la part des choses était l'une des caractéristiques de sa personnalité. J'aurais de nombreuses autres anecdotes à vous conter cependant je m'en voudrais d'abuser de votre temps.

Qu'il me soit seulement permis de dire à la famille et aux proches de Mario ainsi qu'à ses collègues et à tous ceux qui l'ont apprécié que je ressens profondément le vide que son départ a entraîné. Il restera le meilleur exemple d'un esprit démocratique qui aura contribué à l'avancement des idées politiques et scientifiques de notre temps tout en maintenant les valeurs intellectuelles et humanistes qui font la grandeur de l'être humain.


Mario et son exemple resteront toujours avec nous.

Whose Ocean is it anyway? How to further societal engagement with the Ocean

Ned Dwyer

Executive-Director, EurOcean

Professor Mário Ruivo was one of the driving forces behind the creation of EurOcean – the European centre for Information on marine science and technology. Its establishment followed on a joint French-Portuguese initiative aiming to implement the recommendations of the report "Towards a new marine dimension for Europe through research and technological development", adopted in the year 2000 by a group of governmental experts from 15 European countries brought together at the invitation of the then Portuguese Minister for Science and Technology. The idea of creating EurOcean was to have a permanent structure that could focus on creating, maintaining and making permanently available information on marine science and technology, overcoming the then lack of visibility and difficulties of information access. Since then EurOcean has gone from strength to strength and is now made up of 12 members from 10 European countries and four cooperating members. This presentation will focus on Professor Ruivo's legacy and will highlight initiatives related to information dissemination, ocean literacy, outreach and stakeholder engagement, which reflect his vision that society needs to be more aware of and engaged in issues of the ocean.



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Direito do Mar e Investigação Científica

Scientific research in the EEZ and in the Continental Shelf under UNCLOS: Portugal's experience in addressing foreign entities' requests for access

Maria Eduarda Gonçalves¹ and Maria Inês Gameiro²

The United Nations Convention on the Law of the Sea (UNCLOS) has profoundly altered the legal framework of maritime activities. For Portugal, UNCLOS triggered apparently contradictory effects: on the one hand, the reinforcement of the rights and powers of the state on their Exclusive Economic Zones and Continental Shelf; on the other hand, the reduction of the opportunities of free access to areas today under the jurisdiction of other states.

A basic feature of the new regime of marine scientific research is the jurisdiction of coastal states over marine scientific research activities in their EEZ and on their continental shelf. This implies the rights of coastal states to regulate, authorise and conduct marine scientific research in these areas, so-called consent regime. Yet, according to UNCLOS, coastal States shall, in normal circumstances, grant their consent for marine scientific research projects by other States or competent international organizations. Still, states have got the power to oversee activities carried out in these areas, which may lead to the acquisition of knowledge concerning marine resources and ecosystems, and to require that foreign entities accept researchers from the coastal state in their cruises, grant access to the research results, and assist in their interpretation.

An issue then is how coastal states, particularly those that are not the major seagoing distant-water research nations, are exercising their rights, to what extent they are allowing research entities from foreign countries to have access to their EEZ or continental shelf, and under what conditions, what has been the scope of participation of local researchers in such activities; ultimately, how the new regime is impacting on scientific knowledge and scientific capabilities on a national scale.

In this paper, we attempt some very preliminary responses to these questions based on analysis of data collected by the Comissão Oceanográfica Intersectorial (COI-MCTES) [Intersectorial Oceanographic Commission of the Ministry for Science, Technology and Higher Education] on requests by foreign research entities to undertake research campaigns in marine areas under the sovereignty or jurisdiction of Portugal, and their aftermaths (2006-2016).

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² Researcher, Dinâmias CET-IUL; CEDIS, FD-UNL.

O Ordenamento e a gestão do Espaço Marítimo Nacional: o contributo do Professor Mário Ruivo

Vasco Becker-Weinberg

O projeto de proposta de lei que esteve na génese da Lei n.º 17/2014, de 10 de abril, que estabelece as bases da política de ordenamento e de gestão do espaço marítimo nacional, posteriormente desenvolvida pelo Decreto-Lei n.º 38/2015, de 12 de março, foi objeto de um amplo debate público e político, dentro e fora da Assembleia da República.

Um dos intervenientes nesse debate foi o Professor Mário Ruivo, em particular, na sua qualidade de presidente do Conselho Nacional do Ambiente e do Desenvolvimento Sustentável (CNADS). Com efeito, para além de assinar o parecer emitido pelo CNADS e da sua profícua intervenção pública, o Professor Mário Ruivo também participou, em representação do CNADS, nas audições promovidas pela Assembleia da República sobre o referido projeto.

O objetivo desta apresentação é dar a conhecer e analisar o contributo do Professor Mário Ruivo e do CNADS para o regime jurídico do ordenamento e da gestão do espaço marítimo nacional.

