Ocean Decade Tsunami Programme

A FRAMEWORK FOR INTERNATIONAL COOPERATION TO ENHANCE THE END-TO-END TSUNAMI EARLY WARNING AND MITIGATION SYSTEMS

Srinivasa Kumar TUMMALA

Chair

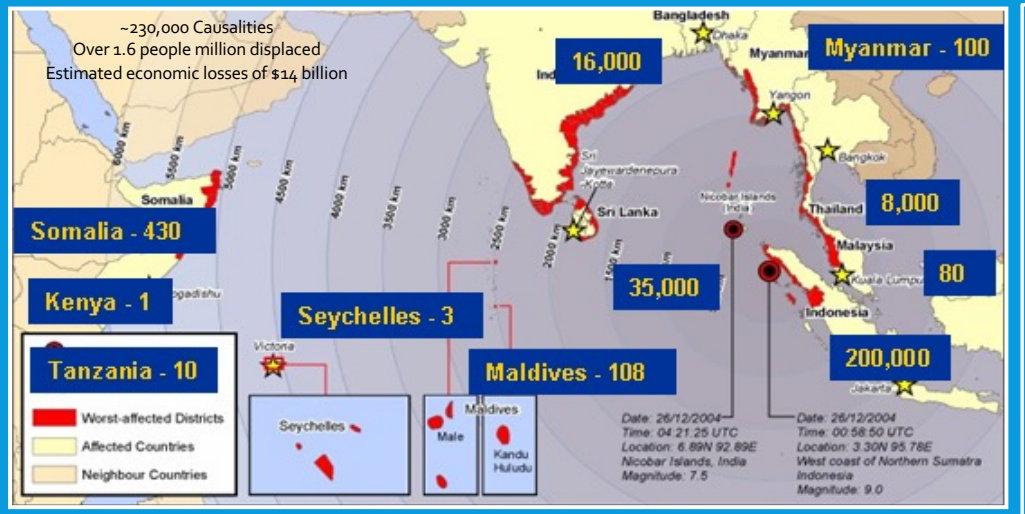
Ocean Decade Tsunami Programme Scientific Committee (ODTP-SC)

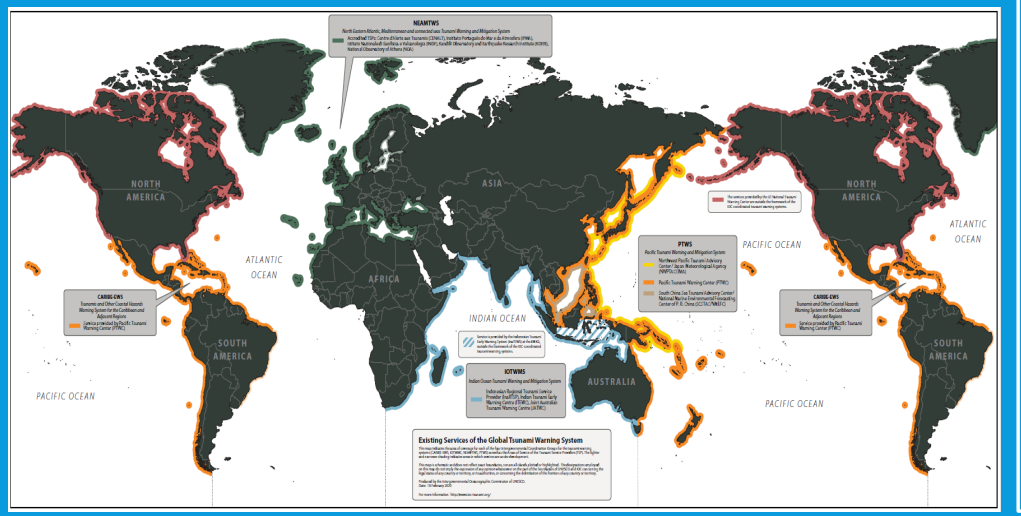
S.K. Tummala, A. Frolov, A. Rabinovich, A. Yahav, C. Von Hillebrandt-Andrade, D. Coetzee, F. Schindele, H.P. Rahayu, M. Angove, S. Barrientos, S. Chacon-Barrantes, Y. Hayashi, B. Aliaga Rossel, D. Chang Seng, R. Bailey

