

Ocean Science for Sustainability

Muscat Global Knowledge Dialogue

27 January 2025 | Muscat, Oman

Inputs from ISC Unions and Associations

Lead: Maria Paradiso, ISC Governing Board member

v. 22 January 2025

Subject: Request for Contributions: Ocean Science for Sustainability Session at the ISC Muscat Global Knowledge Dialogue

Dear Unions Colleagues,

I would be grateful if you could please read this email carefully and prepare your responses accordingly.

You probably know that I have been asked, as ISC Governing Board member and expert in marine studies to serve as panelist in the Ocean Science for Sustainability session at the ISC Global Knowledge Dialogue on 27 January. The session coordinated by Martin Visbeck and Mia Strand is devoted to the Ocean Sciences/Ocean Sustainability. My role there, beyond providing my own statements, is about accommodating Unions' voices' and making some examples of work done by Unions in the field of Ocean studies.

In my view, it is important to engage members and beyond the session time leaving a legacy to the ISC about Unions expertise and achievements in Ocean Science. Accordingly, I am suggesting that each of the Unions prepare **a max 2 PPT slide (or MS Word document 1 page)** that specifically addresses the following questions (or some of them):

- **How can the discipline(s) represented by your Union contribute to and shape the Ocean Science (if you deal with of course)?**
- **Please provide 1-2 examples maximum of your best work done (scientific, or dissemination, or assisting policy making from science).**
- **What do you think ISC should do regarding Oceans science and sustainability? What is about a message that the ISC should give to UN?**

I am happy to provide a reflexive note on your materials by citing examples, responses and lists of respondents. Since in the ISC GB I worked a lot on the issue of engaging memberships and I am also part of the Unions as Vice President of the International Geographical Union, I do hope and trust that you can sustain my action in making a sound collective voice on the important topic of ocean sustainability and to leave a legacy for the ISC future action and entering GB.

Therefore, I would like to kindly ask you to provide and submit to me (1mariaparadiso@gmail.it) and Anda Popovici (Anda.Popovici@council.science) Max 2 ppt slides (or one-page MS Word document) with your logo, in response to the above question **by not later than Tuesday 21st January 2025**.

Thank you very much for your important and appreciated cooperation,

Maria Paradiso
Professor of Geography, University of Naples Federico II
Governing Board, ISC
Vice President, IGU
Former Section Chair, Academia Europaea



What the International Council for Industrial and Applied Mathematics (ICIAM) could contribute with in Ocean Science

Modeling is absolutely necessary to understand the possible scenarios in Ocean science depending on the different parameters and evolutions. The models in Ocean science are very complex, since the phenomena to be studied correspond to the interaction of many different problems at different scales.

Many scientific fields are necessary to understand most of the phenomena in Ocean science: Physics, Mechanics, Mathematics, Chemistry, Biology, etc. Mathematics (and more concretely, Applied Mathematics) can help to analyze many of the different models, or simplified versions of them, since they are written often in mathematical equations, equations of fluid mechanics, the interactions gas-fluids, the interaction of fluids at different temperatures and scales, etc. And when I say Mathematics, we are not only speaking about analysis of the different models, but also the scientific computing necessary to extract concrete data about the solutions of the models.

Reading the titles of projects that have taken place in the Applied Mathematics community recently can be found for instance:

- Mathematics of Extreme Sea Waves: Tsunamis, Rogue Waves and Flooding
- Energy Transfers in Atmosphere and Ocean
- Subgrid scale modeling for ocean climate models
- Marine Acoustics: Direct and Inverse Problems
- Oceans and climate
- Ocean – atmosphere interaction
- Finite Element Models for Ocean Circulation Problems
- Math Behind Sea Ice & Our Changing Planet
- Examining the Dynamics of Ocean Mixing

ICIAM, in collaboration with other unions, can contribute to a better understanding of the complex models to the studied in Ocean evolution.



Commission on Coastal Systems

How can the disciplines represented by IGU CCS contribute to and shape the Ocean Science?