The deep-ocean – a new stewardship frontier

Ana Hilário¹ and Maria Baker²

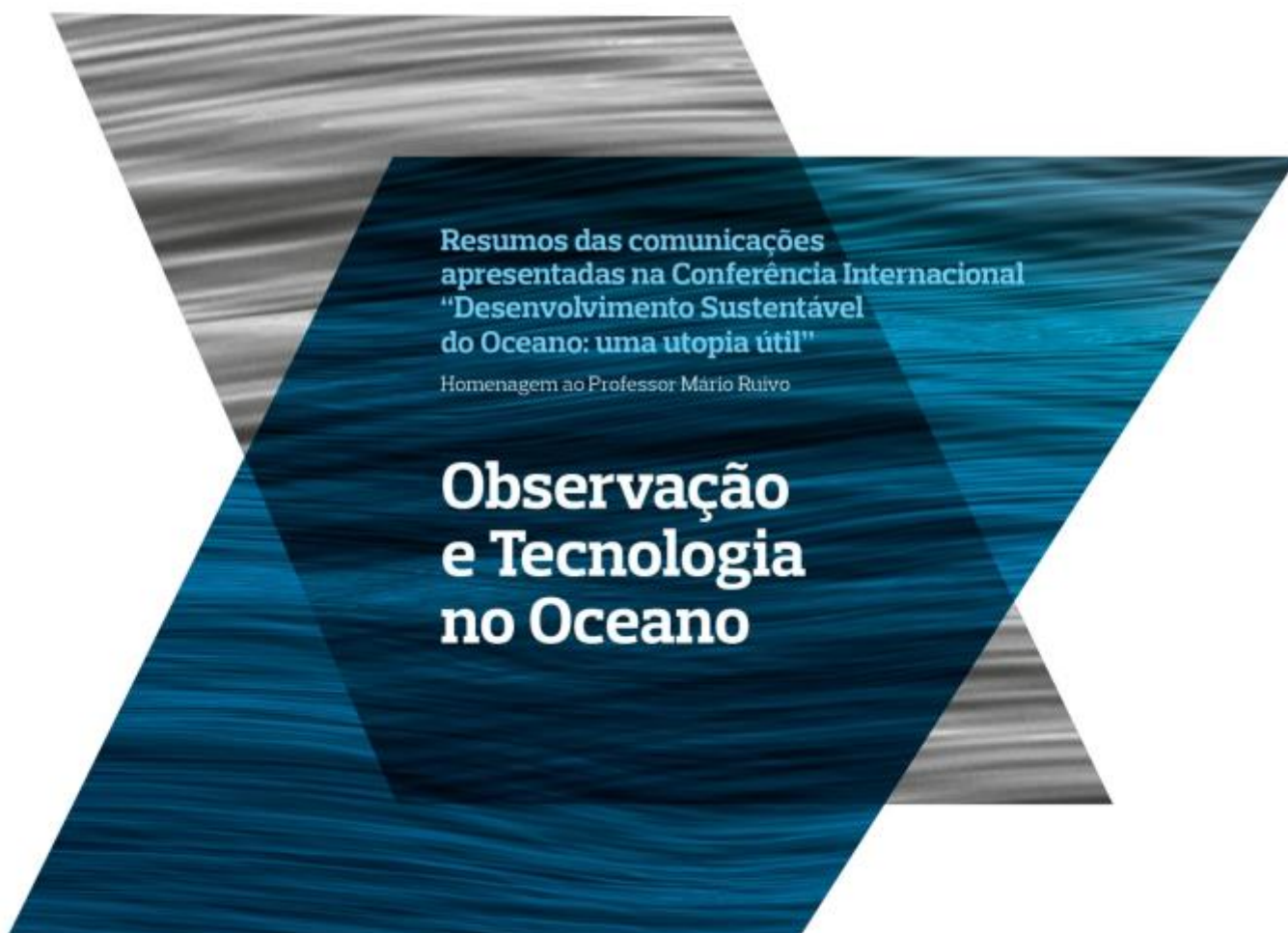
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²University of Southampton, UK

One of the greatest challenges of the 21st century is managing the deep ocean sustainably, i.e., achieve appropriate protection while enabling use of living and nonliving resources. Resources such as fish, oil and gas have been taken from the deep sea for many decades, in most cases with poor or non-existent management strategies in place, leading to the depletion of fish stocks, ecological damage and habitat destruction. More recently, due to the demand of rare and precious metals, deep-sea metalliferous deposits have become increasingly attractive to commercial operators and there is a risk that deep-sea mining will start without adequate environmental planning. Further, as pH and oxygen concentration decline as a consequence of climate change, and as marine pollution increases, the resilience of deep-sea ecosystems and the services they provide are compromised. The deep ocean supports a wealth of supporting, provisioning, regulating and cultural functions and services that hold benefits to mankind as a whole. As such, it should be managed from a global, multi-sectorial dialogue and interdisciplinary research must occur at the intersection of biodiversity, resource economics, climate science, law and policy.

Major challenges in deep-ocean management arise from gaps in knowledge and governance. Technological advances in recent decades underpin the massive progress in the exploration and characterization of deep-sea ecosystems, revealing highly diverse deep-sea floor habitats, new ecosystems that challenged scientists' views of life on our planet, and a realm that is vulnerable to disturbance. Nonetheless, less than one percent of the sea floor has been sampled or monitored, thus we remain largely ignorant of how deep-ocean ecosystems change in space and time, both naturally and in response to human activities. Likewise, gaps in deep-ocean governance abound as most legal frameworks, both national and international, lack essential mechanisms to manage and protect ocean resources such as provisions for integrated, ecosystem-based and systematic planning and management. Moreover, conventional models of governance (and diplomacy) will not succeed; instead, deep-ocean management requires flexible approaches to international cooperation, informed by scientific evidence and supported by practical scientific partnerships. A significant challenge here is that management needs to keep pace with fast-growing industries.

This talk will review the recent progress and current gaps in deep-sea ocean management, focusing on three main aspects of the legacy of Professor Mario Ruivo for sustainable use of the Oceans: 1) scientific discovery and observation; 2) legal and policy tools; and 3) awareness and global environmental justice.

The cover features a large, stylized letter 'X' shape. The left and right arms of the 'X' are filled with a grey, textured pattern resembling water ripples. The top and bottom arms are filled with a dark blue, textured pattern also resembling water ripples. The text is centered within the blue section of the 'X'.