World Tsunami Awareness Day 2023 Webinar by ICG/IOTWMS & IOTIC

07 November 2023

Global Tsunami Warning Systems



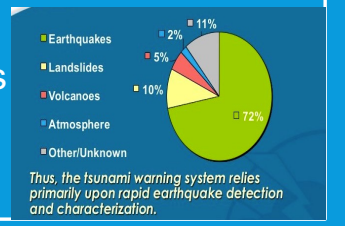


Great progress since 2004

- 4 Regional Systems coordinated by the IOC UNESCO - PTWS, IOTWMS, CARIBE EWS, NEAMTWS
- Operate as inter-operable “system-of-systems”
- Network of NTWC/TWFPs receiving tsunami forecast information from one/more TSPs
- Sovereign responsibility of NTWCs/TWFPs to provide warnings, watches, and advisories to their citizens
- Seismic & Sea Level Observing networks, models, computational, communication facilities, DSS and SOPs
- Tsunami Ready
- Successfully monitored and issued warnings for several events

Several challenges evidenced from recent events

- Tsunami warning is race against time - Uncertainties in tsunami warning
- Gaps in Warning and Response capabilities, specially for non-seismic and near-field sources
- Gaps in SOPs and Early Warning Chains
- Gaps in preparedness & response



Ocean Decade Tsunami Programme

- UN Ocean Decade (2021-30): Once-in-a-generation opportunity to achieve "transformational gains" in tsunami warning and mitigation system by addressing gaps in tsunami warning and enhancing community preparedness.
- IOC Assembly 31 in June 2021 (Dec. A-31/3.4.1) established the "Ocean Decade Tsunami Programme" and "Scientific Committee" to Develop Research, Development & Implementation Plan
  - Technological & Observational Advances to reduce uncertainties in tsunami warning
  - 100 % at risk communities prepared & resilient to tsunamis by 2030 (Tsunami Ready, etc.)
- Contributing to "A Safe, Predicted and Accessible Ocean" Decade Outcomes via Challenge 6 on "Multihazard Early Warning Services & Community resilience" and Challenge 9 on "Capacity Development" and aligns with all three Decade Objectives related to Identification, Gerneration and use of knowledge for Sustainable development. Directly supports SDG 11 by applying advancements to Ocean Science to saving lives and reducing number of affected people and economic losses in coastal cities and communities.

UN Ocean Decade Tsunami Programme Scientific Committee

Annex to Dec. A-31/3.4.1

Membership:

- Four (4) members nominated by the each of the TOWS-WG Task Teams;
- Three (3) members nominated by the TOWS-WG on the basis of their scientific expertise;

2022-2023

Srinivasa Kumar Tummala
Chairperson

Christa von Hillebrandt

Amir Yahav

Harkunti Pertiwi Rahayu

David Coetzee

Silvia Chacon

Srinivasa Kumar Tummala

François Schindele

Yutaka Hayashi

Michael Angove

Sergio Barrientos

Alexander Rabinovich

Annex to Dec. A-31/3.4.1 (cont.)

- All members will serve for a period of two years and would be eligible for renewal once.
- In selecting Expert Members, due consideration will be given to geographic, generational and gender balance.

UN Ocean Decade Tsunami Programme Scientific Committee

Terms of References (ToRs) (Rev IOC EC-55)

i. Develop a Draft 10-Year Research, Development and Implementation Plan for the Ocean Decade Tsunami Programme based on the concept paper *"Protecting Communities from the World's Most Dangerous Waves: A Framework for Action under the UN Decade of Ocean Science for Sustainable Development"*;

ii. Identify and address gaps in global tsunami hazard assessment as follows:

   a. comprehensive assessment to include all potential tsunamis, anywhere in the world, regardless of their source,

   b. strategies to validate historical tsunami sources, through the application of paleotsunami techniques and historical seismology;

iii. Identify gaps in tsunami detection, measurement, forecasting, with a special emphasis on tsunamis generated close to populated coastlines;

