



# Co-Designing a safe ocean in the Western Tropical Atlantic within the framework of the UN Decade of Ocean Science for Sustainable Development

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## ABSTRACT

The frequency and intensity of ocean related hazards and its overlapping and cascading effects are escalating with devastating and unsustainable impact on life and livelihoods in the Western Tropical Atlantic. From the Bahamas to Brazil, from Mexico and Central America to the Lesser Antilles, coastal and maritime communities have been impacted by hurricanes, storm surges, earthquakes, sargassum and oil spills along with other climate, weather and human induced events. In addition to the coastal impacts, ocean hazards also have affected the safe and timely delivery of goods and services in a region that is extremely dependent on maritime transport. COVID-19 has compounded even more the situation of millions of people in the region and put extreme pressure on government officials, including disaster management and health professionals as well as the maritime industry. Climate change will only exacerbate the situation. The UN Decade of Ocean Science for Sustainable Development (2021-2030) presents itself as a once-in-a-lifetime opportunity to stop the cycle of disasters with “A Safe Ocean” as one of its seven major societal outcomes. The Western Tropical Atlantic Safe Ocean Working Group was established to co-design and co-deliver with local, national and regional partners transformative strategies that will facilitate and inspire actions to reduce and mitigate the ocean related threats while creating resilient and safer coastal communities and maritime activities. At the core is an Integrated Multi Hazard Ocean Data and Forecast System. Its services would be linked to education, outreach, readiness and communication that empowers and recognizes national and local policy decisions and includes individual response for the protection of life and livelihoods. This effort should support relevant science and strengthen capacity leaving no one or country behind.

**Descriptors:** Safe ocean, Western tropical atlantic, Coastal communities, UN Decade of Ocean Science for Sustainable Development, Ocean hazards.

## INTRODUCTION

On January 1, 2021 the UN Decade of Ocean Science for Sustainable Development was launched with the Vision “The Science we Need for the Ocean we

Want”. The journey began in 2016 when the UNESCO Intergovernmental Oceanographic Commission (IOC) initiated the concept. Through the IOCARIBE (IOC Sub Commission), the Western Tropical Atlantic (WTA) was actively engaged in the discussions and contributed to the process. A Regional Planning Group and Working Groups were then established to further support the decade outcomes and actions.

In 2016, the first World Ocean Assessment of the United Nations highlighted the dependency of life

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and livelihoods on the state of the ocean and stated that humankind was running out of time to start managing the ocean sustainably (UNGA, 2016). In response to the report and the critical situation, including many other ocean related challenges, the Intergovernmental Oceanographic Commission of UNESCO (IOC) initiated the concept of a UN Decade. The following year, in December 2017 the UN General Assembly (UNGA) proclaimed the UN Decade of Ocean Science for Sustainable Development 2021-2030 (referred to as 'the Ocean Decade').

From 2018 through 2020 the Ocean Decade Implementation Plan was developed. Over the course of the three years, over 1900 people participated in global, thematic, and regional planning meetings. Participants spanned the scientific community, governments, UN entities, NGOs, private sector, and donors across ten ocean basins.

The Western Tropical Atlantic held its regional workshop virtually on April 28-29, 2020. Over 300 scientists, policymakers, program managers, and government officials, representatives from tourism, maritime sector and communicators discussed and identified regional priorities, and recognized and engaged new and expanded stakeholders and partnerships. As with other events, the results fed into the Ocean Decade Implementation Plan. Regional and thematic challenges and actions were also identified.

After another broad round of consultations, the Ocean Decade Implementation Plan V2 (UNESCO, 2020) with the vision "The science we need for the ocean we want" was submitted in August 2020 for consideration by the UNGA 75<sup>th</sup> Assembly. On December 31, 2020 the Plan was "noted with appreciation" giving a green light for the Decade to begin on January 1, 2021. The Ocean Decade Implementation Plan includes seven outcomes, ten challenges and three objectives as well as providing a roadmap for actions. It also highlights data, information and digital knowledge management as well as capacity development and addresses mechanisms for decade engagement, as well as a governance and coordination framework and resource mobilization.

One of the outcomes is a Safe Ocean. It focuses on the protection of life and livelihoods from ocean-related hazards. It is inclusive of meteorological, ocean dynamics, geophysical, biological and human induced hazards and their devastating, cascading

and unsustainable impacts on coastal communities, ocean users, ecosystems, and economies. It acknowledges that changing frequency and/or intensity of weather and climate-related hazards are exacerbating these risks. A safe ocean requires mechanisms and processes for assessing priority risks and forecasting and warning of these hazards with the goal of mitigating or formulating adaptive responses to reduce short- and longer-term threats on land and at sea. The need for systematic higher density oceanic and coastal data collection and improved forecasting systems - including those related to sea level, marine weather and near real-time climate at decadal scales is highlighted. It stresses the importance of an integrated approach linked to education, outreach, and communication, in order to empower policy and decision-making and mainstreaming individual and community resilience. Directly linked to the Safe Ocean are other outcomes like the "Predicted Ocean", "Accessible Ocean" and "Inspiring and Engaging Ocean" outcomes.

Among the 10 challenges identified, the most relevant to a Safe Ocean is the challenge to "Enhance multi-hazard early warning services for all geophysical, ecological, biological, weather, climate and anthropogenic related ocean and coastal threats, for mainstream community preparedness and resilience". However, similar to the outcomes, there are other challenges such as understanding the ocean-climate nexus, ocean and coastal mapping, capacity development and overcoming barriers to behavior change, that also need to be addressed for a safe ocean. On July 8, 2021 the regional workshop, "Breaking down the Silos for More Effective Multi Hazard Early Warning", focused on trans sectoral priorities and actions.