- Interdisciplinary Research
- Coastal-Ocean Interactions
- Climate Change and Resilience
- Policy and Sustainable Development
- Biodiversity and Ecosystems
- Education, Awareness and Ocean Literacy

Please provide one max 2 example of your best work done (scientific, or dissemination, or assisting policy making from science):

Coastline Changes: A Reconsideration: *Colin D. Woodroffe, Niki Evelpidou, Irene Delgado-Fernandez, David R. Green, Dhritiraj Sengupta, Anna Karkani, and Paolo Ciavola*: **Cambridge Prisms - Coastal Futures** – Special Issue from the Dublin IGC

What do you think ISC should do regarding Oceans science and sustainability?

- Global Coordination of Ocean Science
- Promotion of Interdisciplinary Research
- Capacity Building and Equity
- Advocacy for Policy Integration
- Innovation in Monitoring and Technology

What is about a message that ISC should give to UN?

- Strengthen Science-Policy Interfaces
- Enhance Global Ocean Monitoring
- Support Inclusive Capacity Building
- Accelerate Action on Climate-Ocean Linkages
- Promote Interdisciplinary Collaboration
- Commit to a Decade of Transformation

David R. Green – Chair IGU CCS

Answers about IGU Islands Commission's connections with Ocean Science

1. How can the discipline(s) represented by your Union contribute to and shape Ocean Science?

Scientists involved in the work of the IGU Islands Commission come from diverse fields of geography, with some having a stronger focus on Ocean Science. What unites the members of the Islands Commission is their shared interest in studying islands surrounded by the sea, whose development is directly influenced by their marine environment. Furthermore, activities on islands have both direct and indirect impacts on marine ecosystems.

An interdisciplinary approach combining marine biology, coastal social-ecological systems analysis and Island Studies can contribute significantly to Ocean Science and sustainability, putting an emphasis on integrating marine ecological and social sciences to shape a sustainable future for the Oceans we need. For example, the work of dr. Annette Breckwoldt (in research, capacity development and teaching) combines natural and social science approaches to support participatory, inter- and transdisciplinary integration of academic and ecosystem user knowledge on coastal marine resources and their multi-faceted values.

The majority of human-non-human dynamic relationships are located within a relatively confined area, encompassing terrestrial and marine environments. The field of Island Studies, through its examination of fundamental concepts such as ecotones, intertidal geographies, and the over-utilization of shorelines, has the potential to provide a substantial contribution to the understanding of marine human-non-human dynamics. Moreover, this field stresses the importance of considering human dimensions of marine biologies (fisheries, users' conflicts, policies, arts etc.).

2. Provide one or two examples of your best work done (scientific, dissemination, or assisting policy making from science).

Here are some of the activities done by our members Dr. Annette Breckwoldt and Dr. Stefano Malatesta:

1. Co-leading the binational, inter- and transdisciplinary "A Sea of Connections" - projects SOCPacific + SOCPacific2R, exploring the socio-cultural, geopolitical, and policy connections within which fishing practices and coastal conservation efforts occur in Small Island States such as Fiji and New Caledonia.
2. Leading and contributing to interdisciplinary research teams at ZMT (Leibniz Centre for Tropical Marine Research) and AWI (Alfred-Wegener Institute Helmholtz Centre for Polar and Marine Research), focusing on perceptions, knowledges, and participation in decision-making processes for local resource use and management; and co-leading ZMT's interdisciplinary Programme Area 5 'Ocean Literacy, Equity and Leadership'.
3. In 2024 a four-years MCDN project (coordinated by University of Milano-Bicocca) started with the specific objective of creating a community of early career experts in the study of the human dimensions of Biodiversity <https://mediverseaty.eu/>
4. 2025 EUGEO Session (n.194) is collecting contribution on Human Dimensions of Mediterranean Biodiversity from a Geographical Perspective (<https://www.eugeo2025.eu/eugeo-2025-sessions/>)

Also, we are providing some papers published by our members that deal with ocean environments:

1. Kochalski, S., Kluger, L.C. und A. Breckwoldt (2024). Kleine Küstenfischerei und Meeresschutzgebiete: Ein gemeinsamer Weg zu „30x30“? Im Auftrag des Bundesministeriums für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ). Herausgeber: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Bonn und Eschborn. <https://www.giz.de/de/weltweit/134623.html>
2. Partelow, S., Schlüter, A., Ban, N.C., Batterbury, S., Bavinck, M., Bennett, N.J., Bleischwitz, R., Blythe, J., Bogusz, T., Breckwoldt, A., Cinner, J.E., Glaser, M., Govan, H., Gruby, R., Hatje, V., Hornidge, A.-K., Hovelsrud, G.K., Kittinger, J.N., Kluger, L.C., Kochalski, S., Mawyer, A., McKinley, E., Olsen, J., Pittman, J., Riechers, M., Riekhof, M.-C., Schwerdtner Manez, K., Shellock, R.-J., Siriwardane-de Zoysa, R., Steins, N.A., Van Assche, K., and S. Villasante (2023). Five social science intervention areas for ocean sustainability initiatives. *npj Ocean Sustainability* 2:24, DOI: 10.1038/s44183-023-00032-8
3. Špeh, N, Čuka, A. (2023). Evaluation of landfill sites on Pašman Island and islanders' perceptions regarding waste management issues // *Hrvatski geografski glasnik*, 85, 2; 47-80. doi: <https://doi.org/10.21861/HGG.2023.85.02.02>

3. What do you think ISC should do regarding Ocean science and sustainability? What message should ISC give to UN?

- Emphasize the need for interdisciplinary approaches combining ecological and social sciences and humanities in ocean research and management.
- Promote the integration of diverse stakeholder knowledges and perspectives in coastal and marine resource use and management.
- Encourage research that addresses crucial sustainability issues such as overfishing, destructive resource extraction, power hierarchies/equity, and conflicts over resource access.
- Support the development of academic landscapes that enable holistically conceptualized interdisciplinarity to connect local, national, regional, and global knowledge, science, policy, and decision-making for implementing the Agenda 2030.
- Provide a special focus on ECOPs (Early Career Ocean Professionals) for all these points.
- Change the discourse of the UNOD from 'the Ocean we want' to 'the Ocean we need'.



International Geographic Union – Union Géographique Internationale

Commission on Toponymy jointly with the International Cartographic Association

IGU Chair: Prof. Elena Dai Prà, University of Trento (IT)

Contributions on sea/ocean issues by members of the current IGU Commission on Toponymy

6th-7th June 2023, IGU Thematic Conference at University of Milano-Bicocca, Italy

“The Oceans and Seas in Geographical Thought”

Peter Jordan and Cosimo Palagiano as chairs of the 15th session *“Names and naming of oceans and seas as a specific and politically delicate issue”*. Contributions:

- Sungjae Choo, *Names of seas and oceans as a container of identity and perception: Issues and prospects*
- Wenchuan Huang, *Naming policy and Practice on the Land reclamations of Hong Kong Island*
- Peter Jordan, *Is the endonym/exonym divide applicable on oceans and seas?*
- José Willian Morais Antunes de Sousa, *La classification des océans à la lumière des travaux de Camille Vallaux et son apport à la Géographie Maritime*
- Joseph Stoltman, *Education and media: using alternative geographical names for spaces and features*

Peter Jordan addressed the question of whether and how the endonym/exonym division can be applied to maritime names. Some publications:

- Jordan, P. (2009). *The endonym/hexonym divide related to cross-border characteristics: recent discussions in the UNGEGN Working Group on Exonyms*. In: The Society for East Sea (ed.): The 15th International Seminar on Sea Names, Seoul: pp. 6-15.
- Jordan, P. (2010). *Is 'Esonimus' an appropriate term for feature names beyond any sovereignty?* In: The Society for East Sea (ed): The 16th International Seminar on Sea Names, Seoul: pp. 41-43.
- Jordan, P. (2016). *When exonyms and endonyms become international names: an additional function that needs a term*. In: The Society for East Sea (ed), Seas and Islands: Connecting People, Culture, History and the Future. Proceedings of the 22nd International Seminar on Sea Names Jeju, Korea, 23-26 October 2016, pp. 57-63. Seoul, The Society for East Sea.

Sungjae Choo, together with some of his Korean collaborators, investigated the issue of the Sea of Japan/East Sea. (*Endonym, geographical feature and perception: the case of the name East Sea/Sea of Japan*, Journal of the Korean Geographical Society, Vol.44, No.5, 2009; this paper was presented at the 15th International Seminar on Sea Names held in Sydney, Australia, September 3-5, 2009).