iv. Propose to enhance sensing and analysis strategies to enable the rapid characterization of tsunami sources through the combined use of land-based seismic and geodetic sensors, GNSS terminals, coastal sea level gauges, deep-ocean tsunameters, SMART repeaters on deep-ocean fiber-optic cables and satellite-based observations;

v. Propose a roadmap for collaboration with the ITU/WMO/IOC SMART Joint Task Force cable initiative to fully explore the feasibility of widespread deployment of scientific instrumentation on deep-ocean fiber-optic cables to improve capability to rapidly detect and characterize tsunami sources as well as propagating tsunami wave fields;

vi. Consider and propose strategies, programmes and content to enhance societal resilience for tsunami and other ocean hazards;

   a. Build the framework needed to ensure the training and development of the next generation of technical-scientific expertise,

   b. Identify strategies that allow to characterize structural and social vulnerability in tsunami hazard zones

   c. Propose strategies for promoting implementation of community preparedness initiatives such as IOC Tsunami Ready to ensure 100 % at risk communities are prepared & resilient to tsunamis by 2030

vii. Overview the consolidation of inputs received to IOC Circular Letter 2825 on Inventory of actions being considered under the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) in the field of Tsunamis and Other Sea-Level Related Hazards warning and mitigation;

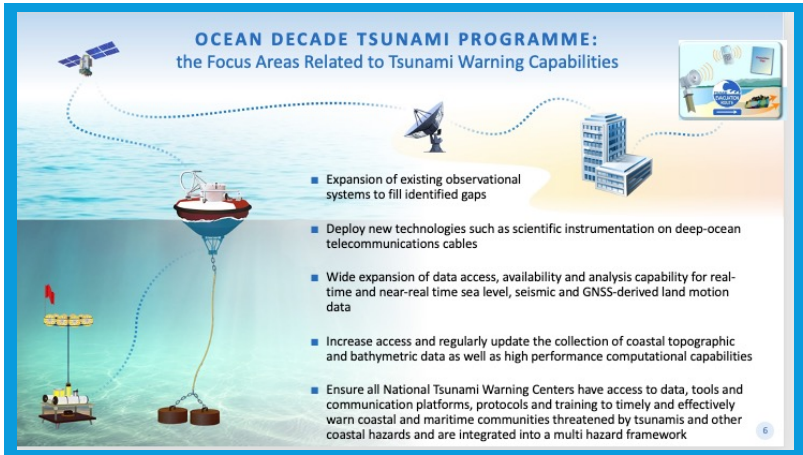
viii. Submit a Draft 10-Year Research, Development and Implementation Plan for endorsement by the TOWS-WG at its 16th meeting.

UN Ocean Decade Tsunami Programme Scientific Committee

Goal=Draft a 10-Year Research, Development and Implementation Plan for the Ocean Decade Tsunami Programme

Important Milestones in the Development of the Plan

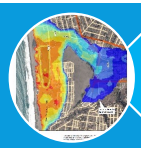
ODTP- Objectives



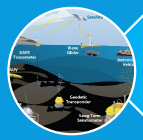
1. To develop the warning systems' capability to issue actionable and timely tsunami warnings for tsunamis from all identified sources to 100% of coasts at risk

2. 100% of communities at risk be prepared and resilient to tsunamis by 2030 through programmes like the IOC-UNESCO Tsunami Ready Recognition Programme (TRRP)

Key Elements of the Research, Development & Implementation Plan



1. Tsunami Risk Knowledge: Identify and prioritise at-risk communities



2. Tsunami Detection, Analysis and Forecasting: Expand existing, and deploy new observing technologies and warning systems