The decade objectives focus on identifying, generating and increasing the use of ocean knowledge. The Ocean Decade seeks to facilitate and help advance science in support of the UN 2030 Sustainable Development Goals (Figure 1). The most direct link is with Sustainable Development Goal (SDG) 14, life under the sea. In the case of the Safe Ocean Outcome, almost every SDG is relevant, but most important Sustainable Cities and Communities.

The Decade is to be action oriented and its Implementation Plan addresses this through three levels of endeavors: Programmes, Projects and

# SUSTAINABLE DEVELOPMENT GOALS



**Figure 1.** The UN Sustainable Development Goals.

Activities. A Decade programme is long-term, typically global or regional in scale and would contribute to the achievement of one or more of the Ocean Decade Challenges. A Decade project is more discrete and focused and may be regional, national or sub-national. A Decade activity is a one-off standalone initiative (such as an awareness-raising event, a scientific workshop, or a training opportunity). These actions can be proposed by countries, scientists, NGO's, industry, consortiums or by the UN system.

Data, information and a digital knowledge management framework will be collectively developed throughout the Decade. A significant increase in volume and range of ocean-related data, information and knowledge is expected. In order for it to be relevant and applicable will require significant enhancement of infrastructure, interoperability, data sharing and stewardship. Collaboration and communication between data users and providers will also be key for the provision of the Multi Hazard Warning Services.

In order to reduce risk, communities must be encouraged to implement effective mitigating measures and become aware of the hazards they face (IOC UNESCO, 2016). Capacity building and ocean literacy are critical to engage science, society and decision-making. The use of scientific resources and advances are fundamental in capacity building to ensure that all nations have access to the necessary information for coastal adaptation planning to marine geohazards and safe and secure operations in the marine environment (IOC UNESCO, 2017). Capacity building is required in ocean observing, updated models and

forecasting capabilities of the ocean - climate systems and the development of local decision support tools.

The success of the UN Decade of Ocean Science will depend on global capacity building efforts where nations at different levels of wealth and development collaborate with ethical responsibility reducing the asymmetry in technology and knowledge and seek equality in all its forms. No one should be left behind, irrespective of race, gender, generation, ability or geography, including Small Island Developing States, Least Developed Countries and Land-locked Developing Countries. Grant programs, national investments in education, research and infrastructure can help. Strengthening long-term partnerships and privileging collaborative research to overcome background conditions that impinge on equitable research capacities will help accelerate the transformation (Visbeck, 2018).

While no country should be left behind, the Decade also recognizes that no country, institution on its own can achieve on its own the decade outcomes. Partnership and collaboration within the United Nations and Intergovernmental Organizations, academic institutions, research organizations, NGOs, private sector and others is a cornerstone for success. Resource mobilization will also be required for decade actions and coordination. The funding will have to be identified and secured by the proponents of actions or through funders and resource providers.

The IOCARIBE Sub Commission of the Intergovernmental Oceanographic Commission of UNESCO, as the WTA Ocean Decade Coordination

mechanism, has the overall responsibility for formulation of policy, principles and strategy, and for planning and coordination of the Ocean Decade in the Western Tropical Atlantic region. In October 2020 IOCARIBE established a Regional Planning Group (WTA RPG) to advance and coordinate strategic partnerships and actions for Western Tropical Atlantic engagement in the Decade. Furthermore, it established seven Working Groups to achieve each societal outcome. In addition to the Safe Ocean Working Group, there are also groups focused on: Clean Ocean, Healthy and Resilient Ocean, Predicted Ocean, Sustainably Harvested and Productive Ocean, Transparent and Accessible Ocean and Capacity Development.

## DISCUSSION

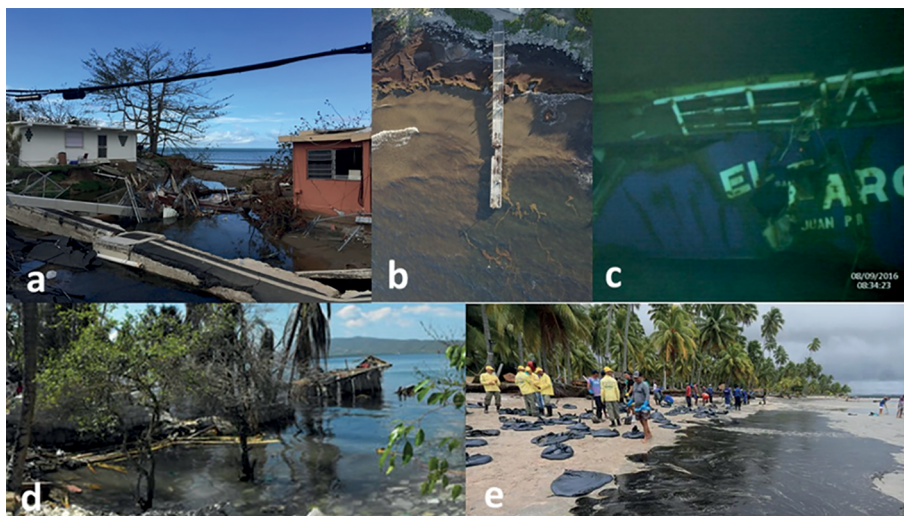
### OCEAN RISKS AND VULNERABILITY

“The reality we are living in is that disasters are all playing out simultaneously like a horror movie. Our oceans are crying; our people are dying and we must act quickly.” These words were part of the intervention from Sharlene Dabreo, Permanent Secretary and Past Director of the Department of Disaster Management of the British Virgin Islands on the Safe Ocean panel

of the WTA Regional Planning Workshop in April 2020 (UNESCO IOCARIBE, 2020).

