GEO “Oceans and Society: Blue Planet” Initiative

2020 – 2022 Implementation Plan

1. Executive Summary

"Oceans and Society: Blue Planet" Initiative (GEO BLUE PLANET)

Overview

We live on a blue planet, and Earth's waters benefit many sectors of society. The future of our Blue Planet is increasingly reliant on the services delivered by marine, coastal and inland waters and on the advancement of effective, evidence- based decisions on sustainable development. GEO Blue Planet is a network of ocean and coastal-observers, social scientists and end-user representatives from a variety of stakeholder groups, including international and regional organizations, NGOs, national institutes, universities and government agencies. GEO Blue Planet aims to ensure the sustained development and use of ocean and coastal observations for the benefit of society.

GEO Blue Planet's mission is to:

- advance and **exploit synergies** among the many observational programmes devoted to ocean and coastal waters;
- **improve engagement with** a variety of stakeholders for enhancing the timeliness, quality and range of services delivered; and
- raise awareness of the **societal benefits** of ocean observations at the public and policy levels.

Planned Activities

During the 2020 – 2022 work programme period, GEO Blue Planet will work to identify and share best practices on stakeholder engagement and societal awareness; communications; data discovery, access and utilization; and capacity development. The initiative will collaborate with various GEO activities and partners to support GEO's engagement priorities and strengthen linkages with stakeholders. GEO Blue Planet will also work to support data access and the development of decision-support tools for the below activities:

- Multi-hazard Information and Alert System for the Wider Caribbean
- Early Warning System for Marine Flooding of Reef-lined Islands
- Early-warning Systems for Water-associated Diseases
- Data and Information for Monitoring and Management
- Data and Information for Coral Reef Monitoring and Management
- Systems for observing, quantifying, and classifying marine debris

Points of Contact

Role	Name	Email
Steering Committee Co-Chair	Paul DiGiacomo	Paul.DiGiacomo@noaa.gov
Steering Committee Co-Chair	Sophie Seeyave	ssve@pml.ac.uk
Secretariat Lead	Emily Smail	Emily.Smail@noaa.gov

Purpose and Activities

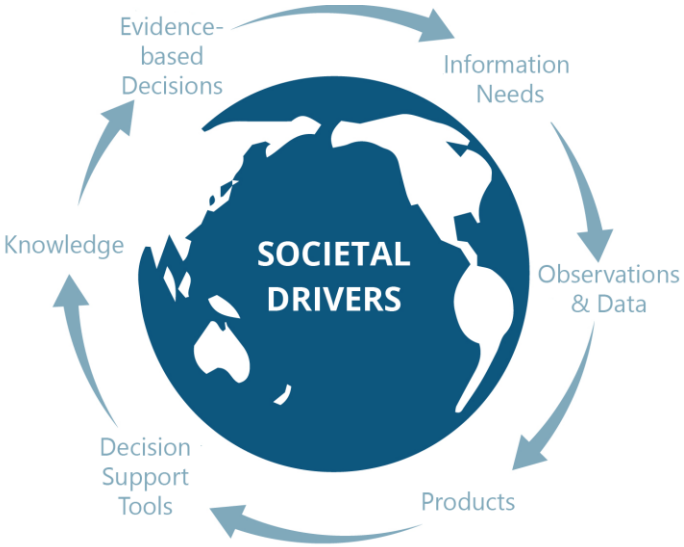
We live on a blue planet, and Earth's waters benefit many sectors of society. The future of our blue planet is increasingly reliant on the services delivered by marine and coastal waters. For example, approximately 60 million people rely on fisheries and aquaculture for their livelihoods and over 80% of the world's trade is carried by sea (FAO, 2018; UNCTD, 2017). The social and economic future of these and many other sectors is increasingly dependent on the services delivered by marine and coastal waters. In recent years, the global community has prioritised the need for concerted action to maintain these services through the agreement on the United Nations (UN) Sustainable Development Goal (SDG) targeted at the oceans (SDG 14: Life Below Water) and the proclamation of a Decade of Ocean Sciences for Sustainable Development (2021 – 2030) (UNESCO, 2017; UNGA, 2015). Maintenance of these services relies on the advancement of effective, evidence-based decisions by governments, civil society and the private sector about sustainable development, ecosystem management, food security, ocean-resource utilization and natural disasters.

Evidence-based decisions in the marine realm need to be underpinned by the collection of physical, chemical and biological data about coastal and open-ocean areas through direct (or "in situ") measurements and remote-sensing technologies, commonly referred to collectively as ocean and coastal observations. These observations are transformed into information products, ocean forecasts and services that can be used to create knowledge for effective, evidenced- based management and policy decisions. For example, the implementation of the Sendai Framework for Disaster Risk Reduction requires ocean observations for early warning systems to allow people to prepare and mitigate against ocean-related hazards such as tsunamis, storm surges and extreme waves (Arduino et al., 2017; UNISDR, 2015). The ocean has significant impact on global climate patterns, and observations provide essential information for forecasting precipitation and drought, the source of replenishment of water supplies, and of climate events that can lead to public health incidents or changes in energy demand (Malone et al., 2010; McCarthy et al., 2018; Mendez-Lazaro et al., 2014).

Coastal and ocean observations are important Essential Climate Variables (ECVs) developed in support of the United Nations Framework Convention on Climate Change (UNFCCC) (GCOS, 2016). These are now fully incorporated in the Global Ocean Observing System (GOOS) Framework for Ocean Observing (Lindstrom et al., 2012) as Essential Ocean Variables (EOVs) that address biology, ecology, and biogeochemistry in addition to physical ocean characteristics. A further complement are the Essential Biodiversity Variables (EBVs) being developed by Marine Biodiversity Observation Network (MBON), a theme of the GEO Biodiversity Observation Network or GEO BON (Miloslavich et al., 2018; Muller-Karger et al., 2018; Navarro et al., 2017). In addition, ocean observation of these variables helps improve predictions of longer-range forecasts of weather (Legler et al., 2015). Ocean biological and biodiversity observations are critical in monitoring the health of and changes to ocean ecosystems, and biodiversity and are required to gauge progress towards the Aichi biodiversity targets (Andrefouet et al., 2008; CBD, 2010, 2014; Miloslavich et al., 2017). Ocean observations are also important in managing fisheries and aquaculture (Hazen et al., 2018; Saitoh et al., 2011; Solanki et al., 2015). More generally, ocean information and decision support tools are needed for sustainable management of the oceans and seas and a sustainable development of the blue economy.

The global ocean community recognises the need for a step change in the way in which we coordinate and "hardwire" the links between technological innovation and sustained observations of the oceans, the data, information and services they provide, and approaches to ecologically sustainable development and ocean policy. There is therefore an urgent need for the scientific community to work together to leverage resources and agree on the variables that need to be measured (Essential Variables) and to implement these in a systematic, sustained and globally-distributed manner (Lindstrom et al., 2012). GEO Blue Planet works to address this need by bringing various ocean observing organisations, programs and projects into the Group on Earth Observations System of Systems (GEOSS) to work together to achieve common objectives. As stated by the European Space Agency (ESA), "What is needed now, that GEOSS will help achieve, is to integrate the outputs from these various marine monitoring and observation efforts into a cohesive system of systems which will enable researchers, resource managers and policy makers to rapidly assess what is known about a particular marine region" (Fellous & Bequignon, 2010).

GEO Blue Planet is a network of ocean and coastal-observers, social scientists and end-user representatives from a variety of stakeholder groups, including international and regional organizations, NGOs, national institutes, universities and government agencies. GEO Blue Planet aims to ensure the sustained development and use of ocean and coastal observations for the benefit of society. In the value chain of ocean and coastal observation collection, transformation and use, GEO Blue Planet focuses on connecting stakeholders with available data and products, working with stakeholders to develop decision support tools and identifying additional information needs.



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- raise awareness of the **societal benefits** of ocean observations at the public and policy levels.

The initiative promotes, partners with and leads working groups, projects, communities and programmes that support the GEO Blue Planet mission. Information about GEO Blue Planet activities and related activities are organized around three cross-cutting areas and ten thematic areas.

Planned activities for the 2020 – 2022 work programme period are summarized below.

Cross-cutting Activities

GEO Blue Planet has three standing working groups that implement cross-cutting activities:

- Stakeholder Engagement and Societal Awareness Working Group
- Capacity Development Working Group
- Data Discovery, Access and Utilization Working Group

The primary role of these working groups is to identify and share best practices. A core group of working group members identify and guide priority activities. Task Teams with additional members from the GEO Blue Planet Steering Committee and other interested parties are formed to implement short-term activities (6 - 18 months).