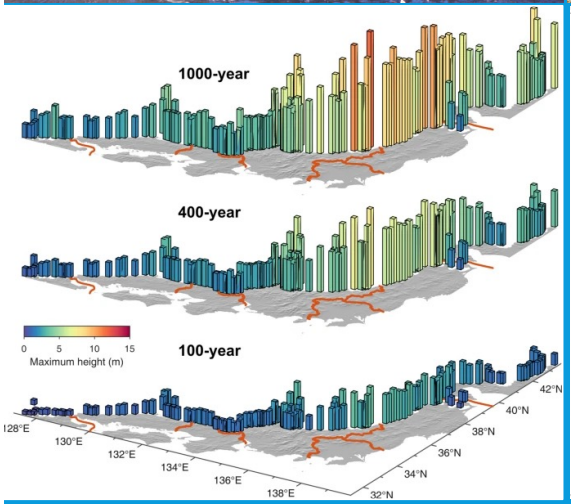
3. Warning, Dissemination and Communication: Access to data, tools, communication platforms, protocols and training to effectively warn coastal and maritime communities

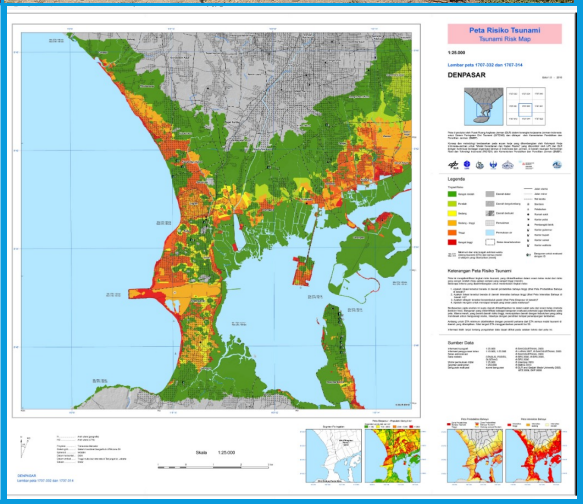
4. Preparedness and Response Capabilities: To build tsunami-resilient communities

5. Capacity Development, SIDS and LDCs, Multi-hazard Framework: Underpinning elements

6. Governance and Pathways to Implementation

Tsunami Risk Knowledge - Goals





Definition of inundation areas, flow depths and arrival times through Tsunami Hazard Assessments

- Catalogue of historical tsunami records
- Database of tsunami source scenarios
- Coastal digital elevation data
- Access to Tsunami numerical models
- At least one person able to do tsunami modelling
- Defined the inundation area for the chosen community

Definition of vulnerability and exposure

- Identified critical infrastructure at risk
- Identified vulnerable groups
- Identified number of population
- Identified economic assets
- Identified built & natural environment

Definition of methodology to calculate risk

Definition of capacity to respond

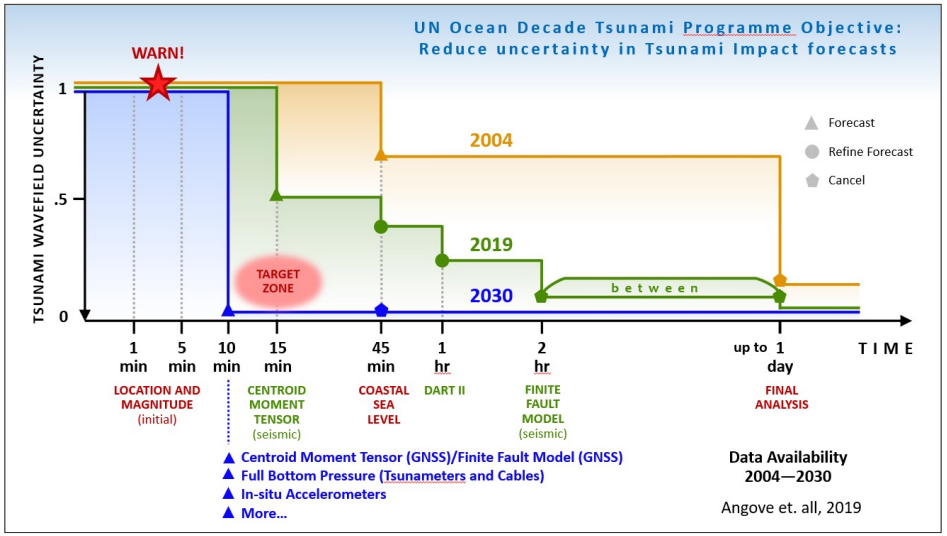
- Bridged the gaps on legal framework
- Bridged the gaps on institutional framework
- Bridged the gaps on EWS