The Western Tropical Atlantic is home to over 500 million people distributed across 44 Countries and Territories, 52% of which are Small Island Developing States (SIDS). A significant portion live in coastal areas that are less than 10 meters above sea level in the WTA. Sixty eight percent of all the countries/territories have all their landmass located within 100 km of the coast. In addition, 84% of the volumes traded in the region come through its ports and harbors (Sanchez, 2020 com. pers.). Life and livelihoods of coastal communities are fundamentally linked with the state of the ocean. Over the past decade the WTA has suffered repeated loss of life and social and economic impact from hurricanes, sargassum influx coastal earthquakes, sinking ships and oil spills (Figure 2).

The number of hurricanes and tropical events in the Western Tropical Atlantic have increased along with their faster development and intensity. Many countries in the Caribbean are still suffering and trying to recover from the impacts of the devastating Hurricanes Irma and Maria (2017), Hurricane Dorian (2019) and Hurricanes Eta and Iota (2020). In the case of the small islands and territories, 100% of the population was impacted.



**Figure 2.** (a) Impact of Hurricane Maria (2017) along the coast of Mayagüez, Puerto Rico (Christa von Hillebrandt-Andrade). (b) Sargassum in Skeetes Bay, Barbados (courtesy of the Blue Green Initiative), (c) Remains of the hull of El Faro lying on seabed 15,400 feet below surface of Atlantic Ocean, (d) 2010 Earthquake and tsunami damage near Petit Paradis, Haiti (Hermann M. Fritz, Georgia Institute of Technology, NOAA/NCEI), (e) 2019 oil spill cleanup in Búzios beach in Rio Grande do Norte State, Brazil (courtesy of Bruno Campos/JC Images/Estadão Journal).

Submarine and coastal earthquakes and their associated hazards, also put in jeopardy the sustainability of the coastal and maritime ecosystems. In the past 20 years, the greatest cause of deaths in the region was the 2010 Haiti earthquake in which claimed the lives of 222,570 people. In fact, the Haiti earthquake alone accounts for 98 percent of deaths, 89 percent of injuries, 27 percent of people affected and 15 percent of total damage from disaster in the entire Caribbean and Latin America region between 2000 and 2019 (OCHA, 2020). Earthquakes can also generate tsunamis. While there have been several small tsunamis, the most recent destructive tsunami in the WTA occurred in 1946 in the Dominican Republic with 1790 reported deaths (National Geophysical Data Center / World Data Service, 2021). Considering the explosive population and infrastructure growth and influx of tourists to the coastal areas, the exposure to tsunamis remains high, especially in the Caribbean where more than 70 percent of the population reside in coastal areas (von Hillebrandt-Andrade, 2013; OCHA, 2020).

Biological and anthropogenic threats, like Sargassum, oil spills and shark attacks, also can have significant impact. Since 2011, waves of Sargassum have washed up on shores of the Caribbean impacting tourism and fisheries as well as the quality of life for beachgoers. Governments like Barbados have declared national emergencies (Langin, 2018). Life at sea and along coastlines have also been affected by human induced disasters like oil spills. The explosion on the BP-operated Deepwater Horizon oil rig in the Gulf of Mexico in 2010 and its catastrophic and cascading impacts do not stand alone in the Western Tropical Atlantic. Spills from other wells, tankers and pipelines have become sites of recurring oil pollution (Jernelov, 2010). In Recife, Brazil, another threat, shark attacks, saw an abnormally high rate after the construction of the Suape port due to environmental impact from the construction but also in association with higher maritime traffic (Hazin et al, 2013).

COVID-19 has added an additional layer of risk, taking lives and causing significant economic disruption. Coastal and offshore earthquakes have caused devastation in the WTA and tsunamis and coastal and submarine volcanic eruptions further threaten lives and economies.

Essential maritime transportation is also subject to ocean hazards. Maritime safety has a direct bearing on human life, property and health of the marine environment. In October 2015 the container ship *El Faro* en route from Jacksonville, Florida to San Juan, Puerto Rico sailed into the path of Hurricane Joaquin. All 33 crewmembers died and all the cargo was lost (NTSB, 2016). The impacts can also be to ports and facilities and extend to the tourism industry, especially in a region dependent on cruise ships.

Some hazards are exacerbated by climate change. Since 1900, seas have risen 20 cm according to an analysis of sea level station data and satellite records (Dangendorf 2019). Global mean sea level could rise  $65 \pm 12$  cm by 2100 compared with 2005 (Nerema et al, 2018). Furthermore, Knutson et al (2020) project higher storm inundation levels, increase in hurricane intensity and a slowdown in translation speed. Droughts which are also expected to worsen with climate change already impact a high number of people in the region (OCHA, 2020).

The Western Tropical Atlantic Planning Workshop held in April 2020 set the stage for the region in terms of themes, strategies, challenges and partnerships. Other meetings and events have provided additional insight and facilitated identification of new stakeholders. In the process of communities becoming safer from the ocean, the ocean also must be kept safe from human impact.