Stakeholder Engagement and Societal Awareness Working Group

The GEO Blue Planet working group on stakeholders and societal awareness works to promote communication between those who need better knowledge of the ocean and coasts with those who are

capable of producing that knowledge using ocean and coastal observation technologies. The current and planned activities of this working group are outlined below.

Stakeholder Engagement Activities in Support of Sustainable Development

Ensuring the sustainability of our oceans, coastal environments and coastal communities requires international collaboration. This is even more evident as we must consider the monitoring and reporting of ocean ecosystems which are beyond national (agreed or not) jurisdiction (i.e. Exclusive Economic Zone waters). The GEO Blue Planet initiative intends to provide mechanisms and opportunities to make Earth Observation technologies and data more useful for the achievement of the United Nations SDGs, The Sendai Framework for Disaster Risk Reduction, and the Paris Climate Agreement.

GEO Blue Planet currently has a task team working to support the United Nations Environment Programme on the methodology development of SDG 14.1.1 (Index of coastal eutrophication and floating plastic debris density). This task team provides UN Environment with information about existing data and methods for monitoring coastal eutrophication and marine debris. The team also provides networking support to link Earth Observation experts with relevant stakeholders. Additional task teams will be formed to support the custodian agencies of SDG 14 and to support stakeholder ocean and coastal observation needs for the 16 other SDGs, the Sendai Framework for Disaster Risk Reduction and the Paris Climate Agreement.

Organizing regional and thematic workshops aimed at identifying and articulating ocean and coastal information needs and stakeholder priorities

Understanding the decisions stakeholders are required to make and what information is required to support those decisions is a key focus of GEO Blue Planet. GEO Blue Planet works to plan regional workshops that bring together representatives of government, research institutions, industry and NGOs, to assess the local needs in terms of ocean and coastal observation-based products and services, as well as the capacity development required for the use, as well as the development/hosting/maintenance of such services. GEO Blue Planet also makes understanding information needs and stakeholder priorities a focus of international GEO Blue Planet symposiums. These symposiums are held every one to two years in different regions. Previous symposiums have taken place in Brazil, Australia, the United States and France. Upcoming symposiums will be held in 2020 and 2022 in locations to be determined.

Compiling examples of societal benefits achieved from ocean and coastal observations

The ocean is generally not recognized by large portions of the world's population as being a priority, despite being a major source of food, transport and recreation, a large contributor to the global economy, supporting a significant proportion of the global population. Many social and economic processes on land are impacting the ocean severely (for example, the flows of nutrients, plastics, and chemical pollutants into the ocean, and the increased absorption of atmospheric carbon dioxide) while awareness of these impacts is generally very low. If people are not aware of the importance, as well as the vulnerabilities, of the ocean, they are even less likely to understand the impacts that ocean observations can have (and do have) on their everyday lives and how their actions impact the ocean. The GEO Blue Planet working group on stakeholder engagement and societal awareness works to explain, in simple and meaningful terms, to a lay audience, what ocean observations are, what types of products and services can be derived from them, and how they are essential for the health, wealth and well-being of humankind and the sustainability of our global civilization.

The working group formed a task team to compile some iconic examples of ocean observing products that have a direct and tangible positive impact on society, e.g. saving lives, supporting livelihoods, producing economy benefits, etc.

Developing and sharing of co-development of decision support tools based on ocean and coastal observations

The GEO Blue Planet initiative recognizes the importance and value of engaging with all institutions that play a role in converting ocean and coastal observations to meet the information needs of communities and stakeholders. After decades of Earth observation development, there is a realization of the importance of meeting these needs in terms of societal benefit and sustainable development. Information that is co-produced with scientists and stakeholders has been demonstrated to lead to more concrete and effective outputs (Howarth & Monasterolo, 2017; Kirchhoff et al., 2013; Lemos & Morehouse, 2005; Reed et al., 2014; Roux et al., 2010; Walter et al., 2007). The stakeholder engagement and societal awareness working group works to share best practices for stakeholder engagement and co-develop decision support tools in order to support beneficial changes in policy and behavior.

Mapping the ocean and coastal observation and services "oceanscape"

There is a clear need to make existing services more easily discoverable and usable by non-specialists. Governments and industry are simply not aware of much of what the ocean observing community is doing and how it can be used for societal benefit. Part of the issue is the apparent lack of clarity on who is doing what and how all the organisations fit together, as highlighted and discussed at both the Kick-Off and 2nd Blue Planet Symposia. During the 3rd Blue Planet Symposium, there was very strong support for the idea that Blue Planet would work on producing a diagram that would provide some clarity on which organisations are doing what in relation to ocean observing (e.g. capacity building, data management, coordination of observations, user engagement etc) (GEO Blue Planet, 2017). Because it is such a complex field, it was agreed that an interactive web-based system would be most appropriate. This would allow each organization to be tagged with various criteria (e.g. global/regional, intergovernmental/NGO, etc) for greater clarity in presentation. It was also noted that a simplified version would be needed to reach decision makers and other people outside the field. A prototype has been developed by GEO Blue Planet, which will be launched and further refined during the 2020-22 implementation phase. In particular, during 2020-22 products and services will be added to the database, which is currently focusing only on organisations.

Best practices in science communication and outreach

This aspect of the Blue Planet Working Group is led by "Ocean Communicators United", an informal grouping of representatives of international, regional or national oceanographic research organisations that provides a forum for its members to share information, expertise, best practices and materials related to marine science communications. The current and planned activities of this group are outlined below.

- Maintain and share a distribution list of communications points of contact for marine research institutes and international organisations
- Share communications products via e-mail, social media and alongside relevant international conferences and events

- Have quarterly on-line meetings to discuss science communication topics
- Work collectively to develop best practices in science communication and outreach
- Support communications projects including communications for the UN Decade of Ocean Science for Sustainable Development (2021-2030)

Capacity Development Working Group

The GEO Blue Planet working group on capacity development works to link and build on existing capacity development efforts related to sustained ocean and coastal observations, products and services. Best practices will be shared broadly with the GEO Blue Planet and broader GEO community, and in particular submitted to IODE Ocean Best Practices repository (www.oceanbestpractices.org). The current and planned activities of this working group are outlined below.

Compiling and summarizing best practices for evaluating the impact of capacity building programmes

A task team on best practices in capacity building is being formed and will work closely with the GEO Task Team on Capacity Building and the Committee on Earth Observation Satellites (CEOS) Working Group on Capacity Building and Data Democracy, and other groups as relevant, to share information with the GEO community at large and leverage existing efforts. The leads of the GEO and CEOS groups will be invited to participate, and/or act as liaisons with the GEO Blue Planet task team.

This task team will discuss best practices in evaluating the impact of capacity development programmes. The Partnership for the Observation of the Global Ocean (POGO) and The Scientific Committee on Oceanic Research (SCOR), who have worked together on this in the last 2 years, will provide their insights and invite other organisations to contribute theirs, with a view to compiling best practices in both:

- How to conduct such an evaluation (surveys, testimonials, metrics…),
- How to analyse and interpret the results (e.g. what recommendations can be drawn on how to improve programmes or how to select the best type of programme to meet a particular need or requirement).

Assessment of capacity development needs of developing countries

The working group plans to subsequently form a task team to assessing the capacity building needs of developing countries. IODE has done some work in this area and could share their experience and methods. SERVIR, a joint venture between NASA and the U.S. Agency for International Development, which has been running for the last 10 years, has developed some guidelines on the full planning cycle, from scoping user requirements to engagement and evaluation.

Data Discovery, Access and Utilization Working Group

The GEO Blue Planet working group data discover, access and utilization is working to share best practices and support activities to increase data discoverability and integration of data sets. The working group is particularly focused on supporting the advent of systematic and regular provision of analysis ready quality assured data. The current and planned activities of this working group are outlined below.

Networking existing regional and international efforts in improving data interoperability and access

Significant investment has been made by some nations in a range of ocean data, modeling and analysis at regional, national and global scales. Despite the growing number of datasets and data portals, stakeholders continue to express that data access, discovery and use remains a challenge (CSIRO, 2018; Plag & the workshop participants, 2018; Scarrott et al., 2018).