Using results from Tsunami Risk Assessments

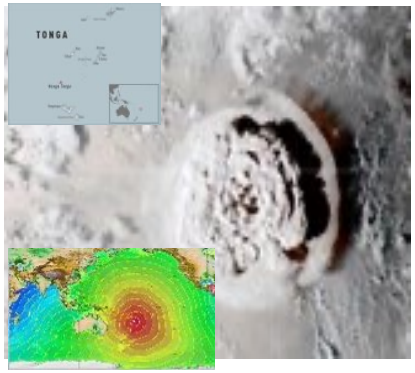
- Performed TRA studies
- Developed tsunami risk reduction tools

Tsunami Detection, Analysis And Forecasting - Goals

- Tsunami Threat Life Cycle : Initial indicators, confirmation, forecasting, validation and cancellation
- Throughout the threat life cycle it is possible to provide information on the potential threat
- Initial indicators based on seismic proxy provide necessary timelines but can be inaccurate
- Additional challenges with non-seismic and near-source tsunamis



Angove et. all, 2019



- Greatly expand international cooperation in tsunami warning and mitigation, to improve capability to directly detect and measure tsunamis and reduce reliance on seismic proxy relationships in terms of projecting impacts
- To develop the warning systems' capability to issue actionable and timely tsunami warnings for tsunamis from all identified sources to 100% of coasts at risk
- Most urgently, the ODTP will aim to provide tsunami confirmation within 10 minutes or less of origin for the most at-risk coastlines