## SAFE OCEAN THEMES

Ten key themes for a safe ocean emerged at the Regional Planning workshop (von Hillebrandt et al, 2020).

1. URGENCY - the increasing frequency and cascading events associated with ocean related hazards have escalated and require action for the protection of life and livelihoods.

2. OCEAN SAFETY: A CROSS-CUTTING DIMENSION OF UN SUSTAINABLE DEVELOPMENT GOALS - in addition to SDG-14, life under the Ocean, many other SDG's are supported and need to be addressed and considered within a safe ocean strategy: Poverty, Zero Hunger, Health and Wellbeing, Education, Gender Equality, Sustainable Cities and Communities, Decent Work and Economic Growth, Reduced Inequalities, Climate Action, Life on Land, Peace and Partnerships.

3. OCEAN SAFETY & PROTECTION - protection must be expanded to embrace an ecosystem approach rather than just human communities.

4. ACTION TOWARDS OCEAN SAFETY- UN Decade vision "The Science we Need for the Ocean we Want" requires concrete actions.

5. THREATS TO OCEAN SAFETY WITHIN A MULTI-HAZARD FRAMEWORK - ocean hazards such as coastal flooding (storm surges, sea level rise, tsunamis, coastal erosion, saltwater intrusion), drought, sargassum spread, coupled with prevailing preparedness inertia and human actions e.g. climate change, oil spills, land to reef pollutions, poor land use management continue to represent significant threats to ocean safety. The participants agreed that these threats could best be addressed in a regional multi-hazard framework that serves all communities at risk.

6. RELEVANT AND ACCESSIBLE DATA & INFORMATION - while it was appreciated that there is a need for additional observational, bathymetric and other data for informed decision-making, the participants concurred strongly that most importantly, information and products generated must be accessible and relevant for policy and decision-making.

7. REGIONAL DIVERSITY & OCEAN SAFETY - the region contains a spectrum of Small Island Developing States and Developing and Developed Countries comprising UN Member States and Overseas Territories and States which present specific challenges regarding the use and management of the ocean, and ultimately the attainment of a safe ocean. Small Island Developing States account for 52% of the countries of the Western Tropical Atlantic. Haiti is also on the UN list of Least Developed Countries

8. COVID-19 & OCEAN SAFETY - COVID19 impact and response has the potential to adversely affect ocean safety through the restrictions on servicing and management of ocean and hazard monitoring instrumentation and meetings along with reduced Member State capacity to respond to coastal threats as well as a reduction in availability of funding for non-COVID-19 activities, giving rise to the adoption of deeper harmonization of programmes with multi-hazard potential.

9. PARTNERSHIPS & RESOURCES - there are many UN, international, regional and national organizations and initiatives that have been advancing resilience in

the region. These need to be complemented by new governmental, nongovernmental and private partnerships resources.

10. CAPACITY DEVELOPMENT - a priority to stop the cycle of Disasters that needs to be addressed at the regional, national and local level. Ocean Literacy and online and in person training can help bridge the gaps.

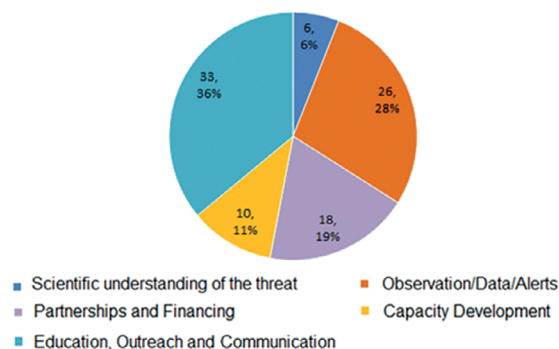
## REGIONAL PRIORITIES

Safe Ocean Regional Priorities in the Western Tropical Atlantic were also discussed in the April 2020 workshop. A poll was conducted (Fig. 2) among all participants to identify the highest priority for a Safe Ocean by 2030. Education, Outreach and Communications was identified as the highest priority (36%), followed by Observation, Data and Alerts (28%) and Partnerships and financing (18%), with fewer persons identifying Capacity Development and scientific understanding of the threat (Figure 3).

In addition to these priorities, the participants and panelists also highlighted geopolitical and health considerations.

The COVID 19 pandemic brought to light the need to give a higher priority to the interrelationship between public health and coastal hazards for the development of hazard assessments. Dr. Garmalia Mentor, a Medical Doctor working in Disaster Risk Reduction in Haiti, recalled in her intervention at the WTA Regional Workshop (IIOCARIBE, 2020) that even before disasters hit, countries around the world and especially in the Caribbean are not able to provide quality emergency services. She recommended that

### Highest Regional Priority for a Safe Ocean by 2030



**Figure 3.** Regional priorities for a Safe Ocean per survey conducted in the 2020 Western Tropical Atlantic Regional Workshop. 117 people participated in the survey.

lessons learned from COVID 19 should be considered and integrated.

### SAFE OCEAN CHALLENGES

The region's ocean economy is not well measured or understood. According to Patil et al (2016) the World Bank estimated the annual economic value of the ocean economy in the Caribbean was on the order of US\$407 billion in 2012. This consists almost entirely of market-based activities, since the non-market values of many ecosystem services are not easily valued monetarily. Furthermore, Patil et al (2016), indicated that the value of the ocean is dominated by the volume of cargo shipped through the Caribbean Sea (76%), together with tourism (11.5%) and oil and gas (10%). In the case of tourism, the Caribbean is the most dependent region in the world. In terms of total value-added contribution to GDP it was 19% in 2006-2011, which is almost three times the world average. In many countries like Bahamas, Barbados, Jamaica and most of the Eastern Caribbean States tourism has been the dominant industry and source of income (Thomas, 2015). A Safe Ocean is a key factor for the stability and growth of tourism as well as shipping and oil and gas.