GEO Blue Planet works with data providers to increase data discoverability and integration of data sets including traditional geospatial data (e.g., management boundaries), time series monitoring data (e.g., coastal and ocean moorings), gridded datasets (e.g., satellite remote sensing products) and complex multi-dimensional data cubes (e.g., ocean models). GEO Blue Planet is particularly focused on supporting the advent of systematic and regular provision of analysis ready quality assured data. A primary way this will be accomplished during the work programme period is through support for the development of and contribution to IODE's Ocean Best Practices System.

In addition, GEO Blue Planet will examine the development of Data Cubes and Analysis Ready Datasets (ARDs) to see how these may be applied to the ocean and coastal domain. Recognising the potential of Data Cubes as initiatives to increase the value and use of satellite data by providing users with access to free and open data management technologies and analysis platforms, and considering that Data Cubes have been currently focused for land and in-land water applications, GEO Blue Planet will look to assess the feasibility of building Data Cubes for ocean and coastal applications.

Working with data providers to support GEOSS and generate knowledge

GEO Blue Planet works to support the use of Earth observation data to enable decisions based on actionable knowledge. We need to understand the state of our planet and thereafter be able to take informed decisions on how best to make use of our resources. Within this context, the knowledge we enable must be reliable, robust and replicable. The low entry costs associated to the analysis of very large Earth observation datasets has redefined the traditional paradigm through which users have been accessing data. In addition, programmes such as Copernicus, are paving the way to a democratisation of access to Earth observation data.

GEO Blue Planet is ready to take stock of this new environment and invest in co-designing and co-producing Earth observation-based services for different set of communities, at different scales. Within the next reporting period GEO Blue Planet will work with data and information providers to register assets within the GEOSS framework and encourage the ocean and coastal observing community to adopt GEOSS data sharing and management principles. GEO Blue Planet will also work to collect best practices on co-design and co-production of services and decision support tools.

Thematic Activities

GEO Blue Planet welcomes proposals for thematic activities that address one of GEO Blue Planet's themes. Additional information about the process for selection of new activities can be found in the Terms of Reference (Annex D, Section 2). Current thematic activities include:

- Understanding Flooding on Reef-lined Island Coasts Working Group
- Multi-hazard Information and Alert System for the Wider Caribbean Project
- Water-associated Diseases Working Group
- Marine Debris Working Group

- Fisheries Working Group
- Coral Reef Working Group

Understanding Flooding on Reef-lined Island Coasts Working Group

The Understanding Flooding on Reef-lined Island Coasts (UFORIC) Working Group works to develop action plans that can be used globally, regionally, and nationally to help guide research and development activities related to understanding and predicting flooding along tropical coral reef-lined shorelines over the coming years.

Major focus areas of the Working Group

1. The need for early-warning systems to provide short-term forecasts of flooding on the order of days. Short-term forecasts are dominated by tides, wind-waves, local wave set-up, and barometric pressure. The goal is for disaster risk reduction by reducing risk to life and assets by providing a warning to increase preparedness or allow for evacuation.
2. The greatest needs to develop early-warning systems include: coral reef bathymetry and island topography; in situ wave, water level, and flooding observations to calibrate and validate numerical models of wave-driven flooding over coral reefs; and the study of records from past flooding events to define local event thresholds.
3. The need for future scenarios of flooding focused on the timeframe of decades, starting in a few decades. Long-term projections are primarily governed by sea-level rise, wind and wave climates, coral reef biogeomorphology and sediment budgets, and anthropogenic impacts. The goal is to provide guidance to prioritize planning to mitigate or adapt to forecasted impacts and thus increase the resiliency of coastal communities.
4. The greatest needs to develop future projections include: downscaled pressure and wind fields for more accurate future wave modeling; historic coastal change data, especially island vertical development; carbonate sediment budgets; and coral reef and island coring to understand how they have evolved over recent changes in sea level.

Early Warning System for Flooding of Reef-lined Islands

The UFORIC Working Group is working on a project to develop an Early Warning System for Wave-driven Flooding of Reef-lined Coasts. The project aims to develop a simplified Early Warning System (EWS) that covers all coral-reef lined coasts in the world and provides a wave-driven flood forecast out to 7 days. This initial EWS would be able to forecast wave-driven flooding events in general terms, picking up the larger events well, but likely missing some smaller events.

The Working Group expects that they will be ready to begin implementing the EWS globally by 2020 and a fully implemented version 1 of the EWS will be running in experimental mode within two to three years of the beginning of the rollout, with a fully working version 1.1 of the EWS to be running throughout the world within 5 years of the start of the global rollout (note that funding for the global rollout is yet to be identified). The initial EWS would be useful for flood forecasting and will serve as a basis for further refinement of the global EWS and as a useful framework within which much higher resolution flood models can be developed. It will also serve to help scientists understand the relative importance/sensitivities of the various components of marine flooding models/products. This will assist scientists as they seek to develop more sophisticated and detailed models and products.

Initially, the project will utilize existing satellite and modelled wave and sea surface height products and outputs, combining them with existing bathymetry with significantly simplified assumptions about friction coefficients, shallow water bathymetry profiles, wave direction, beach morphology, etc. The result should be an EWS that works but will have significant room for improvement.

Multi-hazard Information and Alert System for the Wider Caribbean Project

In recent years, the Caribbean region has faced challenges from oil spills and an influx of floating sargassum seaweed. Large-scale oil spill incidents have included an April 2017 spill at Pointe-à-Pierre, Trinidad and Tobago and a July 2017 oil spill in Kingston Harbor, Jamaica. Illegal dumping of oil-contaminated waste by ships operating in the region is also a common occurrence. An increase in the frequency and volume of sargassum beachings and coastal overabundance has caused another challenge for the region with mats preventing the deployment and retrieval of fishing gear and clogging popular beaches, harbors and bays.

The Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO)'s Sub-Commission for the Caribbean and Adjacent Region (IOCARIBE), its GOOS Regional Alliance IOCARIBE-GOOS and GEO Blue Planet are working with partner organizations and stakeholders to develop a multi-hazard information system for the Caribbean and Adjacent Regions. The project will first focus on sargassum and oil spills and expand to include additional hazards as identified by local stakeholders.

The objective of the information service will be to provide a publicly available monitoring platform and alerting system for oil spills and sargassum based on publically available data (e.g. satellite data and in situ data from countries with open data sharing policies). The service will initially be based on existing technologies and activities, working to augment and improve the framework for information management and delivery and mechanisms for the region and demonstrate the utility of ocean observations and products.

The project will be implemented in two phases with Phase I (2018 – 2019) and phase two corresponding to year (2020 – 2021). See the attached implementation plan tables for additional details on deliverables.

Water-related Diseases Working Group

Several million cases of water-associated disease are reported globally each year from water-borne or vector-borne pathogens. A large number of cases may be avoided through improved access to clean water and sanitation, and more cases could be prevented by improving prediction of disease outbreaks and health risks, using an integrated approach involving in-situ observations, laboratory experiments, remote sensing and modelling.

The GEO Blue Planet Working Group on Earth Observations for Water-Associated diseases aims to identify benefits, best practices and feasibility of incorporating Earth observation measurements into early-warning systems for water-associated diseases. It provides a forum to exchange useful information, share data and coordinate activities where feasible, to maximise benefits to society.

The Working Group engages with specialists in the fields of ecology, epidemiology, bioinformatics, genetics, remote-sensing, modelling, climate, limnology and oceanography, and is linking with end-users, including local communities, governments, health services, intergovernmental organisations, and policy makers.

This initiative has been recognised as an important GEO Blue Planet activity under Theme 2 'Healthy Ecosystems and Food Security', and with societal relevance to public health, food security, water management, biodiversity and ecosystem sustainability, and disaster resilience. The WG activities are further adding value to GEO health community of practice and AquaWatch initiatives.

The Working Group Scoping Meeting was held in Abingdon, Oxfordshire, UK, on 30 and 31 August 2018. During the meeting, the participants agreed to the formation of the WG. Related activities are available at: https://geoblueplanet.org/blue-planet-activities/wg_eo_water-associated_diseases/.

