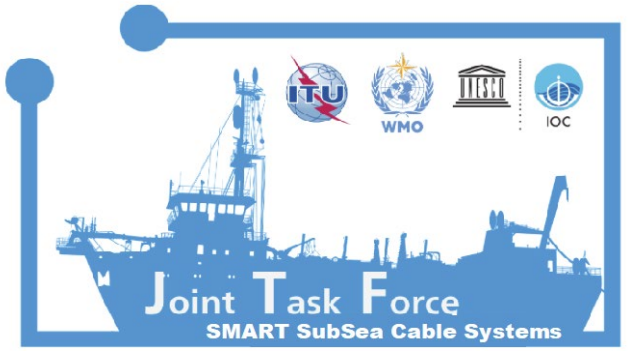
SMART Subsea Cables for Observing the Ocean and Earth:

Update for ICG/PTWS

SMART: Science Monitoring And Reliable Telecommunications



Bruce M. Howe

ITU/WMO/IOC Joint Task Force

University of Hawai'i at Mānoa

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

DEEP OCEAN OBSERVING STRATEGY

pogo Partnership for Observation of the Global Ocean

GORDON AND BETTY MOORE FOUNDATION

Twenty-Ninth Session of the Intergovernmental Coordination Group
for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS-XXIX)
1–2 & 7–8 December 2021

SMART, Tsunami, and IOC

PLAYERS

ITU WMO UNESCO-IOC Joint Task Force

UNESCO-IOC ICG/PTWS, ICG/NEAMTWS, ICG/IOTWMS, ICG/CARIBE-EWS

UNESCO-IOC Global Ocean Observing System (GOOS)

UN Decade for Ocean Science for Sustainable Development 2021-2030

IOC Dec A-31/3.4.1: Warning Mitigation Systems for Ocean Hazards (July 2021)

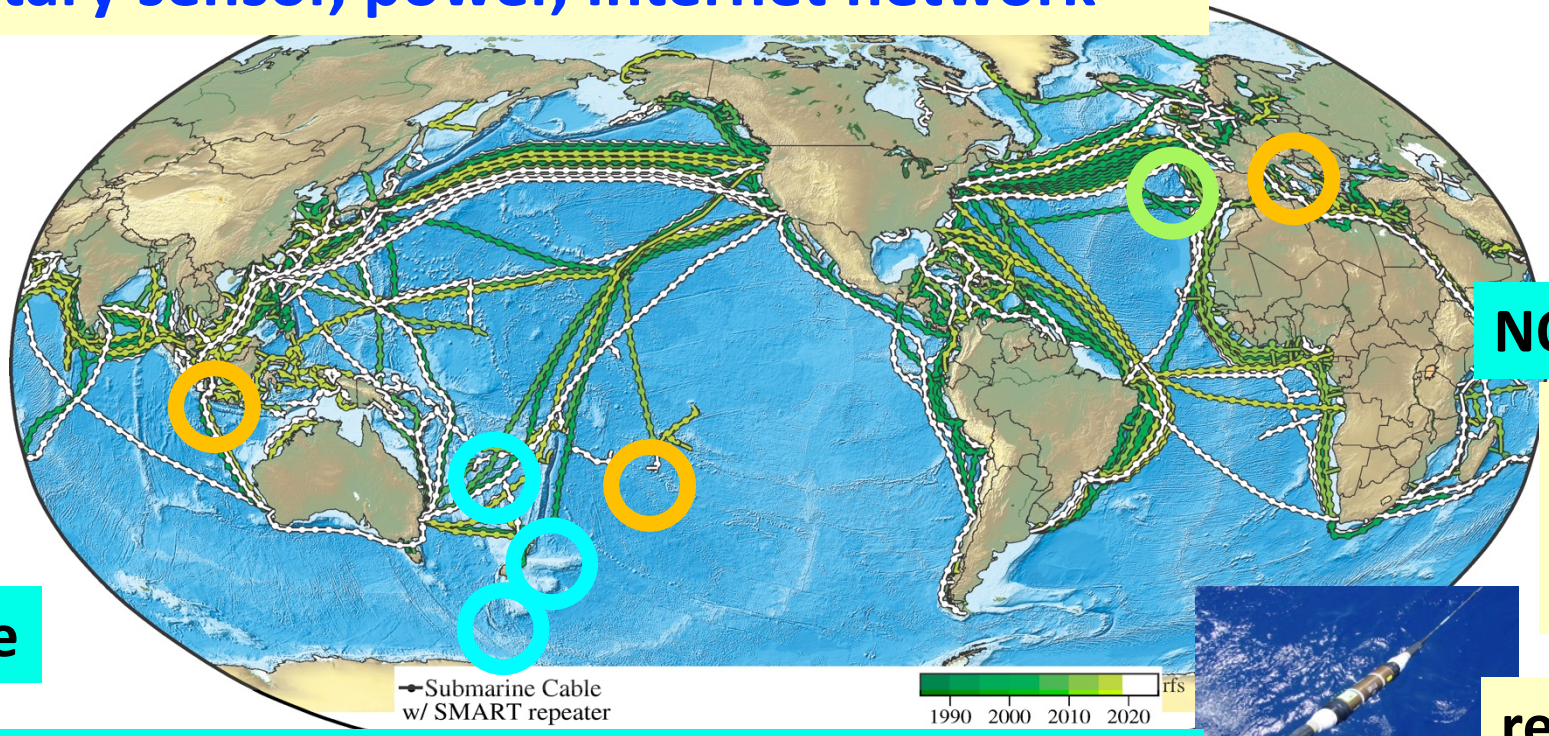
- Decides that the Draft 10-Year Research, Development and Implementation Plan for the UN Decade Tsunami Programme is dedicated to achieving transformational advances in tsunami detection, measurement and forecasting, including tsunamis generated by non-seismic sources. The programme includes the following focus areas related to tsunami warning capabilities:
- **deploy new technologies to address observational gaps** that cannot be covered by existing networks embracing. This would include the **widespread implementation of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables effort**; and submission of a Programme to the UN Decade of Ocean Science for Sustainable Development;