The IGU Commission on Toponymy (jointly with ICA) will participate in the next plenary session of UNGEGN 2025 in the context of which other agencies, which deal specifically with the subject of the sea, will most likely bring up the topic during the general discussion and thus our Commission will possibly be able to participate in the debate and bring its scientific contribution.

Elena Dai Prà will participate as liaison officer with IGU at the 32nd ICC Congress entitled “Mapping the Future: Innovation, Inclusion, and Sustainability” (Vancouver, August 2025) where two separate calls for papers on marine cartography and marine toponymy have been proposed.

How can the discipline(s) represented by your Union contribute to and shape the Ocean Science (if you deal with of course)?

IAPSO is the International Association for the Physical Sciences of the Oceans and one of eight IUGG associations. It has 60 member countries. IAPSO co-organizes biannually international scientific meetings, focusing on all topics of physical and chemical oceanography, including mathematical modelling. These disciplines involve the redistribution of nutrients and suspended matter in the oceans, which are vital for all levels of marine life. IAPSO funds long-term Committee on Properties of Seawater and Permanent service mean sea level, as well as short-term best practice groups that address an issue that, when resolved, will assist in the conduct of oceanographic research. IAPSO is involved in ISC's SCOR-Scientific Committee on Oceanic Research, participating in and evaluating its working groups and committees.

Please provide 1-2 examples maximum of your best work done (scientific, or dissemination, or assisting policy making from science).

One of the joint SCOR/IAPSO working groups was on Thermodynamics and Equation of State of Seawater. It established a new set of computational scripts that form the basis of all physical and chemical properties that determine the state of the oceans. Another joint SCOR/IAPSO working group was on Ocean Mixing to address the gaps of knowledge in all levels of mixing in deep-coean basins, and included its parametrization in large-scale ocean-circulation models.

What do you think ISC should do regarding Oceans science and sustainability? What is about a message that the ISC should give to UN?

Responsible guardianship of our ocean requires a thorough understanding of its mean state and vulneribility to chance. Predications and analysis of the ocean's sensivity to natural and manmade change, are only as good as the models that produce them, and these still have substantial shortcomings, due to the complexity of the ocean-climate system. The UN should therefore encourage the basic theoretical and observational research that is needed to develop our understanding of the ocean, to ensure that we have the tools needed to protect our oceans and anticipate and adapt to future change. We thus urge the ISC and the UN to promote basic research in theory, past and present observations, and the incorporation of results into state of the art ocean-climate models. The ocean seems large but is finite, which makes it vulnerable to changes, whether climatological or artificial. Given the present gaps in our knowledge of the state of the ocean and its sensitivity to change, exploration by mankind should be reduced to a sustainable minimum, especially also of the largely unexplored deep seafloor where the impact of any explorational activities on deep-sea life and its environment is unknown.

Hans van Haren, IAPSO President
Silvia Blanc, IAPSO Secretary General

International Union of Geodesy and Geophysics (IUGG)



MISSION

IUGG's mission is to advance, strengthen and promote Earth & space sciences for the benefit of humanity, through international research cooperation and education, and to communicate the knowledge to governments and policy-makers

CHALLENGES

- **Complex *natural & anthropogenic* processes** within the solid Earth, ice, atmosphere and oceans
- **Global cooperation** of governments, institutions, and individual scientists is necessary
- **Extensive use of *satellite Earth Observation data***
- **Partners** with numerous international and intergovernmental organisations
- **Initiates and supports** international research programs, projects and services

GEOSCIENCE DISCIPLINES

- International Association of Cryospheric Sciences (IACS)
- International Association of Geodesy (IAG)
- International Association of Geomagnetism and Aeronomy (IAGA)
- International Association of Hydrological Sciences (IAHS)
- International Association of Meteorology and Atmospheric Sciences (IAMAS)
- **International Association for the Physical Sciences of the Oceans (IAPSO)**
- International Association of Seismology and Physics of the Earth's Interior (IASPEI)
- International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI)

International Association for the Physical Sciences of the Ocean (IAPSO)