Marine Debris Working Group

GEO Blue Planet, together with partner organizations, is bringing together a collaboration working group focusing on the mounting global challenge of plastic pollution (Law & Annual, 2017; Nash, 1992; Peeken et al., 2018; Schmidt et al., 2017; Villarrubia-Gomez et al., 2018) impacting the marine biosphere (Green et al., 2019; Katz, 2018; Nel et al., 2017; Taylor et al., 2016) and the foodweb (e.g., (Provencher et al., 2018). There is a need for an international agreement on plastic pollution (Borrelle et al., 2017), and the development of such an agreement needs to be informed by Earth observations. Efforts to monitor and quantify the flow of plastics into the ocean and detect ocean plastics are evolving (e.g., (Davaasuren et al., 2018; Garaba & Dierssen, 2018). A workshop held on November 26-27, 2018 in Brest, France (see http://www.gstss.org/2018_Brest) brought together a wide range of societal agents engaged in ocean plastic pollution to initiate the collaboration WG.

More generally, a growing amount of marine debris challenges the health of the ocean. Recent disasters like the 2011 tsunami in Japan (e.g., (Murray et al., 2018) and the 2018 Hurricane Michael create a large amount of debris that is swept into the ocean, which adds to the continuous flow of debris from ocean traffic and rivers. Observing, quantifying, and classifying marine debris are activities that urgently need to be coordinated and extended to ensure that societal stakeholders engaged in reducing this threat to ocean health have the evidence to base decisions and policy on. The Working Group will initially focus on marine technology and data access and integration for marine debris in support of SDG target 14.1.

Fisheries Working Group

There is a need to share existing fisheries resources and collect/integrate new in-situ data: this include fish species, human resources impacting the fishery, as well as other aspects related to artisanal fisheries. This is required to understand the status of resources and exploitation rate and would allow stakeholders in various regions to develop plans and sustainable management practices. Some species are endangered and vulnerable, while some invasive species have been biologically and/or economically affecting some other fish resources in some regions due to climate change, migration and illegal dislodging of ballast waters. This Working Group will work with countries to identify the needs and the gaps in data availability and knowledge sharing for the fisheries community across local, regional and global level and scale of type of fisheries (capture fishery- artisanal, commercial; aquaculture- inland,

coastal and offshore fish farming; species type brackish; socio economic aspect), and support the implementation of an open knowledge platform to empower decision makers.

Coral Reef Working Group

While there are several existing Coral Reef monitoring information systems (e.g. the NOAA Coral Reef Information System (CoRIS) and CSIRO-eReefs System), data collected by researchers and NGOs are often not easily located or shared. This Working Group will work to increase the discovery and accessibility of available data worldwide and encourage the registration of data in shared platforms.

2. Background and Previous Achievements

The creation of the "Oceans and Society: Blue Planet" Task was an initiative of POGO in 2011, to coordinate all the existing ocean observation programmes within GEO, to add new ones to the GEO portfolio, and to create synergies between them. GEO Blue Planet was introduced formally into the GEO work programme in 2012 (as SB:01) (GEO, 2014). The GEO Blue Planet Secretariat was established in late 2015 by the U.S. National Oceanic and Atmospheric Administration (NOAA) leading to GEO Blue Planet being incorporated in the GEO work programme as an initiative in 2017 (GEO, 2017).

In 2017, GEO Blue Planet created a formal Steering Committee and Advisory Board composed of ocean and coastal-observers, social scientists and end-user representatives from a variety of stakeholder groups, including international and regional organizations, NGOs, national institutes, universities and government agencies. GEO Blue Planet has also established a web presence (see: www.geoblueplanet.org and @GEOBluePlanet on Twitter). Working groups have been established as outlined above and the development of decision support tools and data services is underway.

Through the efforts of Steering Committee, Advisory Board, Working Groups and Secretariat, GEO Blue Planet has been working to provide a networking service to the ocean and coastal observing community and other stakeholders. These efforts include supporting the development of partnerships and sharing of information. Though difficult to quantify, this service has played an important role and is recommended as a key focus for the initiative to play moving forward (GEO Blue Planet, 2017, 2018).

Major events and publications that have been supported by GEO Blue Planet in recent years are summarized below.

Symposiums

GEO Blue Planet hosts symposiums every one to two years in different regions for the purpose of increasing regional linkages, promoting linkages between stakeholders and the observing community and gathering community feedback on the focus of GEO Blue Planet activities.

Kick-off Symposium - Ilhabela, Brazil, 2012

A kick-off symposium for the new GEO marine Task SB-01 "Oceans and Society: the Blue Planet" was held in Ilhabela, São Paulo State, Brazil, from November 19 to 21, 2012. The symposium was co-sponsored by the Canadian Space Agency (CSA), GEO, Brazil's National Institute for Space Research

(INPE) and POGO and took place just prior to the GEO-IX Plenary, held in Foz do Iguaçu, Brazil (November 22 and 23, 2012).

2nd GEO Blue Planet Symposium – Cairns, Australia, 2015

The second Blue Planet symposium for the GEO marine Task SB-01 "Oceans and Society: the Blue Planet" was held in Cairns, Australia from 27 to 29 May 2015. The symposium was co-organised by CSIRO and POGO.

3rd GEO Blue Planet Symposium – College Park, MD, USA, 2017

The 3rd Blue Planet Symposium was held in College Park, Maryland, USA from 31 May to 2 June 2017. The symposium was co-hosted by the National Oceanic and Atmospheric Administration, the University of Maryland and the University System of Maryland Foundation.

4th GEO Blue Planet Symposium – Toulouse, France, 2018

The 4th GEO Blue Planet Symposium was held from July 4 – 6, 2018 in Toulouse, France. The symposium was hosted by Mercator Ocean, member of the GEO Blue Planet Initiative and entrusted by the European Commission to operate the EU Copernicus Marine Service. This was the largest symposium to date with attendance of 300 delegates from international organisations and networks, research scientists, government agencies, various industries, ocean science communicators and graduate students.

Workshops

GEO Blue Planet works with various partners to organize workshops that aim to identify stakeholder information needs, support the development of decision-support tools and identify technology and data gaps.

Workshop on Implementing and Monitoring the Sustainable Development Goals in the Caribbean: The Role of the Ocean – St. Vincent and the Grenadines, 2018

This workshop, funded by NASA, was organized as a collaborative effort of GEO Initiatives, governments of the Caribbean SIDS, United Nations Agencies, and regional non-governmental organisations. It brought together 42 participants from sixteen countries.

Workshop on Understanding Flooding on Reef-lined Island Coasts – Honolulu, HI, USA, 2018

This workshop brought together about 30 experts were brought together from around the globe to foster collaboration and assess the state of knowledge of the different factors that control the spatial extent, timing, frequency, and magnitude of coastal flooding along tropical coral reef-lined coasts. The workshop was supported by the United States Geological Survey (USGS) and NOAA and run in collaboration with Deltares and CSIRO.

Workshop on Sargassum and Oil Spills Monitoring for the Caribbean Sea & Adjacent Regions – Mexico City, Mexico, 2018

This workshop was organized by IOCARIBE of IOC UNESCO and its Global Ocean Observing System Regional Alliance, IOCARIBE-GOOS, and the GEO Blue Planet Initiative, and hosted by the Ministry of Education of Mexico and Mexico National Council of Sciences. The workshop brought together 40

experts from 15 countries to discuss sargassum and oil spill monitoring in the Caribbean and Adjacent regions.

Workshop on Technologies for Observing and Monitoring Plastics in the Oceans – Brest, France, 2018
The workshop brought together social agents engaged in assessing and reducing the impacts of plastics in the ocean with experts assessing the sources of plastics in the ocean and scientists and developers focusing on existing and new observation technologies to detect and quantify plastics in the ocean. The workshop was supported by the IEEE Oceanic Engineering Society.

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3. Relationship to GEO Engagement Priorities and to other Work Programme Activities

GEO Engagement Priorities

GEO's global priorities include supporting the UN 2030 Agenda for Sustainable Development, the Paris Climate Agreement, and the Sendai Framework for Disaster Risk Reduction.

UN 2030 Agenda for Sustainable Development

GEO Blue Planet works to engage with users and identify priority information needs to achieve sustainable development priorities. For SDG monitoring and reporting, GEO Blue Planet focuses on supporting custodian agencies with the development of methodologies and to identify sources of data and develop display interfaces for SDG 14 (life below water).

The Paris Climate Agreement

GEO Blue Planet will work in collaboration with partners involved in the development of Climate Services to support the use of ocean and coastal observations for adaptation efforts. A particular focus will be on supporting the information needs for small island states.