SMART Subsea Cables

Global Array: Climate, Oceans, Sea Level, Earthquakes, Tsunamis

Create a Planetary sensor, power, Internet network

1st order addition to Ocean-Earth observing system



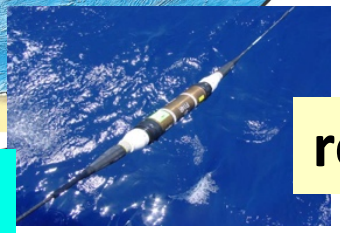
Share submarine cable infrastructure

Telecom + science

↓€$

NO Interference

1.2+ Gm
~20,000 repeaters
20 year refresh



repeaters ~70 km

UN Decade

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Know the environment – protect the network

CAM: 3700 km, Gov't, install 2025 ➜ SMART Continent/Lisbon-Azores-Madeira ring

Bottom temperature, pressure, seismic acceleration

WMO

ITU

Societal Benefits

Climate change – humanity's greatest existential threat

Societal and environmental issues

SMART: UN Decade of Ocean Science Project

Climate
SDG 13

– **Climate change** – ocean temperature, circulation
direct impact on societies, short and long term

Ocean
SDG 14

– **Sea level rise** – hazard for coasts, islands, cities

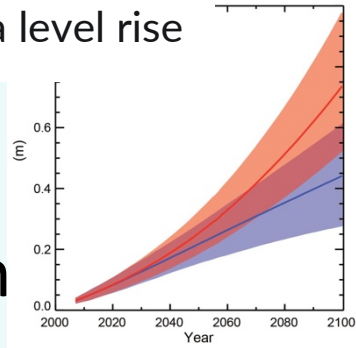
UN
DRR

– **Disaster Risk Reduction** – tsunami
and earthquake monitoring
throughout ocean basins and coastal margins

Infrastructure
SDG 9, 11

– **Societal Connectivity** – Enable progress with
resilient and sustainable telecom infrastructure