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Observação e Tecnologia no Oceano

A Robótica Marinha: Ferramentas para o Estudo e Exploração dos Oceanos

António M. Pascoal

Laboratório de Robótica e Sistemas em Engenharia e Ciência (LARSyS), ISR, Instituto Superior Técnico (IST), Univ. de Lisboa, Portugal

Ao longo dos últimos anos tem-se assistido a um interesse crescente pelo uso de veículos robóticos para o estudo e exploração dos oceanos. A utilização destes veículos tem vindo a permitir libertar os operadores humanos de tarefas fastidiosas, alcançar zonas profundas até agora inacessíveis, e desenvolver sistemas sofisticados para aquisição e transmissão de dados marinhos, assim como para prospeção do fundo do mar. Nesta apresentação dá-se uma visão de alguns dos avanços mais recentes no domínio da robótica marinha, citam-se projetos representativos que ilustram a simbiose necessária entre a ciência e a tecnologia, e perspetiva-se o impacte esperado deste domínio de atividade a nível económico e social. Ao longo da apresentação dá-se relevância às capacidades desenvolvidas a nível nacional e em parceria com investigadores na Europa, Índia e Coreia para o desenvolvimento e operação de robôs marinhos autónomos. Os conceitos introduzidos serão ilustrados com vídeos obtidos no decurso de missões no mar.

Unmanned vehicle systems for ocean observation: Lessons learned and future applications

Renato Mendes, João Borges de Sousa e José Pinto

Laboratório de sistemas e tecnologias subaquáticas, Faculdade de Engenharia da Universidade do Porto

Unmanned vehicle systems are already changing the way some oceanographic field studies are conducted and this trend will certainly accelerate in the next few years. This talk reviews operational field studies conducted by underwater, surface and aerial vehicles developed and operated by the Laboratório de Sistemas e Tecnologias Subaquáticas (LSTS) from Porto University and provides a preview of future operational capabilities. There is an equal emphasis on the conceptual contributions and on tools and techniques that yield more immediately practical benefits, especially in what concerns bridging the gap between science and engineering. This is discussed with reference to the LSTS model of science-driven developments, with a special emphasis on operational testing and evaluation done in coordination with scientists and engineers.

Hydrocarbon-rich fluid seepage in the Gibraltar Arc System: 9 Years of IOC-sponsored Training Through Research Cruises

Luis Menezes Pinheiro

Dep. Geociências and CESAM, University of Aveiro, Portugal

Extensive areas of mud volcanism and gas seepage form in the oceans in all kinds of geodynamic settings and host some of the most interesting deep-sea chemosynthetic ecosystems. In the deep S. Iberia and Northwestern Moroccan margins, an area often described as the “Gulf of Cadiz”, and in the Alboran Sea, extensive multinational and multidisciplinary research carried out since 1999, largely in the scope of the IOC-sponsored Training Through Research (TTR) Floating University Program, has allowed the discovery of large fields of mud volcanoes and other seafloor structures associated with gas seepage, such as pockmarks and diapiric ridges. More than 60 mud volcanoes of various sizes, reaching more than 3km in diameter and a few hundred meters in height, have been identified in these areas by geophysical surveys, confirmed by coring and underwater high-resolution video surveys. Most of these structures concentrate in the compressional accretionary wedge of the Gulf of Cadiz, related to the Africa-Eurasia convergence since the Cenozoic, but also in the Alboran Sea, in an extensional setting. Recently, similar structures were found west of the accretionary wedge along the Azores-Gibraltar Fracture Zone. Thermogenic gas hydrates, a potential alternative energy source for the future, have been recovered from several mud volcanoes in this area, and a large diversity of chemosynthetic communities, including new species for the science, has been identified. Evidence of major past episodes of methane release from depth have been recorded by the occurrence of vast fields of methane-derived authigenic carbonate crusts and chimneys, some of which composed of dolomite, precipitated through anaerobic methane oxidation by consortia of archaea and bacteria. Such episodes of methane release from the deep sea, in particular associated with gas hydrate dissociation in deep sea sediments, may have had a significant impact on past climate change.

Ocean Observation: A Useful Activity for the Society?

Flávio Martins, Davide d'Alimonte, João Janeiro

CIMA, Universidade do Algarve

The capability to observe and predict the behaviour of ocean variables has increased continuously during the last decades. This increase is strongly connected to the improvement of remote sensing platforms and sensors (especially satellite born observations), both in performance and in coverage. Innovative *in situ* platforms has also contributed to increase ocean observation capabilities. Among them, robotized oceanic buoys (such as ARGO) can be referred, as well as autonomous under water vehicles (AUV), underwater gliders and many others. The increase in ocean observation however, is still not enough to assure a sufficiently dense coverage of the ocean. In fact, when compared with other themes in our planet, the observation coverage, and therefore the knowledge we have about the ocean is much smaller than the one we have about the land or the atmosphere. One important reason for that is the extreme difficulty and high associated costs involved in the observation of the deep layers of the ocean. Our capability to forecast the evolution of ocean variables has also increased at a sustained rate during the last thirty years. This forecasting is performed using mathematical models of increasing complexity that must be supported and backed up by ocean observation as well as by the exponential increase in computational capabilities. Currently, several operational modelling systems deliver continuous forecasts of some essential ocean variables for the global ocean with a resolution of a few kilometres. The actual state of knowledge allows us to anticipate the creation of products and services useful to the society. This process however has not been as fast as desirable, due to many factors among which we can refer the difficulty in increasing further the resolution of the models, the need to an even higher coverage and resolution of ocean observation and a difficulty in engaging the enterprises in this process.

In this presentation, the present state of ocean observation techniques, their capabilities and foreseen evolution are reviewed as well as the foreseen evolution of the ocean forecasting systems. Following, the products and services these activities can produce are discussed, and their advantages to the society are analysed in the scope of the strategic European and international goals such as the Blue Economy and the Blue Growth. We finalize with a discussion on what is needed to improve the ocean observation and forecasting capabilities and how this effort can be supported.