The Sendai Framework for Disaster Risk Reduction

GEO Blue Planet works to support the development of early warning systems for the management of disasters related to ocean and coastal impacts. These efforts include the early warning system for marine flooding in reef-lined islands and the multi-hazard information and alert system for the wider Caribbean. GEO Blue Planet will work to develop these activities and collaborate with the Data Access for Risk Management (GEO DARMA) Initiative on projects over the course of the 2020 – 2022 work programme period.

Work Programme Activities

GEO Blue Planet works to develop and support partnerships with other GEO Work Programme Activities. The primary GEO partners for GEO Blue Planet are outlined below. GEO Blue Planet will work to strengthen linkages with these GEO activities and develop new collaborations over the course of the 2020 – 2022 work programme period.

GEO BON

The Marine Biodiversity Network (MBON) of the GEO Biodiversity Observation Network (GEO BON) is GEO Blue Planet's key partner on biodiversity related activities. GEO Blue Planet collaborates with MBON on regional and thematic workshops and projects that are of mutual interest. GEO Blue Planet supports the MBON Seascapes program through the NOAA CoastWatch program and will work to support the development and implementation of the MBON Pole-to-Pole project activities moving forward. GEO Blue Planet also works to help connect the MBON community to resource management practitioners and to policy makers that can define their requirements for Essential Ocean Variables (EOVs) and Essential Biodiversity Variables (EBVs) (see Miloslavich et al., 2018; Muller-Karger et al., 2018). MBON supports biodiversity linkages between GEO Blue Planet and several programs of the Intergovernmental Oceanographic Commission of UNESCO, including the Global Ocean Observing System (GOOS), the Ocean Best Practices System (OBPS), and the Ocean Biogeographic Information System (OBIS).

MBON Seascapes Project

The MBON Seascapes project was funded by NASA under the call for support for GEO activities (PI: Maria Kavanaugh, Oregon State University). This project seeks to identify coherent spatial and temporal

patterns in surface ocean conditions that may occur repeatedly in the world's oceans. The classifications define 'seascapes' as an ecological parallel to terrestrial 'landscapes'. The project characterizes the extent to which seascapes are dynamic on seasonal and interannual temporal scales and over multiple spatial scales. They will be identified using model and satellite remote sensing data that are updated regularly and time series that provide a historical context for reference against which to measure change. Scale, context-dependency, and shifting geographies make it difficult for managers and policy makers to assess baselines against which to measure change in marine ecosystems. Measuring changes in habitats is fundamental to understand multiple stressors on pelagic ecosystems. Yet it is difficult to visualize and understand how different environmental variables interact to define conditions suitable for one group of organisms or another, or how the distribution and abundance of life may change given changes in environmental or biological drivers. Indeed, defining ways to assess marine biodiversity is important to evaluate ocean health and ecosystem services. This project uses Earth Observations to visualize, track, and analyze changes in marine habitats and provide the information to stakeholders in a way that is helpful to address marine conservation and sustainable use.

GEO Blue Planet will work to support this effort over the 2020 – 2022 work programme period by supporting efforts to detect and track changes in marine habitats, including impacts on, for example, benthic communities due to changes in the surface ocean.

GEO AquaWatch

GEO AquaWatch serves as GEO Blue Planet's partner on water quality issues. Water quality information is required for several of GEO Blue Planet's projects including support for SDG 14.1.1 (Index of coastal eutrophication and floating plastic debris density) and the work of the water-associated diseases working group.

GEO Heath Community of Practice

The GEO Health Community of Practice is a partner of GEO Blue Planet's working group on water-associated diseases. GEO Blue Planet seeks to expand collaborations with the GEO Health Community of Practice over the 2020 – 2022 work programme period including those related to pollution and coastal hazards.

GEO ECO

The GEO Global Ecosystem Initiative (GEO ECO) leads a complementary effort, in collaboration with international marine scientists to produce a map of global ecological marine units (EMUs) from a 57 year record of temperature, salinity, dissolved oxygen, and nutrients data. The EMUs partition the global ocean into 37 physically and chemically distinct volumetric ocean regions. While the 1/4° (~27 km) spatial resolution of the EMUs is appropriate for mapping distinct open ocean regions, the satellite remote sensing seascapes provide a much finer spatial resolution for the classification and delineation of surface ocean ecosystems. Even finer spatial resolution is needed for coastal ecosystems because they represent the true land/water interface, often exist as small and linear features, and are often densely populated. An effort to delineate a new set of global Ecological Coastal Units (ECUs) was initiated as a partnership between Esri, USGS, MBON, and individuals representing international government, academic, and NGO organizations (Sayre et al., 2018). The roles of the three leading participating organizations are as follows: USGS provides scientific leadership, coordination, and liaison with the Group on Earth Observations (GEO); Esri is the primary implementing entity, and provides both scientific

and technical leadership as well as tool development and data dissemination; MBON is a commissioning entity and represents both a stakeholder community and pool of subject matter expertise. Individuals from a host of government, academic, and NGO organizations comprise an experts Steering Committee for the ECU development process. The commission, constitution, governance, and operation of the partnership is described, along with a description of the methodological approach to delineate the ECUs.

The initial GEO ECO work to produce the standardized ecological coastal units has resulted in a new online data discovery and exploration tool called the Global Island Explorer (GIE - https://rmgsc.cr.usgs.gov/gie/). This tool allows anyone with an internet connection to visualize and query ~ 340,000 islands and their shorelines at a very high spatial resolution (30 m). Recognizing the value of the data for the ocean science and policy community, GEO Blue Planet invited publication of the global islands and shorelines work in a GEO Blue Planet special issue publication in the Journal of Operational Oceanography (Sayre et al., 2018). GEO Blue Planet is recognized as a partner in the GIE development through logo inclusion on the welcome page. Going forward, Blue Planet intends to continue exposing and promoting the work to the larger ocean science and policy community. The EMUs, ECUs, Global Shoreline Vector, and Global Island Explorer are potentially useful resources for GEO Blue Planet activities, and the GEO Blue Planet community is seen as a source of expertise with which to develop, evaluate, and apply these products.

EO4SDGs

GEO Blue Planet supports the Earth Observations for the Sustainable Development Goals (EO4SDGs) initiative by providing a focal point within GEO for ocean-related issues for the SDGs. This includes taking the lead on GEO support of SDG 14 (life below water). The EO4SDG initiative supports GEO Blue Planet by providing insights on navigating the UN SDG process and representing GEO at high level SDG meetings and events. GEO Blue Planet will continue to collaborate with EO4SDGs over the 2020 – 2022 work programme period.

EO4EA

GEO Blue Planet is working to support the development of ocean accounts within the UN System of Environmental Accounts. The Earth Observations for Ecosystem Accounting (EO4EA) initiative is leading this effort in GEO. GEO Blue Planet will work to support these efforts and collaborate with EO4EA on the development of ocean accounts over the 2020 – 2022 work programme period.

GEO DARMA

GEO Blue Planet is currently working to develop two projects related to disaster risk reduction: the Multi-Hazard Information and Alert System for the Wider Caribbean and the Early Warning System for Marine Flooding of Reef-lined Islands. GEO Blue Planet will work to collaborate with the Data Access for Risk Management (GEO DARMA) over the 2020 – 2022 work programme period on these projects and other projects of relevance.

GEO Carbon and GHG Initiative

GEO Blue Planet seeks to strengthen linkages with the GEO Carbon and Greenhouse Gas Initiative (GHG) over the 2020 – 2022 work programme period. This includes collaborations around climate change mitigation strategies and the development of decision-support tools related to GHGs. GEO Blue Planet

will also work to connect the GEO Carbon and GHG Initiative with the Global Ocean Acidification Observing Network (GOA-ON).

Regional GEO Initiatives

GEO Blue Planet views the regional GEOs as important partners for the development of regional activities related to the ocean and coasts as well as an avenue for connecting with stakeholders in regions of interest. The Ocean and Islands task within the Asia-Oceania GEOSS is an important contribution to GEO Blue Planet and GEO Blue Planet seeks to support and collaborate with this task over the 2020 – 2022 work programme period. GEO Blue Planet also hopes to create and strengthen linkages with the other regional GEOs and is open to project collaborations.