Tsunami Detection, Analysis And Forecasting

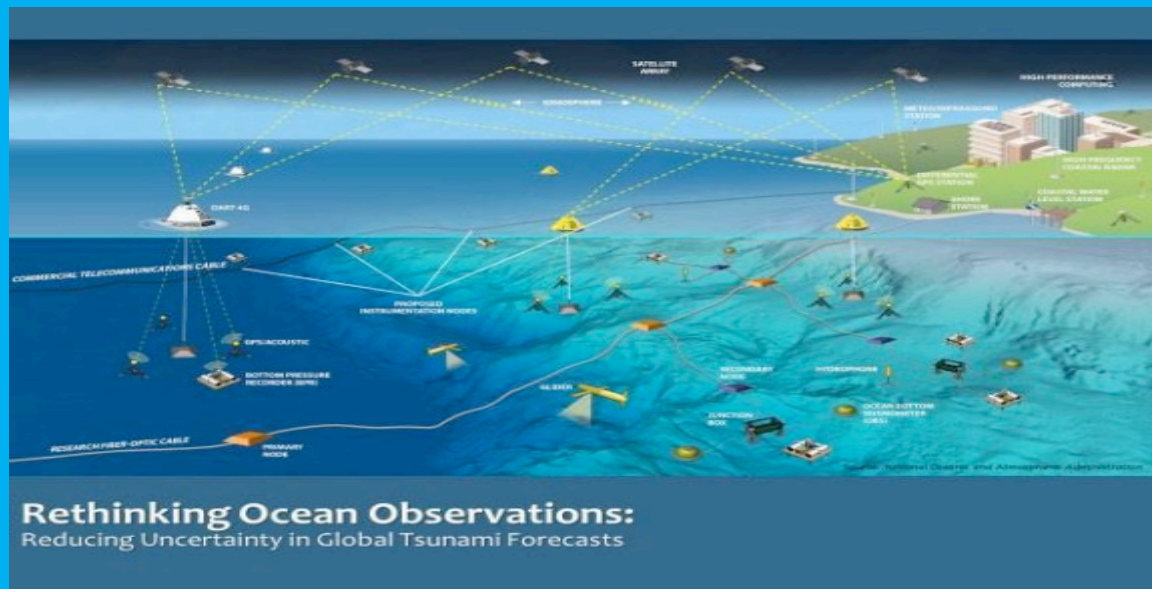
Detection and Measurement

- **Maximize and expand current capabilities**
  - Seismic networks, Tsunameters, Coastal sea level gauges, GNSS, Dedicated observatories
  - Supporting capabilities - Coastal bathymetry, Sensor siting analysis, Global digital synthetic database, Model codes, Potential tsunami sources including non-seismic, Science to practice, Training on tsunami warning operations
- **Implementation of existing capabilities not being applied to tsunami operations**
  - Coastal RADARs
  - Passive/Active Remote Sensing
  - Infrasound
- **Identification of new candidate capabilities**
  - Ionospheric tomography – TEC
  - Fibre Optic Applications – Distributed acoustic sensing

Characterization and Forecasting

- **Research on nature of tsunamis, source mechanisms and characterisation**
- **Probabilistic Tsunami Forecasting Techniques**
- **New Forecast methods**
  - Database Applications and matching Schema for updated Global Threat Database including non-seismic sources
  - AI – ML to relate, discrete or combine observations to potential outcomes
  - Dynamic Characterization using Rapid update cycle models

- **Optimal notional global network design in all ICGs**
  - Mix of observational platforms for tsunami operations in terms of locations, sensors, telemetry, data formats, etc
  - New Technologies for Communication, Sensors, Repeaters,
  - New use cases for Data (multi-hazard, climate, science)
  - Collaboration with Scientific Groups, International Organisations, Industry, etc. for expansion of networks, R&D of new systems, Operationalisation
- **Optimal observing network implementation in all ICGs**
- **Enhanced data sharing in all ICGs**
- **High-Resolution Coastal Bathymetry and Topography**
- **Advanced computing/modelling/impact forecasting/assimilation/analytics in all TSPs**
- **Access to data, tools and communication platforms in all TWCs**



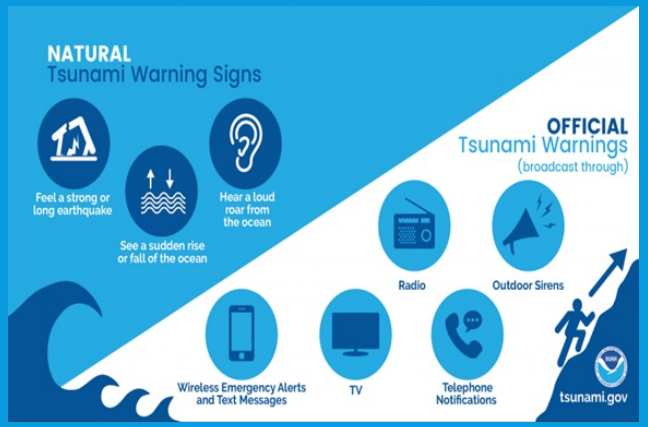
Tsunami Warning, Dissemination and Communication – Goals

The ODTP goal is that by 2030 there will be significant improvements in the national decision making to warn, and mechanisms in place for the effective and inclusive construction, dissemination and communication of warnings.

- 100% of the national authorities will be able to effectively warn communities and population at risk.
- Communities at risk will be able to use these advances to improve local tsunami preparedness and response capabilities and become Tsunami Ready

Key elements that need to be addressed

- Effective decision making to warn - National/local tsunami warning chains and standard operating procedures; Decision Support Tools (Co-design, Competency Development)
- Effective construction of warnings – Time constraints, Inclusive, Actionable content (Use of IT, understand target audience, impact-based warning content)
- Effective dissemination and communication of warnings – Institutional capacity, Communication mechanisms, Multi-Hazard Warning Systems, Multiple sources of information (Standards & Formats, CAP, Broadcast & Social Media)



Preparedness and Response Capabilities - Goals

Aspirational social outcome of the Ocean Decade Tsunami Programme is that 100% of communities at risk from tsunamis are prepared for and resilient to tsunamis by 2030 through efforts like the IOC-UNESCO Tsunami Ready Recognition Programme