Deep sea-from unknown to intended- deep sea observatories, a tool to monitor the human activities.

Ana Colaço

MARE, Açores

Until the last century, the deep-sea environment, despite being the largest ecosystem on earth, has been poorly study. Two main factors contributed to this, the lack of technology and the immense size of the ecosystem, with all its different environments and habitats, such as the pelagic realm, the benthos with abyssal planes, ridges, vents, seamounts, cold seeps, sponge aggregations, cold water corals gardens and reefs, to name just a few.

With the increase technological development, and with the dilapidation of land and shallow water resources, mankind has migrated their activities to deeper in the sea, by extracting oil and gas from the deep-sea, fishing deeper, and extracting minerals from the continental slopes and discussing the possibility to go to the high seas for SMS, nodules and cobalt crusts.

In order to understand the human impacts and mitigate them, we need to understand the environment, how it changes naturally, to identify how human cation is affecting the normal function of the system. To do that, it is crucial to be able to have time series, and ideally continuous measurements of the environmental characteristics of the deep.

To go to the deep-sea it is very expensive, because there is the need of an oceanographic vessel, a vehicle and sensors that cannot be continuously on the spot.

From more than 20 years, the scientific community together with engineers are trying to develop continuous observation systems that will allow to have time series, and to understand the natural fluctuations of the system. The fix point observatories were created in several key places around the globe. They can be cables, tethered or autonomous, measuring continuously or at a higher frequency, and sending the data to shore, in order to be able to take actions in case of a tsunami alert, seismic crises at the bottom of the ocean, or even an increase in the deep-water turbidity.

Portugal is being involved since the beginning, participating and using the one installed in the Lucky strike hydrothermal vent, and raising funds to install one at the Gulf of Cadiz and on the Condor seamount. Examples of how those observatories can be linked and used to detect climate change, monitor mining and contribute to GOOS are given.

Cetacean ecology and health in continental Portugal

Catarina Eira and Sílvia Monteiro

Department of Biology and CESAM, University of Aveiro, Portugal

The Coastal and Marine Vertebrate Conservation team at CESAM is dedicated to the study of cetaceans, seabirds, sea turtles and their environment. Within the framework of several projects, cetaceans, turtles and seabirds stranded dead are collected and analysed in order to determine the cause of death and to study some of their pathologies and levels of contamination. An important percentage of cause of death is related to accidental catch by fishing gear. With respect to contamination, considering 4 different dolphin species, bottlenose dolphins present the highest concentrations of mercury. On the other hand, common turtles revealed relatively high levels of cadmium.

With respect to live strandings, marine animals are brought to the Ecomare rehab center. Rehabilitation attempts to mitigate the effect of some threats, for example marine litter, in the case of turtles and seabirds presenting ingested or entangled litter. It also mitigates bycatch impacts, since a large proportion of the admitted animals show signs of interactions with fishing and sport fishing. These animals are properly treated at the Ecomare and then returned to the marine environment as soon as possible.

Indirectly, the results obtained help monitoring marine environment conditions. Our objective is to further monitor marine vertebrate populations on the Portuguese mainland coast by integrating data on toxicology and microbiology with various population parameters. Only then will we be able to properly assess the effects of threats in the marine environment (well-known and emerging threats) and propose appropriate mitigation measures.

Hydrological Characterization of the Olhos de Água Submarine Groundwater Discharges – Projects FREEZE and TROANTE

Fátima M. Sousa^(1,2) e Helena Frazão⁽¹⁾

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The existence of freshwater springs at the Olhos de Água beach (Algarve, south coast of Portugal) has been known for a long time, being the name of the small fishermen village historically related to these “water eyes” (*olheiros*, in Portuguese) still observed nowadays at the beach during low tide. These springs have also been identified at sea, just in front of the beach, as they can be observed from the coast during days of calm sea. When the outflows are very strong, they drift the small boats of the local fishermen.

The R&D project “FREEZE – Submarine FRESHwater dischargEs: characteriZation and Evaluation study on their impact on the Algarve coastal ecosystem” took place in the period 2010-2013 and its main objective was the study of the Submarine Groundwater Discharges (SGDs) at sea in the Olhos de Água region.

In the frame of FREEZE project, several SAR (Synthetic Aperture Radar) images were processed and analyzed to look for patterns of sea surface roughness (slicks) that could be associated with the potential location of the SGDs over the continental shelf. One image obtained in 9 February 2010, during a particularly rainy winter, showed a slick just in front of Olhos de Água beach. The geographical location of that slick was crucial for the planning of the station array to be occupied during 3 CTD surveys, which took place in the period November 2012 - November 2013. The depths of the stations ranged from 2 to 30 m, being the study area restricted to 3 n.m. from the coast (≈ 5.6 km) due to the small dimensions of the boat.

Salinity, temperature and density profiles and T/S diagrams were analyzed for a total of 196 stations: 166 in front of Olhos de Água beach and 30 stations located in two areas considered as “non-SGDs referee places” (Albufeira and Falésia) thus helping the identification of waters with a coastal oceanic origin contrasting with the waters influenced by submarine springs over the continental shelf off Olhos de Água. The analyses of the whole hydrological data allowed the identification of springs with a strong signal in the entire water column and SGDs near the bottom. Frequently, the signal of the freshwater discharges was detected at several depths in the water column and at the surface, possibly indicating the direction of the propagation of the plumes. SGDs seem to be recurrent as they were detected in the same locations during rainy and dry years, being stronger the signal of the last ones.