4. Stakeholder Engagement and Capacity Building

Stakeholder engagement and capacity building are a crucial component of all GEO Blue Planet activities. Within the ocean and coastal observing community, the Partnership for Observation of the Global Ocean (POGO), the Scientific Committee on Oceanic Research (SCOR) and IOC-UNESCO and its Project Office for International Ocean Data and Information Exchange (IODE) are 3 of the major organisations conducting capacity development at the international level. Their activities include professional training (short courses, distance/blended learning, postgraduate (1 year) courses, visiting fellowships and visiting scholars, funding and mentorship for joint projects in ocean observations, development of low-cost technology for coastal ocean observations etc). These organisations work closely together on joint activities, information sharing and development of common strategies, and all contribute to the GEO Blue Planet Working Group on Capacity Development. Organizations working on stakeholder engagement include the Institute of Marine Engineering, Society and Technology (IMarEST), the regional GOOS alliances and professional trade bodies. The GEO Blue Planet Working Group on Stakeholder Engagement and Societal Awareness will work to increase linkages with these groups over the 2020 – 2022 work programme period.

5. Governance

The governing bodies of GEO Blue Planet are outlined below. For additional information see Annex D – GEO Blue Planet's Terms of Reference.

- Advisory Board: responsible for providing the strategic direction for Blue Planet and advocating for Blue Planet.

- Steering Committee: main decision-making body, responsible for coordinating Blue Planet's activities, identifying and, where possible, contributing resources.

- Management Committee: responsible for managing the daily operations and activities of Blue Planet.

- Secretariat: provides scientific and technical coordination for the GEO Blue Planet Advisory Board, Steering Committee and Management Committee as well as logistical support for GEO Blue Planet activities.

6. Resources

Current direct human resources for GEO Blue Planet operations are provided by NOAA in the form of two full time Secretariat staff members. Other GEO Blue Planet partners have provided in-kind financial and human resources to support GEO Blue Planet symposiums and workshops.

Over the 2020 – 2022 work programme period, GEO Blue Planet will need to acquire additional resources in terms of Secretariat staff and funding for projects. To meet these needs, GEO Blue Planet is working to develop a resourcing strategy and budget requests for the activities outlined in section 2. Resource mobilization efforts are being coordinated with the GEO Secretariat team for resource mobilization. In addition, GEO Blue Planet is exploring is a fiscal sponsor relationship with a non-profit organization to facilitate the acquisition of funds. Additional support for the Secretariat is under development. Confirmed contributions are outlined in table B – Contributions.

Resourcing efforts will include in-kind contributions from the commercial sector (e.g. Esri support for projects), partnerships on projects and proposals for funding. Existing commercial sector partners are included in table A – Participants.

7. Technical Synopsis

GEO Blue Planet generates and utilizes a diverse suite of ocean data, products and derived information in support of its goals and objectives. These include satellite and other remotely sensed observations and in situ measurements, complemented by data assimilating ocean models providing forecasts and other outputs for users. The initiative works to facilitate the user-driven value chain, in particular the progression from observations to data to products to information, providing actionable knowledge for users.

Satellite parameters and products include multi-sensor sea surface temperature (polar and geostationary infrared, microwave, and blended products), ocean color radiometry (e.g., chlorophyll, suspended and dissolved matter), altimetry-derived products (e.g., sea surface height anomalies, significant wave heights, sea ice thickness), scatterometer derived products (e.g., ocean surface vector winds, ice products), synthetic aperture radar (SAR) derived products (e.g., oil spills, sea ice extent, ship detection, coastal winds, flooding extent), sea surface salinity, and moderate and high-resolution imagery of the oceans, coasts, and inland waters and watersheds from geostationary and polar imagers.

Data from the global satellite constellation, acquired from operational and research sensors/platforms, are utilized and guided by scientific/technical expertise and best practices contributed by CEOS, the Coordination Group for Meteorological Satellites (CGMS), the Group for High Resolution Sea Surface Temperature (GHRSST), the International Ocean Colour Coordinating Group (IOCCG), and the Ocean Surface Topography Science Team (OSTST) among other community entities. These data are sourced

from international operational providers, particularly the Copernicus Marine Environment Monitoring Service (CMEMS) and the NOAA CoastWatch/OceanWatch/PolarWatch Program, as well as directly from various met offices, space agencies, academic and research institutions and commercial providers.

In situ measurements complement and expand upon the satellite data, providing sub-surface measurements and measures not possible from space (e.g., nutrients, pathogens), as well as (near) surface measurements that provide crucial validation of the satellite observations. These data are collected at regional, national and local levels for various applications, including regulatory, resource management, research et al., likewise guided by scientific/technical expertise and best practices contributed by GOOS, POGO and other international entities.

These observations are in turn utilized and enhanced by modeling and data assimilation activities driving forecasts, predictions and long-term scenarios by both government (e.g., NOAA's NCEP and UK's Met Office,) as well as academic and private sector entities, guided by scientific/technical expertise and community best practices contributed by GODAE-OceanView (soon to be rebranded as Ocean Predict). Finally, GEO Blue Planet works to enhance the linkages, coordination and communication between data providers, intermediate information providers who ingest data from the upstream providers and finally the end users who consume these different products. In this context we work to facilitate technology transfer and best practices across communities, regions (including developed to developing nations), and from research into operations, applications and end user services.

9. Data Policy

GEO Blue Planet will primarily be a data consumer rather than a data producer. For GEO Blue Planet the onus will be on the co-creation of added value services to cover the needs of users and stakeholders. For the most part, GEO Blue Planet activities will leverage existing systems and datasets from numerous organisations and will work to encourage other data providers to contribute to existing systems. Data types and categories will include a large range of ocean data and other supporting datasets including traditional geospatial data (e.g. management boundaries), time series monitoring data (e.g. ocean moorings), gridded datasets (e.g. satellite remote sensing products) and complex multi-dimensional data cubes (e.g. ocean models). End products will aim to bring many of these data types to end users in useful, usable ways which connect directly to the source data services.

GEO Blue Planet will adopt and promote all of the GEOSS Data Sharing and Data Management Principles of open data sharing, availability with minimal restrictions and with minimum time delay. A key focus will be to leverage and build on the concept of trusted, reproducible, and robust guidance on best use of Earth observation data for decision-making, focusing on open data, data services and data interoperability together with groups such as GEOSS and ODIP. Blue Planet will engage with many other GEO initiatives and other national, regional or global activities to help develop tools and services designed to bring ocean observations to end users. Where GEO Blue Planet does produce new datasets, any new data products and services will be linked to the GEOSS Common Infrastructure where it is appropriate to do so. Data and metadata will be managed and delivered by leveraging existing information platforms which are hosted by supporting agencies, avoiding the multiplication of data platforms/portals.

Annex A – Acronyms and Abbreviations

CBD	Convention on Biological Diversity
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CMEMS	Copernicus Marine Services
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DARMA	Data Access for Risk Management
ESA	European Space Agency
ECVs	Essential Climate Variables
EBVs	Essential Biodiversity Variables
EOVs	Essential Ocean Variables
EWS	Early Warning System
FOO	Framework for Ocean Observing
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GHG	Green House Gas
GOA-ON	Global Ocean Acidification Network
GHRSST	Group for High Resolution Sea Surface Temperature
GOOS	Global Ocean Observing System
OBIS	Ocean Biogeographic Information System
ODIP	Ocean Data Interoperability Platform
IMarEST	Institute of Marine Engineering, Society and Technology
INPE	Brazil's National Institute for Space Research
IOCCG	International Ocean Colour Coordinating Group
IOC-UNESCO	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
MBON	GEO Global Biodiversity Observation Network thematic Marine Biodiversity Observation Network
MSFD	European Marine Strategy Framework Directive
NOAA	National Oceanic and Atmospheric Administration
OSTST	Ocean Surface Topography Science Team
POGO	Partnership for Observation of the Global Ocean
SAR	Synthetic Aperture Radar
SCOR	Scientific Committee on Oceanic Research
SDGs	Sustainable Development Goals
UFORIC	Understanding Flooding on Reef-lined Island Coasts
UN	United Nations

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change

Annex B – List of References

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Annex C – CV of Project Leader

Paul M. DiGiacomo, Ph.D.