MAJOR CHALLENGES FOR IAPSO

- Monitoring Sea Level Rise, tides, storm surges, currents, and circulation, and their *spatial & temporal variations*, using a variety of techniques
- *Gaps in data* for science, especially in deep oceans
- *Integrating* satellite-based and ocean (in situ) observations
- Investigating processes at ice-ocean, atmosphere-ocean & land-ocean *interfaces*
- Improvements in physical *modelling, analysis & interpretation*
- Defining and promoting *international standards*
- Coordination with other organisations, e.g. IOC, etc
- Maintaining long-time series of observations, e.g. Permanent Service for MSL (PSMSL) network and database

IMPORTANCE OF OCEAN SCIENCES

- **Oceans cover >70% Earth's surface**
- **Ocean *circulation* critical for weather & climate processes, food resources, extreme events, Water Cycle, and more**
- **Monitoring of circulation, *Sea Level Rise (SLR)*, and other physical parameters, crucial for understanding *Climate Change* impacts**
- ***IAPSO engaged in measuring SLR, studying interface (ocean with Ice, Atmosphere, Land) processes, modelling, etc***
- ***Ocean Science* knowledge, and monitoring services, addresses most *Sustainable Development* issues, e.g. see **SDGs****
- **Note *UN Decade of the Oceans for Sustainable Development***
<https://www.oceandecade.org/>

INQUA – International Union for Quaternary Research



ABOUT

INQUA serves as the global representative body for **Quaternary science, continental as well as marine**.

INQUA fosters global collaboration in Quaternary Science and seeks to enhance communication and cooperation via networking initiatives.

INQUA provides **financial assistance** for various projects, including the establishment of **International Research Networks and International Skill Activities**.

Furthermore, it offers funding opportunities for individual researchers through its **Fellowship Program**.

COASTAL AND MARINE QUATERNARY RESEARCH PROJECTS:

- **INTIMATE** - *INTEgrating Ice core, Marine and Terrestrial records for advanced palaeoclimate reconstruction*
- **PALSEA_next** - *PALEo constraints on SEA level rise -*
- **OnSea** - *EvolutiOn of Seascapes*

Website: <https://inqua.org/>

CONTACT

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Quaternary Paleoceanography

Oceans are one of the main components of the climate system

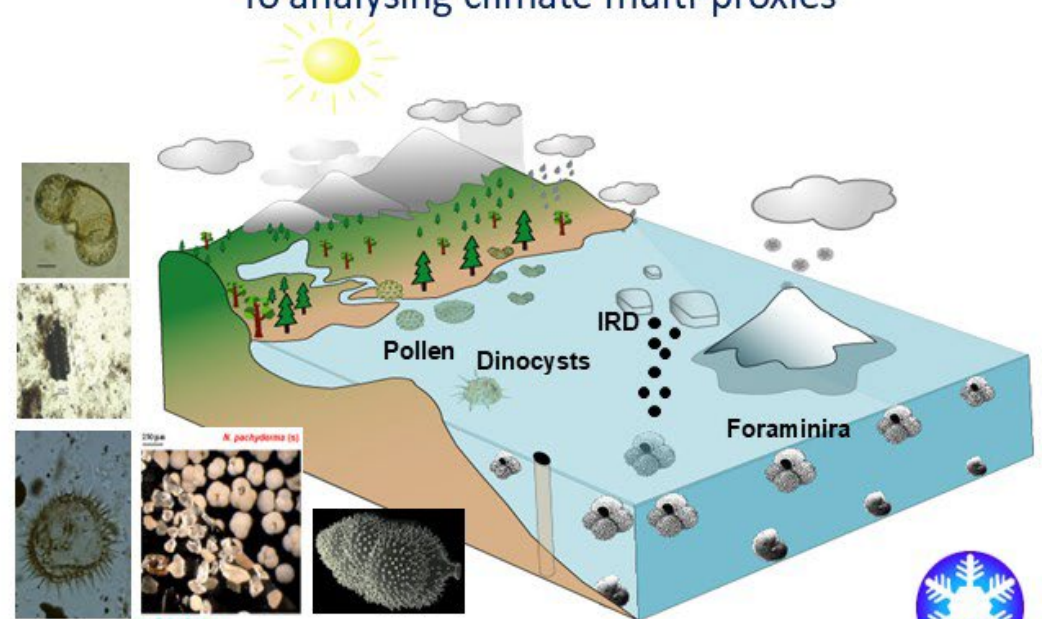
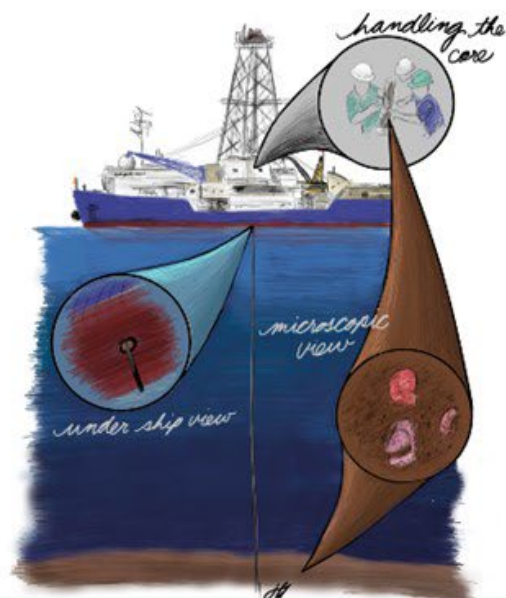
Documenting past oceanic changes is crucial to: a) understand natural climatic changes