In the frame of the ongoing RD&I project “Desenvolvimento de Tecnologia UAV para Utilização de Âmbito Conjunto e Dual – TROANTE”, an infrared radiometer will be used onboard an UAV to measure sea surface temperatures offshore Olhos de Água to detect the thermal signatures of the SGDs at the surface.



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Recursos Marinhos

Peixes diádromos: uma vida passada entre o mar e o rio

Diadromous fish: living between the sea and the river

Pedro R. Almeida

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Os peixes diádromos evoluíram no sentido de utilizarem dois meios completamente distintos durante o seu ciclo de vida (*i.e.* o rio e o mar), e subdividem-se em anádromos (*e.g.* lampreia-marinha, sável) e catádromos (*e.g.* enguia, muge), consoante a sua reprodução se realiza em água doce, ou em ambiente marinho, respetivamente.

Em Portugal, o elevado valor comercial da maioria destas espécies torna-as o alvo principal de pescarias artesanais, estando documentados fenómenos de sobrepesca, a par de uma intensa atividade furtiva. A perda da continuidade longitudinal nos rios, fruto da construção de barragens e outras obras hidráulicas, contribuiu igualmente para o declínio dos efetivos populacionais das espécies diádromas, situação agravada pela regularização de caudais e pela escassez de água associada às alterações climáticas que se fazem sentir a nível global.

A complexidade e abrangência territorial destas ameaças exige a implementação de medidas integradas de gestão e conservação e, nesse aspeto, a componente científica pode atuar como ligação entre todos os agentes intervenientes no processo, designadamente, a administração local e central, os pescadores profissionais, os promotores privados e o público em geral.

O trabalho que está a ser desenvolvido através do Plano Operacional de Monitorização e Gestão de Peixes Anádromos em Portugal, as intervenções de reabilitação do habitat em curso em algumas bacias hidrográficas nacionais (*e.g.* Mondego, Vouga), e a revisão da regulamentação da pesca comercial realizada numa lógica de exploração sustentável têm contribuído decisivamente para a recuperação das populações de peixes diádromos no nosso país.

Sustainability of small-scale fisheries: social and economic importance, challenges and future opportunities

Cristina Pita

Department of Environment and Planning and CESAM, University of Aveiro, Portugal

For decades, EU fishery policy has focused on large-scale fishing, disregarding small-scale fisheries, even though these are worth around 2 billion euros annually (25% of the revenue generated by EU fisheries), account for 80% of the EU fleet (approx. 85,000 vessels) and employ over 40% of EU fishers (90,000). Only recently small-scale fisheries are gaining centre stage at the EU scale with the 2014 reform of the Common Fisheries Policy calling for, amongst other things, a move towards a differentiated management regime for small-scale fisheries, increased participation of fishers in the decision-making process, and the implementation of co-management arrangements.

Small-scale fisheries in Europe are quite diverse but face some common challenges which may arise from the competition for resources with other activities, such as recreational fisheries, that usually target similar species and fishing areas. Also, urban development and tourism may affect many of the small-scale fishing activities developed along the coast, in beaches or harbor areas. The competition with larger fleets for resources and markets cannot be underestimated either.

Despite the importance of small-scale fisheries in Europe, there is a general lack of knowledge and data on this sector. Most work done on small-scale fisheries is focused on the biological and ecological impacts caused by the fishing activity, and little is known about the social and economic importance of the activity and its management and governance.


The talk will summarize findings from a book about small-scale fisheries in Europe, with the emphasis on 'people' (less on technology or catches). It will characterize small-scale fisheries in the EU in terms of social and economic importance, as well as identify the challenges the industry faces and opportunities for the near future.

Tropicalization of temperate marine systems in a context of global changes - challenges and policy implications

Emanuel Gonçalves

MARE - Marine and Environmental Sciences Centre & Oceano Azul Foundation

Marine systems are being subjected to significant impacts from global climate change. In temperate coastal ecosystems, species composition, distribution and abundance patterns are changing markedly in response to these circumstances. The cyclic conditions typically found in temperate regions are being disrupted and oceanographic features greatly influence these conditions. The tropicalization of temperate environments mean that species are migrating polewards but these conditions do not affect all species equally. The importance of temperate zones as 'barometers' of climate change is highlighted and the policy implications of these changes to fisheries and conservation strategies are discussed.



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do Oceano: uma utopia útil"

Homenagem ao Professor Mário Ruivo

Exploração de Recursos e Biotecnologia Marinha

Deep-sea mining: a manageable necessity or a curse?

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There is much ignorance on the role of mineral resources in our everyday lives, and on the situation concerning the availability of many of these resources. Many people and some organisations put forth that minerals in use are sufficient, that the circular economy and recycling will soon render primary mining needless, especially on the deep seafloor.

The above opinions fail to consider that growing population and growing income place growing demand on resources, especially the aptly called critical resources, such as cobalt, rare earths, platinum group metals, and many others.

The main factors which define criticality include supply from one or a few countries only, and forecasts of limited availability. Critical resources are essential in a very large number of everyday industrial products, including TV sets, computers, smartphones and many others. Ditto for green energy devices, including hybrid and electric automobiles, wind generators and solar panels. Recycling is very welcome, but its success is variable. Recycling is very difficult for many resources, such as the rare earths, not only for economic but also for energy consumption reasons.

The deep seafloor contains very large amounts of resources. As demand grows, there are plans to mine seafloor massive sulphide (sms) deposits and polymetallic nodules, for copper, gold, manganese, cobalt, nickel and several others. Ferromanganese crusts, especially cobalt-rich, may become an important resource as well. They contain the above metals and small but valuable amounts of platinum and rare earths (and others still). Recently many abyssal sediments have been shown to contain mineable amounts of rare earths. Not to mention hydrocarbons and deep biosphere extremophile biomolecules.