NOAA/NESDIS Center for Satellite Applications and Research (STAR)
NCWCP (E/RA3), 5830 University Research CT, College Park, MD USA 20740-3818
Office Phone: +1-301-683-3302; Office Email: Paul.DiGiacomo@noaa.gov

Professional Preparation

1990	B.S., Biology (Ecology focus; Minor in Marine Science), Penn State University
1999	Ph.D., Biology (Oceanography focus), University of California, Los Angeles

Appointments

1999-2001	*Resident Research Associate* (Biological Oceanography), National Research Council, NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
2001-2005	*Scientist*, Oceanography Group, NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
2005-2006	*Supervisor* for Earth Mission Concepts Group, and, *Discipline Program Manager* for Carbon Cycle and Ecosystems, NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
2006-2009	*Chief*, Marine Ecosystem and Climate Branch, NOAA/NESDIS Center for Satellite Applications and Research; NOAA CoastWatch *Program Manager*, Camp Springs, MD
2009-present	*Chief*, Satellite Oceanography and Climatology Division, NOAA/NESDIS Center for Satellite Applications and Research, Camp Springs/College Park, MD
2014-present	CoastWatch *Program Manager;* MOBY *Project Manager* (Additional Duty)

Selected Honors and Awards

- JPL-Dr. Charles K. Witham Environmental Stewardship Award
- National Research Council (NRC) Resident Research Associate Award
- UCLA Dissertation Year Graduate Student Fellowship
- NASA Graduate Student Researchers Program (GSRP) Pre-Doctoral Fellowship
- NASA Earth System Science (ESS) Pre-Doctoral Fellowship (declined for above)

Professional Interests & Experience

- Marine ecosystem dynamics: research, applications, resource management
- Development and implementation of global and coastal ocean observing networks
- Multi-sensor remote sensing of inland, coastal and oceanic waters (water quality focus)
- Linking coastal/ocean data providers and users for applications and management

- Student and public outreach, education and engagement on coastal/marine issues

Peer-reviewed Publications

Bograd, S. J., P. M. DiGiacomo, R. Durazo, T. L. Hayward, K. D. Hyrenbach, R. J. Lynn, A.W. Mantyla, F. B. Schwing, W. J. Sydeman, T. Baumgartner, B. Lavaniegos, and C.S.Moore, 2000: The state of the California Current, 1999-2000: Forward to a new regime? *California Cooperative Oceanic Fisheries Investigations Reports*, **41**, 26-52.

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dynamics within the Southern California Bight. *Continental Shelf Research*, **27**, 2427-2448, 10.1016/j.csr.2007.06.015.

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Drinkwater, M. et al., 2010: "Status And Outlook For the Space Component Of An Integrated Ocean Observing System" in *Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society (Vol. 1)*, Venice, Italy, 21-25 September 2009, Hall, J., Harrison, D.E. & Stammer, D., Eds., ESA Publication WPP-306, doi:10.5270/OceanObs09.pp.17

GCOS, 2010: Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 Update), GCOS-138, WMO, 186 pp.

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IOCCG, 2012: Ocean-Colour Observations from a Geostationary Orbit. Antoine, D. (ed.), Reports of the International Ocean-Colour Coordinating Group, No. 12, IOCCG, Dartmouth, Canada.

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Selected Professional Activities

- Chair of Coastal/Inland Water Quality Sessions at Ocean Sciences Meetings et al.
- Invited Speaker, Steering Committee Member, Session Chair et al., numerous conferences, workshops and other scientific, technical and general public events on coastal and ocean science, observing & management, 1999 to present
- Peer-reviewer for various scientific journals, 1999 to present
- Proposal reviewer and peer-review panel member (NASA, NOAA, NSF, international agencies et al.), 2001 to present
- Co-Chair, Integrated Global Observing Strategy (IGOS) Coastal Theme, 2002-2007
- Panel Member, Coastal Module of the Global Terrestrial Observing System (GTOS), 2002-2005
- Chair of Water Quality Committee and Member of Steering Committee, Southern California Bight '03 Project, 2002-2007
- Contributor and co-author, NSF Coastal Ocean Observatory Science Workshops and Reports, 2002-2003
- Deputy PI, Coastal Ocean Carbon Observations and Applications (COCOA) coastal satellite mission concept team, NASA/JPL, 2003-2006
- Member, Executive Steering Committee for the Southern California Coastal Ocean Observing System (SCCOOS), 2004-2006
- Co-Chair, GEO/GEOSS Coastal Zone Community of Practice (CZCP), 2005-2015
- Member, Federal-State Task Team on Research Priorities for the Subcommittee on Integrated Management of Ocean Resources (SIMOR), 2005-2006
- Member, NASA Carbon Cycle and Ecosystems Management Operations Working Group (advance/strategic planning group), 2006-2008

- NOAA Representative to the International Ocean Colour Coordinating Group (IOCCG), 2007-2018
- Co-Chair, GOOS Panel for Integrated Coastal Observations (PICO), 2008-2012
- NOAA Representative (Alternate), U.S. Interagency Working Group on Ocean Observations (IWGOO), 2008-2010
- Member, NASA GEO-CAPE Science Working Group, 2009-2018
- Member, Plymouth Marine Laboratory's (PML) Science Advisory Council, 2009-2012
- Member, ESA CoastColour Project Science Team, 2010-2012
- Member, GEO User Interface Committee and GEO Societal Benefit Implementation Board, 2010-2015
- NOAA Representative (Alternate), U.S. Interagency Ocean Observations Committee (IOOC), 2010-present
- Founder/Chair, NOAA Ocean Color Coordinating Group (NOCCG), 2011-2015
- Member, Steering Committee, NSF Ocean Observation Research Coordination Network, 2012-present
- Co-Chair, U.S. IOOS Summit, 2012-2013 (including report as above)
- Member, Pool of Experts of the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, 2013-present
- Co-Chair, Committee on Earth Observation Satellites (CEOS) Ocean Color Radiometry Virtual Constellation (OCR-VC), 2013-2018
- Member, ESA Sentinel-3 Validation Team, 2013-present
- Lead, JPSS Ocean Environmental Data Records (EDR) Discipline Team, NOAA/NESDIS, 2013-present
- Co-Chair, International Ocean Colour Coordinating Group (IOCCG) Working Group on Earth Observations in Support of Global Water Quality Monitoring, 2014-2018
- Chair, GODAE-OceanView/Ocean Predict Patrons Group, 2014-present
- Member, Tenant Board for the NOAA Center for Weather and Climate Prediction (NCWCP), representing NESDIS/STAR, 2015 to 2016
- Co-Chair, GEO AquaWatch Initiative, 2015-2018
- NESDIS Representative, NOAA Executive Steering Committee for Ecological Forecasting, 2015-present
- Member, Advisory Board for the European Union Horizon 2020 Coastal Waters Research Synergy Framework Project, 2016-2018
- Co-Chair, GEO Blue Planet Initiative Steering Committee, 2016-present
- Keynote speaker on operational oceanography at the 3rd International Ocean Colour Science Meeting; Lisbon, Portugal, May 2017
- Co-Chair, International Operational Satellite Oceanography Initiative, 2018-present

Professional Affiliations

- AGU, ASLO, TOS, MTS

Post-Docs and Doctoral Committees

- Dr. Emmanuel Bosc, JPL Post-doctoral fellow, 2003-2005
- Dr. Guangming Zheng, NOAA/University of Maryland Visiting Scientist, 2013-2014 (then transitioned to full-time staff in my division, 2014-present)
- Ms. Nicole Bartlett, Ph.D. Candidate, University of Massachusetts-Boston; Principal Advisor is Professor Robert Bowen

Teaching and Outreach Experience

- UCLA Lecturer: Taught *Introduction to Marine Science* course
- UCLA Teaching Assistant/Associate/Fellow: various undergraduate courses, including Biology of Organisms; Organismic and Environmental Biology Laboratory; Ecology, Evolution and Behavior; Oceans; Biology of Invertebrates.
- Extensive experience and engagement in general public as well as K-12 and undergraduate/graduate biological and marine science education while at UCLA and JPL, particularly participating in the NSF-funded Marine Science Teacher Education Program (M-STEP) and the Leadership in Marine Sciences (LIMS) Programs at UCLA. These programs included classroom instruction at UCLA, ship-based activities on UCLA Research Vessels, and on-site field activities at the USC Wrigley Marine Science Center on Catalina Island, California

Annex D – Terms of Reference

Terms of Reference (version 2.0)

GEO "Oceans and Society: Blue Planet" Initiative

Adopted on December 7, 2018

1. Overview of the Governance of Blue Planet

The governing bodies of GEO Blue Planet include:

Advisory Board: responsible for providing the strategic direction for Blue Planet and advocating for Blue Planet.

Steering Committee: main decision-making body, responsible for coordinating Blue Planet's activities, identifying and, where possible, contributing resources.

Management Committee: responsible for managing the daily operations and activities of Blue Planet.