During the Western Tropical Atlantic planning workshop an Integrated Multi Hazard Ocean Data and Forecast System surfaced as the ultimate grand challenge. Ocean science would be required at many levels to deliver on this action. For weather and climate change, the better understanding of the ocean-climate nexus is needed to improve short term to longer-term forecasts. Equally, a greater understanding is required of the geophysical, ecological and biological threats within the Western Tropical Atlantic. Knowledge and solutions are required to mitigate, adapt and build resilience to the effects of the broad spectrum of hazards. A sustainable ocean observation system that delivers accessible, timely, and actionable data and information to all users is a core requirement. A comprehensive digital representation of the ocean, including a dynamic ocean map, with high-resolution coastal topography and bathymetry which is free and accessible is needed for exploring, modeling and visualizing past, current, and future ocean conditions in a manner relevant to diverse stakeholders. It is also essential that there is an appreciation of the multiple values and services of the

ocean for human wellbeing, culture, and sustainable development. Barriers to behavior change need to be identified and overcome.

In the Western Tropical Atlantic, there are a number of Early Warning and coordination efforts addressing ocean and coastal hazards. These include, but are not limited to: National Meteorological and Hydrological Services, National Hurricane Center and its Hurricane Specialist and Storm Surge Units, World Meteorological Organization Regional Association IV Hurricane Committee, the UNESCO/IOC Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (CARIBE EWS), Caribbean IOCARIBE Global Ocean Observing System, Marine Biodiversity Observation Network, GEO Blue Planet, IOCARIBE and partners oil spill information system and sargassum information hub and the Caribbean Community Centre for Climate Change. The challenge is to see how these efforts can be integrated, enhanced and further developed to better serve the corresponding authorities, communities and stakeholders.

### CO-DESIGNING A SAFE OCEAN

A fundamental concept of the Decade is the Co-Design process. To address this concept, two global and a Western Tropical Atlantic and Eastern Tropical Pacific virtual events were held, in addition to other regional meetings. They explored opportunities and challenges and discussed best practices to deliver co-designed, solution-oriented research that will lead to transformative Decade Actions with long-lasting benefits to the ocean and society.

Examples of successfully co-designed and co-delivered processes included the UNESCO/IOC Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions, GEO Blue Planet, IOCARIBE and partners oil spill information system and sargassum information hub and Caribbean Community Center for Climate Change (CCCCC) mitigation and adaptation projects. Furthermore, consideration of the existing gaps between science and policy, the need for capacity development at many levels, the empowerment of ocean communities at sea and along the coast, trust and targeted education and outreach and communications for the public that is more solution and action based.

It has also been recognized that citizen science in particular has great potential to gather long-term local data to inform decisions. Multi-stakeholder collaborations need to be iterative and approached with an open mind to accept and understand different priorities and perspectives.

The following important next steps in co-design have been identified:

1. Identification of key national and regional stakeholders and partners to support delivery of objectives, with a special focus on private sector, women, youth, elders and indigenous and local communities;
2. Identification of the varied pathways for engagement with those stakeholders;
3. Assessment and selection of the communications processes and systems to be utilized throughout the decade; and
4. Build on existing networks of actors, as well as existing public policies, ensuring the delivery of science to support those policies.
5. Aid and Development agencies have for decades been a key partner in disaster risk reduction and comprehensive disaster management and need to be engaged in the early stage of co-design.

## **DATA AND INFORMATION**

The WTA Regional workshop and United Nations Office for Disaster Risk Reduction (UNDRR, 2021) recognized the need for relevant data and information. Although there have been significant improvements in the quality of data and information on risk and disasters over the last three decades, there remain gaps. Continued investment in information quality and standardization, sustainability, and its application from warning through land use planning are required.

Cost effective technological advances such as working with telecommunication companies to instrument new submarine cables with temperature, bottom pressure and seismic accelerometers, deploying inexpensive water level sensors along coastlines to validate flooding. Expensive technology (radar or ocean observing systems for short through long term sea level changes or e-DNA sampling devices to identify toxic algae species) is likewise required along with more advanced computer power and machine learning to achieve better forecasting and effective hazard warnings.

Development of a network for the exchange of knowledge and analyzed data and action strategies among coastal populations and the maritime sector within the region are needed to strengthen policy and decision-making at all levels and build appropriate infrastructure. Development of standards and best practices for a comprehensive and integrated data collection and information system, which is sustainable and accessible to all and can be used by policy makers and scientists for national and regional ocean observations, forecasting and alerting.

An approach which addresses education, outreach and communications as well as data and alert services, needs to take cognizance of the varied geo-political and economic situations of the region and the concomitant diversity in priorities at the local, country and sub-regional levels. Consideration needs to be given to those peculiar to Small Island Developing States (SIDS) and least developed countries, as well as developed countries.

The incorporation of citizen or participatory science programmes which contribute to sustainable data collection was one of the recommendations of the WTA April 2020 workshop. It was suggested that citizen science could also help raise awareness and trust in science while collecting critical small-scale data. Hicks et al (2019) in their global mapping of citizen science used for disaster risk reduction highlighted programmes in Latin America and the Caribbean from the US thru Brazil, including Haiti, Montserrat and Grenada. Projects in the region included volcano, earthquake, landslides and weather climate events and spanned the spectrum of monitoring and warning, collection of disaster data and film making. Through the participatory programmes, awareness y raised and the science is enriched. As concluded by Hicks et al, the participation of “non specialists” is playing an increasing role and could be particularly helpful in low and middle income countries, including SIDS.