Seafloor mining raises concerns over impacts on the ecosystem. Appropriate sets of rules must be created, and strictly enforced. Illegal and unregulated mining operations must be shut down. It will be necessary to create reserve areas alternating with mining areas; The procedures must be sound, and adapted to the findings of scientists; There must be intimate co-operation between science, industry and governance.

Environmental challenges of deep-sea resource exploitation

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The deep-sea is the largest single ecological unit on Earth providing over 95% of global biosphere. Scientific knowledge from the deep sea greatly depends on the high-tech remotely-operated vehicles and manned submersibles that are necessary to reach and operate at these depths. As such, only less than 0.0001% of the deep sea has been target of scientific research. Nevertheless, recent technological breakthroughs have triggered the economic interest in exploiting its non-living resources. The environmental hazard posed by deep-sea mining activities needs to be evaluated using an integrated approach and should be applied to each potential mining site prior to exploitation. Still, current scientific knowledge is not enough to warrant its exploitation with a good environmental management of its resources.

Phage solutions for aquaculture systems

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Considering the increasing importance of aquaculture and the fact that several fish farming plants often suffer from heavy financial losses due to the development of infections caused by pathogenic bacteria and that the filter feeder bivalve molluscs are frequently implicated in the transmission of pathogenic bacteria to humans, more environmentally-friendly strategies to control pathogenic bacteria in aquaculture are urgently needed. Phage therapy appears to represent a useful and flexible tool for the inactivation of bacterial pathogens in aquaculture. In this presentation it will be highlight some of our recent works on phage therapy applied during the production of juvenile flounder fish and during cockles depuration.

In the production of juvenile flounder fish, phage therapy was used to inactivate *Aeromonas salmonicida* which is the causative agent of furunculosis, a systemic disease characterized by high mortality and morbidity in aquaculture. The results showed that AS-A phage inhibited the growth of the *A. salmonicida*, causing a decrease in bacterial abundance of $\approx 3 \text{ CFU mL}^{-1} \log$ after 6 h of treatment. After 72 h, the mortality of juvenile fish was higher (34%) in the fish exposed to *A. salmonicida* but not treated with phages than in the infected and treated groups (0%). The addition of AS-A phage to aquaculture water did not cause a detectable impact on the structure of the natural bacterial community. However, the bacteriome of the fish was significantly affected by the addition of the AS-A phage, but the differences were lower when the phage was added in the presence of the host bacteria.

In the bivalves decontamination, two *Escherichia coli* phages (phT4A and ECA2) and two phages (phSE-2 and phSE-5) of *Salmonella enterica* serovar Typhimurium (*Salmonella* Typhimurium) were used during the depuration of natural and artificially contaminated cockles (*Cerastoderma edule*) in depuration systems with (mimicking industrial depuration conditions) and without recirculating water. The results showed that, for both bacteria, approximately 2 log were inactivated in artificially contaminated cockles and approximately 0.6 – 0.9 log for *E. coli* and *Salmonella* Typhimurium in naturally contaminated ones. It was also found that the use of phages during depuration decreased bacteria concentration faster than the use of depuration alone, as to achieve the same bacterial concentration decrease, two more hours were needed if no phage was used. It was observed development of bacterial resistance to phages ($\sim 1 \times 10^{-4}$ - 1×10^{-5}), but mutant of *E. coli* and *Salmonella* Typhimurium grew much slower and their colonies were small than the susceptible ones.

Results provide evidence that phage therapy is a feasible alternative approach against furunculosis during fish juvenile production in aquaculture systems and that combining phage therapy with depuration procedures enhance bivalve microbial safety for human consumption by improving decontamination efficiency. Moreover, this approach also displays the advantage of reducing the time required for depuration and consequently its associated costs. Furthermore, as phage-resistant bacteria growth slowly and were smaller than colonies formed by the non-phage added control, mutants should be less fit, so they can be expected to be eliminated from the environment faster than their wild-type relatives. These results suggest that the emergence of phage-resistant mutants should not be a major problem to the application of phages to control bacterial infections in aquaculture.

Sustainability of using Ria Formosa Currents On Renewable Energy production

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Europe has the potential to tap into an exceptional renewable energy resource from as yet unexploited offshore wind, wave and tide resources. The MORE - Marine Offshore Renewable Energy team - is a group of researchers from CIMa - Centre for Marine and Environmental Research. Our research focus is on support the optimization of different types of marine renewable technologies to produce energy from the ocean processes. We aim on creating new tools and methods to quantify the marine energy resources; and study the effects of exploitation of energy in marine ecosystems, using and testing full-scale prototypes and keeping a strong partnership with the industry.

The project SCORE financed by the Portuguese Foundation for Science and Technology proposes to test for the first time a floatable tidal energy converter on Portuguese waters, the Evopod 1:10th scale prototype from OceanFlow Energy. The innovative aspect of TEC testing in Portugal lies with the unique morphological characteristics associated with the device deployment site at Ria Formosa, a coastal lagoon protected by a multi-inlet barrier system located in southern Portugal (Algarve Region). Ria Formosa can be used as representative of the vast majority of shallow coastal areas where these extraction devices can be used in the future. It is therefore ideal to analyse both the energy extraction efficiency and eventual impacts that extracting energy from the flowing currents will have on the ecological communities and physical settings. The main expected outcome of the proposed research is to construct an operational envelope which can be used by technology developers on design concepts of efficient devices based on environmental and sustainability principles, contributing to the growth of the blue economy.