Secretariat: provides scientific and technical coordination for the GEO Blue Planet Advisory Board, Steering Committee and Management Committee as well as logistical support for GEO Blue Planet activities.

1.1 Details of the governing bodies

This section provides information about the roles and responsibilities and *modus operandi* of governing body. Participation in the Advisory Board, Steering Committee and Working Groups will not be remunerated. Attendance of Advisory Board and Steering Committee members at symposiums, workshops and events will generally be funded by the members themselves, although opportunities for travel funding will be sought by the Steering Committee, particularly for members from developing countries.

1.1.1. Advisory Board

The Advisory Board will provide oversight and strategic direction to the Steering Committee. The Advisory Board will meet quarterly via teleconference, and if possible once yearly in person.

The Advisory Board will be composed of high level individuals representing foundational ocean observing organizations and users. Nominations will be invited via an open call sent out to ocean observing organizations and high level user representatives (i.e. UN Groups, World Bank). Self-nominations will be welcome. The Steering Committee will review nominations and select a maximum of 10 members to serve terms of 2 years, renewable once.

1.1.2 Steering Committee

The Steering Committee is the main decision-making body, responsible for coordinating Blue Planet's activities. Steering Committee duties are:

- To promote the aims and objectives of Blue Planet and expand its profile and prominence;
- To review and endorse the Implementation Plan and Annual Work Plans of Blue Planet;
- To monitor and evaluate institutional effectiveness of Blue Planet against aims and objectives outlined in the Implementation and Annual Work Plans;
- To represent stakeholder and shareholder interests;
- To provide guidance and support to Blue Planet Components and monitor their progress;
- To coordinate the production of deliverables for reporting to the GEO Secretariat;
- To work with the Blue Planet Secretariat and the GEO Secretariat to identify new stakeholders and shareholders that would contribute to and benefit from Blue Planet.
- To identify opportunities for collaboration between stakeholders/shareholders.
- To facilitate and coordinate relevant activities and mobilise resources when opportunities arise, in concert with the Advisory Board.

The Steering Committee will, as far as possible, operate by consensus. Decisions requiring a vote will be decided by simple majority of the votes cast. The quorum for a valid vote is participation of one half of the voting members of the Steering Committee. Votes may be held at meetings or by appropriate electronic means. These procedures will apply, for example, to make any changes to the Terms of Reference. The Steering Committee will meet in person at least once yearly and via teleconference on a bi-monthly basis.

The Steering Committee will consist of contributing shareholders and stakeholders. Contributing shareholders, as defined here, are those organizations that contribute resources for the overall coordination of Blue Planet (e.g. Secretariat, publications, Symposiums, etc.) and/or the production of new services (specifically as Blue Planet products). Stakeholders are those organizations that contribute to, or benefit from, the Blue Planet Mission and Objectives, and in particular the work of the Components, either from the provider or user end. It is anticipated that between one third and half of the Steering Committee will consist of representatives of user communities.

Steering Committee members will be elected by the existing Steering Committee, from among the nominations received following an open call. Nominations can be made by the Advisory Board, stakeholder and shareholder organizations, or members of the community. Self-nominations will be welcome. In their decision, existing Steering Committee members will take into account the contributions of the shareholder organisations being represented, the relevance of the stakeholder organisations being represented, the balance between "providers" and "users", geographical representation and gender balance.

Steering Committee members will serve a 3-year term with the potential for two one-year extensions (not to exceed 5 years in total). Steering Committee members must attend at least one Steering Committee meeting every six months or make alternate plans to meet with the Secretariat to remain on the committee.

The term may be shortened if the member is representing an organization and changes positions or if the member is unable to make the required time commitment. Three Co-Chairs will be elected by the Steering

Committee members, and will serve terms of three years, with the potential for two one-year extensions (not to exceed 5 years in total).

1.1.3 Management Committee

The Management Committee is responsible managing the daily operations and activities of Blue Planet. Management Committee duties are:

To provide support to the Secretariat on day to day operations and activities;
To review progress on activities between Steering Committee meetings;
To identify and support additional partnerships and funding opportunities;

The Management Committee is composed of the 3 Steering Committee Co-Chairs. A small number of members-at-large (preferably no more than 3) may be appointed by the Steering Committee to fill gaps in geographical representation and/or expertise. The Management Committee will operate via regular e-mail correspondence and conference calls with the Secretariat will be held on average every two weeks.

1.1.4 Secretariat

The GEO Blue Planet Secretariat provides scientific and logistical support for GEO Blue Planet activities. The Secretariat also provides coordination support for activities and developing partnerships. The GEO Blue Planet Secretariat reports to the Steering Committee and Advisory Board.

The Secretariat is composed of a Principal Secretariat Office staffed by a Director and support staff pending funding availability. The Secretariat will also have regional and thematic nodes depending on availability of funding. Secretariat nodes can be regional, thematic or a combination of regional and thematic.

The duties of the Principal Secretariat Office are:

- To provide overall support and coordination to the GEO Blue Planet network;
- To support and manage GEO Blue Planet activities as required;
- To provide direction and leadership for the regional and thematic secretariat offices;
- To support the Steering Committee in the coordination of GEO Blue Planet deliverables;
- To provide logistical support to the Advisory Board;
- To promote GEO Blue Planet in the international arena;
- To interface with and report to the GEO Secretariat on behalf of GEO Blue Planet;
- To support the organisation of GEO Blue Planet Symposia;
- To manage the GEO Blue Planet website, social media and other communications.

The duties of the regional Secretariat nodes are:

- To connect GEO Blue Planet with relevant ongoing regional activities;

- To provide technical /or administrative support to the principal secretariat office;
- To coordinate regional GEO Blue Planet activities;
- To coordinate with and support regional GEOSS initiative activities related to oceans and coasts (e.g. AOGEOSS Oceans, Coasts and Islands task).

The duties of the thematic secretariat offices are:

- To connect GEO Blue Planet with relevant ongoing activities related to the office's thematic area;
- To provide technical and/or administrative support to the principal secretariat office;
- To develop and support GEO Blue Planet activities related to the office's thematic areas;
- To coordinate with and support thematic GEO activates related to the office's thematic area (e.g. GEO BON/MBON, GEO Carbon and GHG Initiative).

2. Overview of GEO Blue Planet Activities

GEO Blue Planet supports and promotes activities that are aligned with the initiative's mission.

GEO Blue Planet's mission is to advance and exploit synergies among the many observational programmes devoted to ocean and coastal waters; to improve engagement with a variety of users for enhancing the timeliness, quality and range of services delivered; and to raise awareness of the societal benefits of ocean observations at the public and policy levels.

GEO Blue Planet supports and promotes internal and external activities in three cross-cutting areas and ten thematic areas.

2.1 Supported Activities

GEO Blue Planet supported activities are those whose formulation, funding and implementation are directly supported by the GEO Blue Planet Steering Committee or Secretariat. These activities include working groups and fixed-term projects. Supported activities will be identified as GEO Blue Planet activities on the website and in other outreach materials.

2.1.1 Process

The GEO Blue Planet Steering Committee will solicit and review proposals for working groups and projects on an ongoing basis.

- Proposals will be selected based on applicability to stakeholder needs, cost/benefit and GEO priorities.
- For activities that require funding, GEO Blue Planet Steering Committee, Secretariat and activity leaders will work to apply for and secure funding for the activity.
- Regular updates on progress will be requested by the Blue Planet Secretariat for the website and monthly Steering Committee updates.
- Activity objectives, milestones and deliverables will be reviewed on an annual basis by the Steering Committee.

2.2 GEO Blue Planet Promoted Activities

GEO Blue Planet promoted activities are those that support the mission of GEO Blue Planet but are not actively supported by the GEO Blue Planet Secretariat or Steering Committee. Promoted activities will be listed as related activities on the GEO Blue Planet website and other outreach materials.

2.2.1 Process

- The GEO Blue Planet Steering Committee will review requests for activity endorsements on an ongoing basis.
- Activities will be selected for endorsement by the Steering Committee based on applicability to GEO Blue Planet's mission.
- Selected activities will be asked to provide informal updates to GEO Blue Planet (e.g. by giving a presentation at a GEO Blue Planet Steering Committee Meeting or GEO Blue Planet Symposium, or by providing a new article for the GEO Blue Planet website).

3. Adoption and review of the Terms of Reference

Version 2.0 of these Terms of Reference were adopted by the GEO Blue Planet Steering Committee on December 7, 2018. This document will be reviewed at least on an annual basis by the Steering Committee.