## **CAPACITY DEVELOPMENT, TECHNOLOGY TRANSFER AND OCEAN LITERACY**

A 2020 report of the Inter-American Development Bank highlights the high vulnerability of Caribbean countries to external threats, including small populations, limited economies of scale, and undiversified economies with COVID-19 pandemic exacerbating



the consequences and countries' disaster preparedness and recovery efforts. It also highlights that disaster impacts are even more devastating for vulnerable populations and disadvantaged groups that comprise women, the poor, the elderly, youth, people with disabilities, and various minority groups.

A comprehensive capacity development and equitable access to data, information, knowledge and technology across all aspects of ocean science and for all stakeholders is needed. There is an identified need for an integrated approach of science, including citizen science, and local and traditional knowledge to encourage policy development and promote technology uses and transfer required for the sustainable management of the resources and ready and resilient a resilient ocean community. The cognizance of the varied geo-political and economic situations of the region and the concomitant diversity in priorities at the local, country and sub-regional levels including those peculiar to both developed countries, least developed countries and SIDS will be key to leave no one, no country behind. Capacity Development initiatives will consider existing best practices including recognition programmes which benchmark resilience levels and appropriate learning systems. Figure 4 was developed by the authors based on the

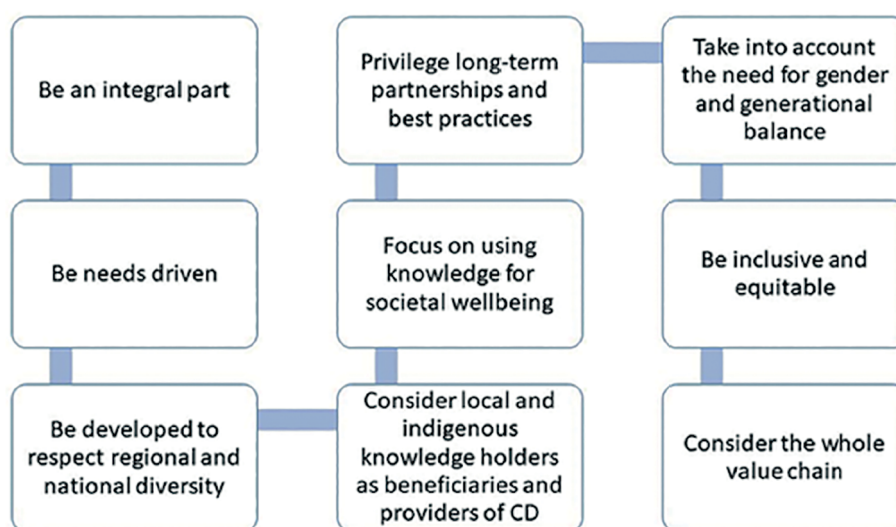
highlights the principles for Capacity Development for the Ocean Decade in the WTA and the Ocean Decade Implementation Plan.

The region requires expanded ocean observation technology and capacity building in order to achieve evenly distributed capacities and actions that focus on mechanisms that accelerate the use of knowledge for societal wellbeing. New knowledge and tools for coastal and maritime settings could increase the adaptive capacity of the most vulnerable people in the region (e.g. local and indigenous communities) and to achieve greater predictive capability to reduce risks.

The UN Ocean Decade should aim at increasing the understanding of the societal relevance of the science, and to use the science to make more informed decisions for sustainable development. Therefore, the targets need to include not only the scientific community but the end-users of knowledge such as governments and policy-makers in the region.

The transformation rate in regional capacity development throughout the Decade will be measured by the achievement of the expected outcomes. These include human resources being developed to accelerate regional transformation for a safe ocean in the WTA by improving work opportunities and equity for

## Capacity Development Principles



**Figure 4.** Capacity Development Principles for Ocean Decade in the Western Tropical Atlantic to achieve a Safe Ocean and other outcomes. Based on feedback from the WTA workshop of 2020 and the Ocean Decade Implementation Plan.

young scientists and technicians through continuous professional training. Access to research, instruments and early warning system infrastructure to reach visible and early awareness through better informed citizens is also important. Capacity development should facilitate the update of policies to achieve the sustainable development goals in benefit of people and the ocean ecosystem.

Capacity development and knowledge transfer in the WTA region can improve science-informed decision-making related to community planning, preparedness, response, and mitigation/risk reduction. SIDS have specific needs that include technology transfer and training for alert systems. The implementation of actions needs to be at the institutional and the individual levels. The WTA region also has a limited capacity for disaster mitigation and recovery infrastructure due to the high cost of the instruments and network coordination. To achieve infrastructure, adapting and strengthening the response to sea level rise, monitoring and emergency warning system needs, capacity development, technology transfer and ocean literacy/education are required. Developing and implementing guidelines for assessing ocean risk for coastal communities, for ecosystem-based disaster risk reduction and for building resilient infrastructure, is a starting point.