Marine Biotechnology: a challenging path to sustainable food, feed, energy and improved human and animal health

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As life began in the oceans, the past, but also the future of the human population is intrinsically linked to marine living resources. The oceans offer a bounty of biodiversity that needs to be protected, properly managed and exploited with responsibility. Recent studies on the biodiversity of marine organisms have revealed that the tree of life is actually a misleading concept. We should rather see it as a web of life with multiple interactions in terms of complex networks of gene transfers, endosymbiotic events and trophic relationships. The understanding of this complexity and the evolutionary history that underlies and explains the biology, biochemistry and ecology of marine life is key to its effective exploitation to benefit human beings as a whole. We will discuss knowledge-based strategies that are currently being implemented in order to use the available marine living resources as novel sources of food, feed, energy and bioactive compounds, so that a more sustainable future can be provided to future generations.

Marine bioremediation: new tools for ecosystems recovery

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The development of strategies to recover marine and coastal ecosystems affected by pollution evens is still a challenge to the scientific community. Bioremediation is a nature-based option for the cleaning of these areas, presenting significant environmental and economic advantages compared to other alternatives such physical and chemical technologies. Bioremediation involves the use of microorganisms to degrade environmental contaminants, making use of their natural capability to degrade organic contaminants. These microorganisms have the ability to use organic contaminants as a carbon source, or by co-metabolism. Several studies ongoing at CIIMAR are exploring the potential of autochthonous organisms for bioremediation of contaminants in marine and coastal areas, through the development of biotechnological tools for ecosystems recovery.

The cover features a large, stylized letter 'X' shape. The left and right arms of the 'X' are filled with a grey, wood-grain-like texture. The top and bottom arms are filled with a vibrant blue, wavy texture that resembles ocean waves. The text is centered within the blue section of the 'X'.

Resumos das comunicações
apresentadas na Conferência Internacional
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Homenagem ao Professor Mário Ruivo

Alterações Globais e Riscos

Humanity and the Three Dimensions of the Ocean

Desenvolvimento Sustentável do Oceano: Uma Utopia Útil

Telmo Carvalho
Ministério do Mar

Like Prof. Mário Ruivo used to say frequently: “The three-dimensional occupation of the Ocean is under way”. An ongoing process of integrating this immense space on the Planet, until a few years ago inaccessible, in a space available from the coast to the high seas and from the surface to the seabed.

And He always related this new trend with what is considered the present geological period (designated by Paul Crutzen) as Anthropocene A period marked by the increasing capacity of the human species to interfere with natural processes, of which climate change is a paradigm, highlighting the degradation of the capacity of the Planet to host humanity.

The Ocean plays a central role in this process, though often unnoticed. Indeed, the "representation" of climate change remains in general public opinion as a fundamentally atmospheric phenomenon, masking the dynamics of the ocean as a mediating system in ongoing global warming.

But this notion (except for the experts) is still very far from the common perception, be it from the population or even from the decision-makers, the Ocean is, in a way, still regarded as a mysterious and unknown space. However, the United Nations Convention on the Law of the Sea already recognizes it (mineral resources of the seabed) as "common heritage of humanity", that is, a space serving the common good. In UNCLOS the ocean tends to be seen in a sustainable development perspective whose ultimate instrument is the management of human affairs, impressive qualitative leap when a few hundred years ago our species wandered only along the insurmountable barrier of seas and inland waters, surviving, observing, and thinking. As Mário used to say “I like the Ocean because I care for the people”.

It was with this perspective that Mário defended (in a visionary, but sometimes considered *naïf* way) that the new ocean economic activities that are rapidly occupying all dimensions of the ocean need to be clearly addressed and regulated, because we are still in a uncertain framework about the potentialities, levels of exploration, impacts and governance modalities or

institutional arrangements, that because of their initiatory nature, are still not “tested enough” even in advanced democracies.

Besides some examples of activities that are impacting or may impact the ocean natural resources, he used to say, and a fully support his idea, that the only way to prevent harmful activities or support sustainable ones, is through solid Knowledge.

That is the reason why he defied, several times in the course of the years, the Scientific Community, to assume its role as an active social actor, as the ones more reliable (because are the ones with the best knowledge available about the ocean) to influence and sustained public policies.

New oceans... impacts of global changes in our seas

Francisco Arenas

Climate change impacts have been recognized across every biome on Earth, disrupting levels of biological organization from genes to ecosystems. In coastal habitats, where the cumulative impacts of land- and ocean-based anthropogenic stressors are severe, the effects of climate change are pervasive. The Fifth Assessment Report of the IPCC reported that while “there is high confidence in the detection of the impact of climate change on the abundance and distribution of a range of coastal species the confidence that climate change has played a major role in many cases is just medium”. Hence ecological research needs to move forward from simple correlative approaches, implementing mechanistic approaches able to identify the functionally most relevant drivers and their combined effects. We present some of the current progress done by CIIMAR teams aiming to increase our predictive and management capacities to mitigate the impacts of climate change on coastal ecosystems.

Climate Change in the Iberian Upwelling Ecosystem

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Global change is a serious concern for the society. It affects the atmosphere and the oceans, as well as all the ecosystems, both terrestrial and marine. Monitoring programs along the past years, using in-situ and remote sensing measurements showed the recent changes in ocean hydrography and circulation regimes. Those changes are already affecting the ocean ecosystems in our region, the Western Iberian Margin (WIM), in many aspects.

This talk discusses some ideas related to our present understanding about the future regimes of hydrography and circulation at the WIM, a region located at the transition between the subtropical and the subpolar latitudes, very likely to be sensitive to climate change.

Using regional ocean models for WIM, and data from several coupled global climate models (CGCM), climatological simulations were set up for the present and for a future scenario, through dynamical downscaling from global to regional scale. Forcing is obtained from averaging the outputs of an ensemble of CGCM provided by the Intergovernmental Panel for Climate Change (IPCC) A2 emission scenario.