Sea level rise



Tsunami

UN Decade of Ocean Science for Sustainable Development 2021 - 2030

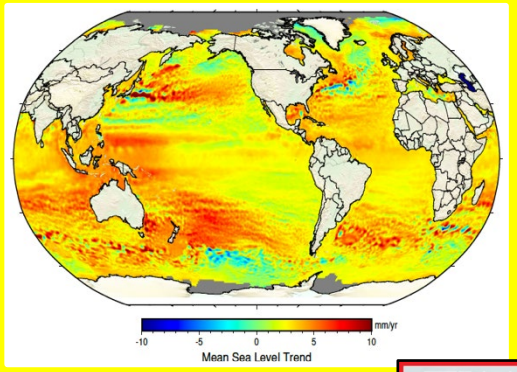
Challenge 5: Ocean-Climate nexus

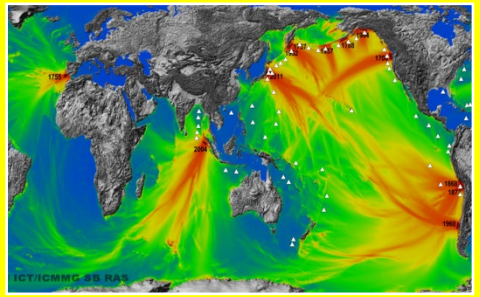
- Contribute to monitoring the atmosphere-ocean-climate-Earth system
- Ocean heat, circulation, time/space variability
- Secular changes of tidal coefficients

Lives and Infrastructure

Outcome 4: Predicted Ocean

Challenge 6: Early warning services





- Early warning earthquakes and tsunamis
- Mitigate coastal flooding, exacerbated by sea level rise.

Outcome 5: Safe Ocean

Challenge 7: Sustainable ocean observing system

- Absolutely!
- Potentially 1000s SMART repeaters
- Global, real time, long life, reliable, sustained, maintained, expandable

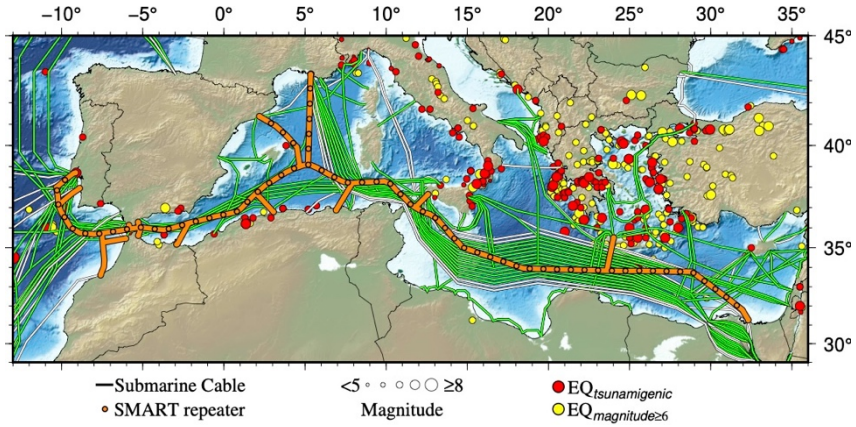
- QC'ed data to users
- Capacity building
- Programme office - all stakeholders

Outcome 6: Accessible Ocean

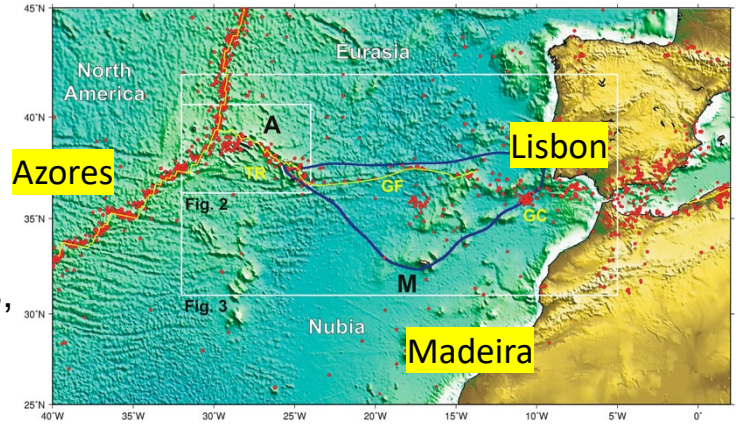
SMART Cables - Europe

NEAMTWS !