Capacity development also needs to address communications. In the Regional Planning Workshop the gaps in communication between science and policy and decision makers was noted. Sharlene Dabreo emphasized the need for translating scientific knowledge making it more accessible and relevant to policy makers and the general public. Ada Monzón, a broadcast meteorologist and CEO of Exploratorio Inc. in Puerto Rico, noted the effectiveness of statements and stories and the need to communicate science strategically and connect and collaborate with people from other disciplines. She emphasized the importance of people understanding their local vulnerability, before catastrophic events happen. If not, the experience of a disaster will continue to be the major driver of education.

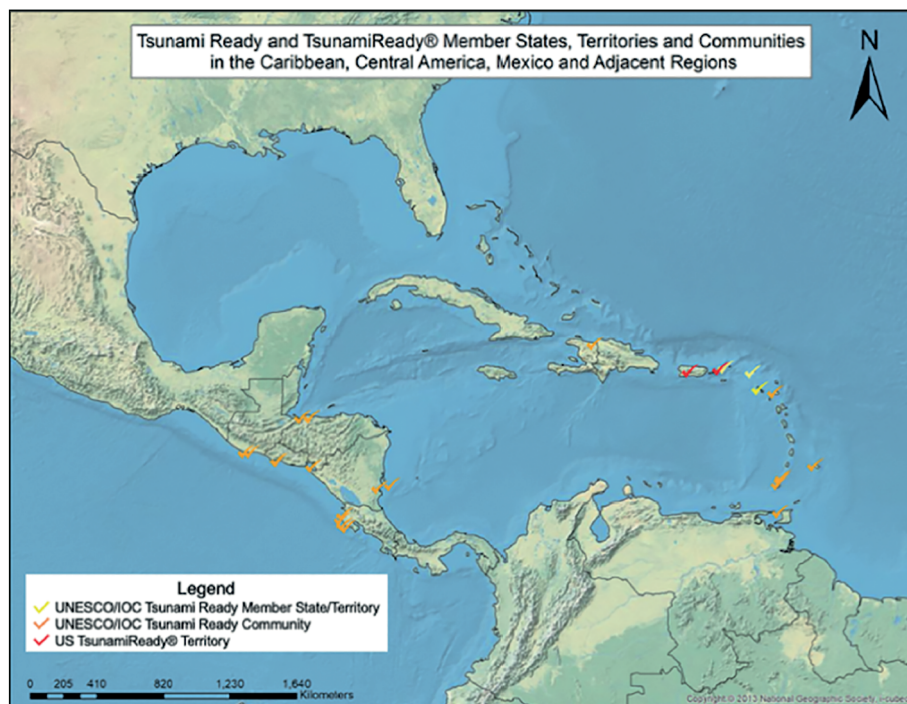
One of the major challenges for coastal communities will be coastal flooding, whether in fast onset events like storm surges and tsunamis or long term sea level rise. Digital Elevation Models are essential for research, modeling, planning, early warning

and visualizing coastal flooding, while observational systems are required to monitor and alert on the changes. Over the years many bathymetry and coastal topography campaigns have been conducted and observational systems have been installed. Nevertheless there are still significant data gaps, as well as challenges with the access and uptake of the data, as well sustainability of the observational systems. A capacity development strategy that addresses these issues will be key for a safe ocean outcome.

Capacity Developing needs to privilege long-term partnerships and best practices. UNESCO/IOCs Tsunami Ready and OTGA are successful examples of two long standing programs which use different strategies to develop capacity in the WTA. During the Decade the strengthening and expansion of these programs is proposed.

The UNESCO/IOC Tsunami Ready ([tsunamiready.org](https://tsunamiready.org)) is modelled after the US TsunamiReady® and StormReady® programs and provides globally agreed mitigation, preparedness and response indicators that communities need to meet and receive recognition (<https://tsunamiready.org>). To date over 60 communities in the WTA have been recognized by the US or UNESCO (Figure 5). These communities have also demonstrated that it has helped in the response to other coastal hazards, like hurricanes (Chacon, 2021). The TOWS, UNESCO IOC's Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems in its XIV Session set the aim of making 100% of communities at risk of tsunami prepared for and resilient to tsunamis by 2030 through the implementation of the UNESCO/IOC Tsunami Ready Programme and other initiatives. This program can also serve as a model or even be expanded to consider other hazards and be part of efforts like Weather Ready Nations (<https://public.wmo.int/en/resources/bulletin/impact-based-forecasting-and-warning-weather-ready-nations>).

Capt. (Retired) Frederico Antonio Saraiva Nogueira, Directorate of Hydrography and Navigation Brazil and UNESCO IOC Vice Chair for Group III and Paula Sierra recalled the important role of the Ocean Teachers Global Academy (<https://classroom.oceanteacher.org/>) at the Regional Workshop and WTA Co-Design event. This UNESCO/IOC program has developed a learning management system which combines online and face-to-face training. It has trained



**Figure 5.** Tsunami Ready and TsunamiReady Member States, Territories and Communities in the Caribbean, Central America, Mexico and Adjacent Region as of October 2021 (<https://tsunamiready.org>).

2,000 students in 120 countries. Colombia and Brazil each host an OTGA training center. In the case of the center in Colombia, Sierra highlighted that most of the courses are developed for professionals and technicians working on marine and coastal issues at different type of institutions and take into consideration the training needs of the participants and the the benefits for their institution and countries. A second phase of development, the OTGA2 began in 2020 with an expanded network of regional and specialized training centers.

#### **PARTNERSHIPS AND ENGAGEMENT AND FUNDING**

The need for strategic partnerships and engagement of the whole safe ocean spectrum will be required to reach the Safe Ocean outcome within the region. In addition to International, Regional, National and Local government efforts there are also the regional Academic Institutions, Technology Networks, NGO and Industry partners.