Results are focused on the continental shelf & slope. In general, the sea surface temperature (SST) seasonal evolution shows, for the future, an increase of about 1-1.5°C during the upwelling season (April to September) and 2-3°C in the rest of the year. However, differences depend on latitude and distance from the coast (higher differences are predicted to the south of WIM and more offshore). There is also

strengthening of the vertical stratification, and SST cross-shore gradient associated to upwelling, which causes narrowing and shallowing of the upwelling jet .

The sea surface salinity (SSS) shows a freshening of about -0.2. These results agree with a general increase in air temperature, and in fresh water input resulting from ice melting in the North Pole, which characterize this future climate scenario. Cross-shore sections show that SST and SSS differences are mainly observed in the upper 200 m. During winter, the typical upper slope poleward flow undergoes a slight weakening and shallowing.

The differences in the physical conditions induced by global change will influence the coastal ecosystems in many aspects: biogeochemical processes and production, acidification, transport and connectivity processes, among others. Thus, it is necessary to conduct modeling studies on these issues, to identify the impact of global change on the marine ecosystems of the Western Iberian Peninsula.

Keywords: Hydrography · Ocean circulation · ROMS ·

Seasonality · Upwelling · IPCC

Climate change impacts on deep-sea ecosystems

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The deep-sea is the largest biome of Earth comprising diverse ecosystems that play a key role in regulating Earth's climate by absorbing excess heat and carbon dioxide from the atmosphere. Through this process the deep ocean is becoming warmer, more acidic, less oxygenated and with altered food inputs with potential impacts on deep-sea ecosystems. Recent projections for the year 2100 suggest that ocean temperatures in the abyssal realm (3000–6000 m) could increase by 1°C, while the most significant reductions in pH (0.29 to 0.37 pH units) are projected for bathyal depths (200–3000), together with declines in oxygen concentrations up to 3.7% or more, and reduced flux of organic matter to the seafloor. Such changes can significantly affect deep-sea organism physiology, life history traits (e.g. growth and reproduction) and recruitment, with concomitant changes in biodiversity and provisioning of living resources by deep-sea ecosystems. This talk will provide an overview of the impacts of these ocean changes on key deep-seafloor habitats such as cold-water corals, sponge grounds, hydrothermal vents and abyssal plains. The potential additive effects of human pressures (e.g., fishing, mineral mining, oil and gas extraction) and climate change and the implications for the management and conservation of these vulnerable marine ecosystems are also discussed.

Coastal hazards and climate change

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Coastal areas face hazards such as erosion and inundation that, in turn, promote risk to life and property damage in occupied areas, and the alteration and/or fragmentation of habitats. Potential coastal damages and risks are expected to increase in the near future due to two effects:

- i) the predicted climate change will be responsible for an aggravated sea level rise and changes in frequency and magnitude of storms which can in turn increase coastal flooding and erosion,
- ii) the on-going (and growing up) coastal development associated to the increasing human occupation of coastal areas.

The potential increase on coastal zone risks in the future requires a re-evaluation and implementation of coastal disaster risk reduction strategies and a new mix of prevention (e.g. dike protection), mitigation (e.g. limiting construction in flood-prone areas; eco-system based solutions) and preparedness (e.g. Early Warning Systems, EWS) measures to avoid or minimise coastal disasters. Without adaptation, flood damage on European coasts increase up to 17 billion Euros per year (IPCC, 2014). These issues are not limited to Europe, as 10% of the world's population (600 million) lives in coastal areas that are less than 10 m above sea level (McGranahan et al., 2007). Worldwide, without adaptation, 0.2–4.6% of the global population is expected to be flooded annually in 2100 under 25–123 cm of global mean sea-level rise, with expected annual losses of 0.3–9.3% of the global gross domestic product (Hinkel, 2014).

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Environmental stressors from the Law of the Sea to World Ocean Assessment

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A healthy ocean is vital for human well-being but is increasingly threatened by anthropic activities. Therefore, the impact of these activities in the ocean needs to be properly managed. For that reason, UNCLOS, that provides the legal framework for ocean governance of all aspects of the oceans, established in its *Part XII Protection and preservation of the marine environment in its general provisions established that states have the obligation to protect and preserve the marine environment* (article 192) and have to take *measures individually or jointly to prevent, reduce and control pollution to the marine environment from any source* (article 194). At that time, the stressors of concern were metals, pesticides and discharges of oil. The efforts taken, during the last 40 years, in the North Atlantic and in other parts of the world to reduce the impact of these stressors was successful. But in the meantime, new substances were produced that have implications to the health of the oceans and to human well-being.

Therefore, the UN, under The Agenda 2030 for Sustainable Development, established 17 sustainable development goals in which sustainable goal 14 deals with conservation and sustainable use of the oceans, seas and marine resources for sustainable development. Meanwhile the first World Ocean Assessment Report (WOAI), recently presented and approved by the General Assembly of the United Nations, highlight concern about the impact of human activities in the marine systems in which sustainable goal 14 is related and establishes that states must prevent and significantly reduce pollution from all kinds, including marine debris.

The lack of proper and innovative wastewater treatment and the release of stressors from land-based sources and from the sea constitute the major threats for the maintenance of good food quality and marine biodiversity. Among these stressors marine debris, which 80% has origin on land-based origin, are presently one of the major global ocean stressors of concern for the safety and maintenance of biodiversity. It is estimated that the density varies between 13000 and 18000 pieces per square kilometre while data on plastic accumulation in the North Atlantic and Caribbean showed to be more than 200000 pieces per square kilometre with high levels occurring in the convergence zones or gyres and it is estimated that 60 to 80% of marine debris is plastics. The impact of plastics and in particular of microplastics (up to 5 mm in size) to the marine resources and to biodiversity will be presented.

COM O ALTO PATROCÍNIO
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O Presidente da República



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