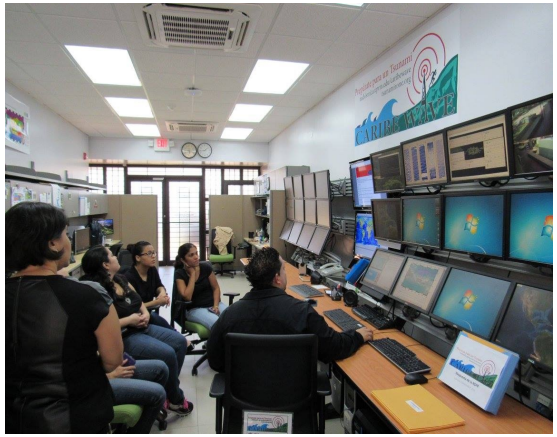
Key elements to be addressed

- **Risk Perception and Awareness** – Risk perception studies need to be encouraged across all regions
- **Preparedness**
  - All at-risk communities have tsunami hazard, inundation, evacuation maps, TEMPP trainings
  - Public display of tsunami information, Tsunami Signage
  - Locally relevant education and awareness resources, institutionalizing tsunami education
  - promote communities to actively participate in the World Tsunami Awareness Day
  - 100% of communities at risk conduct a local tsunami exercise every two years

- **Response Capability**
  - All countries with tsunami risk should have agreed parameters at the national and local level for warning and have approved response plans
  - 100% of at-risk communities have multiple effective and sustainable communication methods in place
  - Inclusive, inventory of resources, natural signs and self-evacuation, multihazard, capacity building
- **Mitigation**
  - Communities have access to an inventory of best practices of plans and structural and nature-based solutions
  - More communities have implemented plans and measures to minimize impacts to critical infrastructure and marine assets from tsunamis and other coastal hazards,
  - Mainstreaming disaster risk reduction into urban planning