b) highlight the relationships with terrestrial environments

c) discriminate natural vs anthropogenic forcing in the ongoing global warming

From drilling/coring ocean sedimentary sequences

To analysing climate multi-proxies





International Union of Soil Sciences ■

How can Soil Sciences contribute to and shape our thinking around Ocean Science?

Edoardo A.C. Costantini

IUSS Past President

Soils play an important role in mediating chemical weathering reactions and carbon transfer from the land to the ocean, thus regulating ocean acidification. Soil weathering slightly elevates the pH of drainage waters, and the receiving coastal waters, thus increasing ocean's buffering capacity.

Moreover, the soils of the shorelines and shallow waters work as "filtration unit" that accumulate, emit and transform anything that comes into them. Thus, the soils of margin ecosystems, on the border between three major Earth spheres - atmosphere, lithosphere and hydrosphere, are extremely specific and often endangered. Serving as the natural geochemical barrier, these soils are affected by any (local or global) impact or environmental change. The huge length of the continental coastline, the diversity of coastal geomorphic features, landscapes, sediments, the character of tidal and surge phenomena, and the salinity of the sea determine the formation of a wide range of soils. A significant part of the coast belongs to the accumulative ones with gentle slopes. This leads to the penetration of surge water onto the land for tens of kilometers; seawater feeds numerous small lakes, flooded swampy meadows, which also affects soil formation in this zone. Thalassosols (or Tidalic soils) comprise weakly developed soils of tidal flats and marshes with varying degrees of salinity and under different plant associations, as well as maritime soils that are affected by the aerial supply of salts with seawater drops and organomineral material from bare coastal areas.

The ocean influences the formation of the soil cover on its margins. On the other hand - "ocean-affected" soils form the hydrochemistry and bioproductivity of the coastal shallow waters. In conclusion, the interplay between soils and water in coastal areas significantly affects water composition and acidity of the oceans. More studies are needed to quantify the processes and define the management policies of these soils.

The IUSS bodies where the underplay between soils of coastal areas and oceans are more frequently studied are the following:

Division 1 "Soils in Space and Time", commissions, (C1.1) "Soil Morphology and Micromorphology" (C1.2) "Soil Geography" (C1.3) "Soil Genesis" (C1.4) "Soil Classification" and, in particular, Commission 1.7 (C1.7) "Permafrost Affected Soils"

Division 2 "Soil Properties and Processes" Working group "Critical Zone System".

References

Gubin, S. V., Lupachev, A. V., & Khodzhaeva, A. K. (2022). Soils of Accumulative Coasts of the East Siberian Sea. *Eurasian Soil Science*, 55(9), 1173-1184.

Renforth, P., & Campbell, J. S. (2021). The role of soils in the regulation of ocean acidification. *Philosophical Transactions of the Royal Society B*, 376(1834), 20200174.