The UNDRR Sendai Platform and the Samoa Pathway have identified many issues and are working towards actions that also include safer coastal and maritime communities. In addition to these, other UN Agencies including but not limited to

UNESCO, the UN Environment Programme, the World Meteorological Organization, the International Hydrographic Organization, the International Maritime Organization, the United Nations Conference on Trade and Development (UNCTAD) have expertise relevant to the Safe Ocean outcome.

In addition, the region has several regional emergency management organizations, Caribbean Disaster Emergency Management Agency (CDEMA) for mostly the English speaking Caribbean, Centro Regional para la Prevención de los Desastres en América Central (CEPRENAC) for Central America and EMIZA for the French territories. Joining efforts with the Network for Indigenous Knowledge and Disaster Risk Reduction and Latin American and Caribbean Network for Disability Inclusive Disaster Risk Management (LAC DiDRR Network) can be key for including sectors that have traditionally been left behind, despite their high vulnerability.

Of particular importance is the engagement of SIDS. Fifty two percent of the countries in the Western Tropical Atlantic are SIDS (UNESCO, 2021). Between 1995 and 2015, 80% of events took place in small and intermediate-sized urban areas (UNDRR, 2020). While SIDS have a unique relationship with

the Ocean, an inadequate capacity has limited their participation in ocean science. In December 2020 the Intergovernmental Oceanographic Commission (IOC) and the Natural Sciences Sector of UNESCO, in partnership with United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLS), convened the virtual session “Fostering innovative ocean science partnerships for Small Island Developing States in the Ocean Decade”. It focused on the importance of transformative partnership-based approaches that are genuine, long lasting, and meaningful. This session explored the transformative partnerships within and between SIDS required to foster knowledge generation, solution-oriented and transdisciplinary research, and to support innovation.

Strategic partnerships will also be required for the resources and funding to achieve the Safe Ocean outcome. While traditionally Aid and Development agencies have supported many disaster risk reduction and disaster management and recovery efforts, other sectors will also need to be engaged. One of these is the private sector. According to UNDRR (2020) over twenty national private sector networks and two sub-regional networks in Central America and the Caribbean have joined Private Sector Alliance for Disaster Resilient Societies (ARISE) in Latin America. By joining the Alliance, the members voluntarily commit to aligning their activities with the Sendai Framework for Disaster Risk Reduction (2015-2030). A complement to these efforts would be the Safe Ocean outcome. Together with contributions from national governments, civil society and NGOs a sustainable source of funding and resources may be identified for the proposed Programmes, Projects and Activities.

In addition to external resources and funding, DaBreo (IOCARIBE, 2020) also emphasized that coastal communities will also need to use their own resources to be able to identify, mitigate, prepare and respond to the effects of these hazards. This bottom up approach will depend also on the success of the Education and Outreach efforts Capacity Development.

Linkages with the other Western Tropical Atlantic Working Groups will also be required. The synergies are needed given overlapping challenges, objectives

and actions. Collaboration between the working groups will also facilitate the participation of the stakeholders, especially in SIDS where it is often the responsibility of the same professionals and institutions. It is also important that the joint collaborative work between Working Groups will facilitate the implementation of actions at the local level and within corresponding sectors.

## MEMBERSHIP

The WTA SOWG has the charge to facilitate the Safe Ocean outcome for the region. Membership of the Safe Ocean Working Group is open to scientists and practitioners from the region. There are currently over 60 people who over the past two years have expressed an interest in joining the working group. The members were identified through the WTA events and by referral. Fifteen of the forty-four countries in the WTA are represented, with eight hailing from SIDS. The countries that have the biggest representation are Brazil and Colombia. Most of the members hail from national institutions, followed by Academia. There are also members from Regional and UN organizations, Industry and NGOs. Areas of expertise span the ocean physical, biological and social sciences. Nevertheless, a need for greater geographical distribution, especially from SIDS has already been identified. It is possible that the COVID-19 pandemic has limited their participation and integration to date. These and other gaps will need to be addressed for effective co designing of transformative solutions and actions.

## CONCLUSION

The UN Decade of Ocean Science for Sustainable Development was launched on January 1, 2021. Many years went into the planning and development of an Implementation Plan. In the Western Tropical Atlantic, the discussion and co-design process began in early 2020 with the later establishment of the Regional Planning Group and the thematic Working Groups. The Safe Ocean Working Group is in its initial stages considering the Ocean Decade implementation plan as well as the outcomes from several regional meetings. Over the course of 2021 it will focus on identifying and integrating thematic existing networks, organizations, experts and stakeholders and catalyzing communication on the UN Decade. It will be seeking

to design and propose transformative, empowering and inclusive regional Decade actions that addresses the issues of a safe ocean for the protection of life and livelihoods along the coast and at sea. The actions may be inclusive of the crosscutting issues identified in the Implementation Plan and in the WTA Regional Workshop as well as engaging other Working Groups and potential resources. While the urgency is real, it is appreciated that co-design takes time and this will all need to be accomplished in a post COVID-19 environment. Despite all its negative impacts, it has also brought opportunities to bridge the gaps between science and policymaking and facilitate actions that make society safer from the ocean, but also the ocean safer from society.

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## AUTHOR CONTRIBUTIONS

C.v.H.A.: Writing - original draft; Writing - review & editing;

A.B.M.: Writing - Writing - review & editing;

E.E.B.: Writing-review & editing.

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