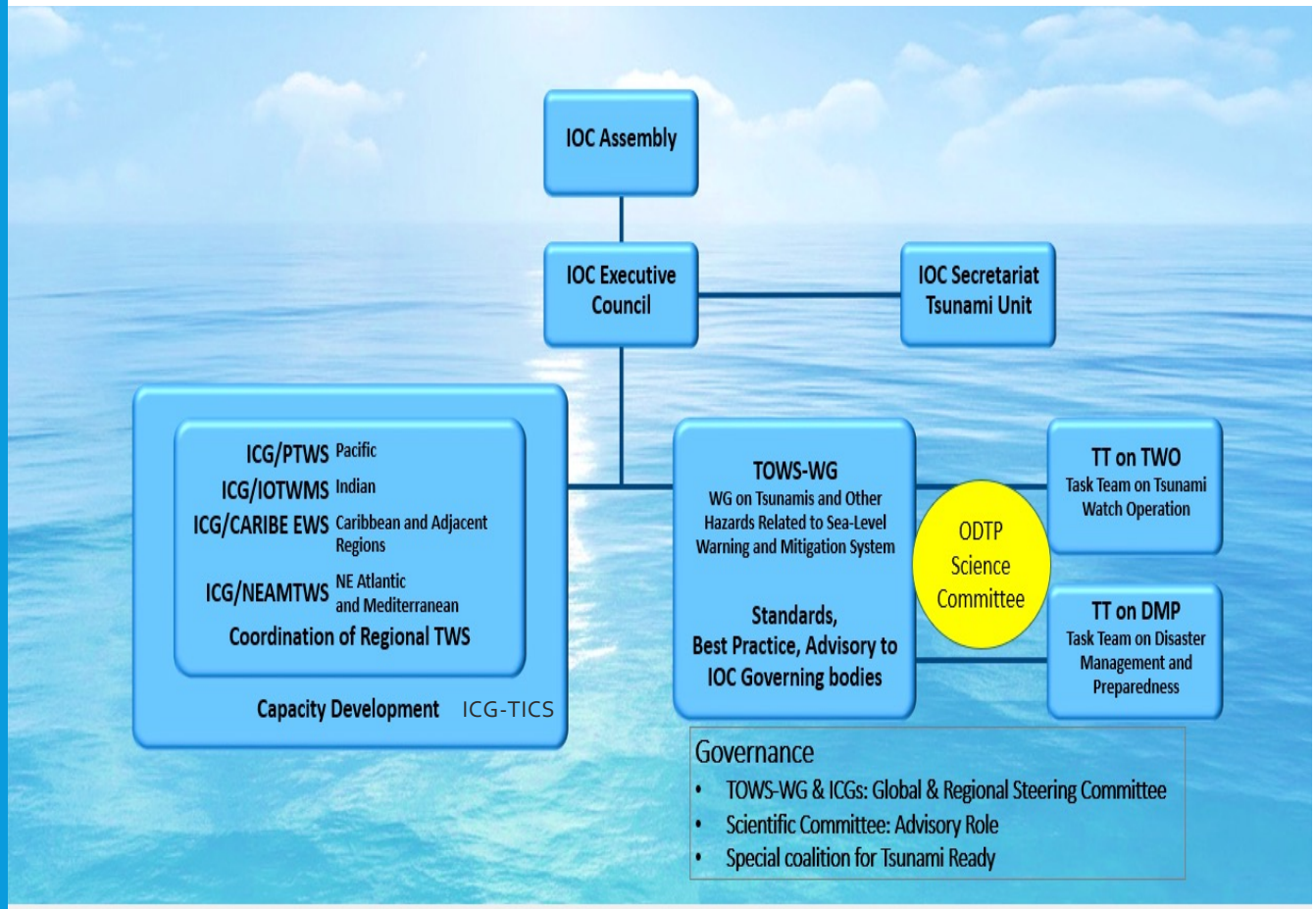
Capacity Development - Goals

- Ensure investment in capacity development for the different stakeholders including the generators and the users of the tsunami early warning system
  - National, regional and local level initiatives to reach the objective of 100% at-risk communities to be prepared and resilient to tsunami
  - Facilitate equitable access to data, information, knowledge, technology, and infrastructure, leaving no-one behind
  - ICG-TICs and OTGA – STCs as the means for the delivery of capacity development
  - Special consideration to be capacity requirements of SIDs and LDCs



- To explore opportunities and establish connections with Decade programmes, projects, contributions, DCCs and CoPs, Calls for Action
- To align with international frameworks, call for action and multi-lateral environmental agreements – SFDRR, SDGs (3, 8, 11, 14), Paris Agreement on climate change, early warnings for all, UN Global Early Warning Initiative (2023-2027) etc.
- To provide new cooperation opportunities by laying out the building blocks, through an international Science Committee and International Tsunami Ready Coalition while renewing and strengthen existing cooperation with partners
- To encourage and promote inclusiveness and gender diversity, and that youth and early career professionals engage and involve in tsunami early warning systems and actions
- To develop and operationalize a transparent performance monitoring system based on international norms, standards and agreements

Governance



The IOC-UNESCO tsunami programme will oversee the overall implementation of the ODTP through contributions and engagement of Member States, in coordination with the ICGs, and with the collaboration of academic institutions, researchers, industry, philanthropic organisations and other stakeholders

Pathways to Implementation

- The ODTP provides a framework for identifying gaps, suggesting solutions, prioritise resources, and implementing actions within the timeframe of the Ocean Decade
- This plan outlines the pathways for achieving overall objectives of ODTP including challenges, solutions, performance indicators, milestones and target dates for the four main components of the tsunami early warning system
- Considering the nature of tsunami hazard, the optimal solutions should have a global design, address regional imperatives, and be implemented through contributions and actions of Member States and other stakeholders
- Scientific objectives of the tsunami warning enhancements will be achieved by maximizing and expanding current capabilities, identifying capabilities that exist but are not currently applied to tsunami, and developing new capabilities through innovation and research
- Member States should endeavour to dovetail their national tsunami warning system plans/programmes with the ODTP objectives
- Member states, academic institutions and industries will seek, possibly through ICG consultation to identify candidate proposals aimed at addressing the solutions
- R&D community and Industry has the opportunity to develop and contribute to scientific understanding, technological solutions, product development and capacity building.
- The intent of the plan is to offer contribution pathways that cover the full spectrum or financial commitment by targeting the objectives most important to advancing Member State capabilities

THANK YOU