- **Wet Demo**, Install 2022
- Three test SMART repeaters (sans telecom)



- **CAM2**
- Domestic, international connections, Digital hub
- 1755 earthquake tsunami
- Seismic, tsunami, ocean, environment
- 3700 km, 50 SMART repeaters, €120M
- RFP 2022, Ready For Service 2025
- ANACOM connection to telecom



LEA – Listening to the Earth under the Atlantic

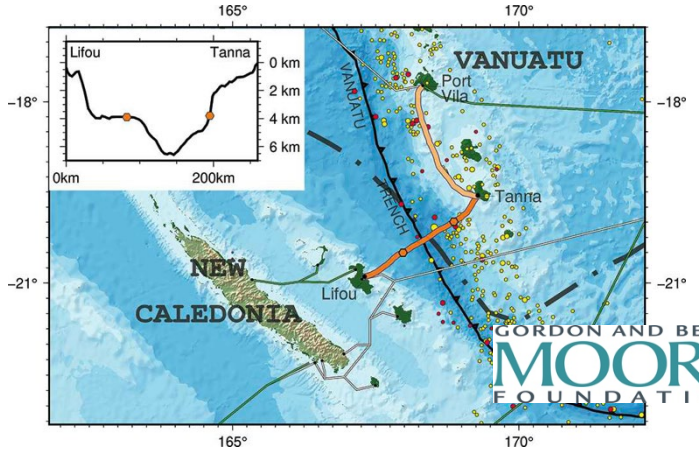
- **MEDUSA**
- Install 2024/25
- Possibly up to ~60 SMART repeaters on main cables

- Improve coverage for large regional area
- Raising funds for SMART capability now

Risk analysis ((V. Silva, pers. comm.)

- Improved EEW (10 s) with less loss of life will more than pay for the system
- Next: include infrastructure and tsunami inundation

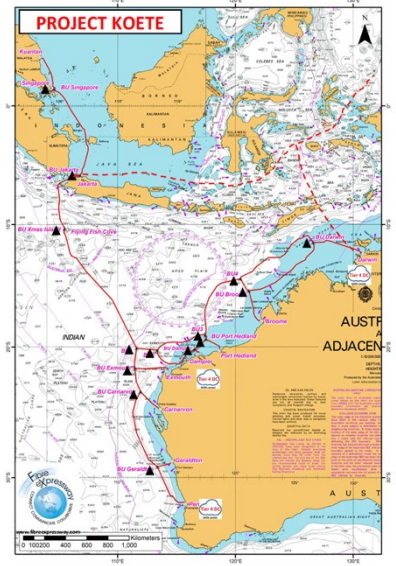
SMART Cables - Pacific



Vanuatu – New Caledonia

SMART, DAS

Partial funding; under gov't review



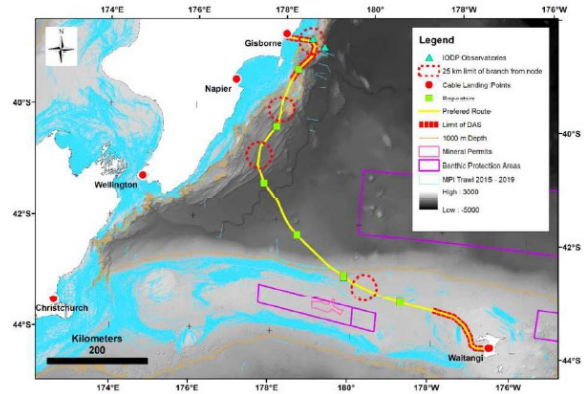
Project Koete

Perth-Darwin-Malaysia

Communities

SMART integral

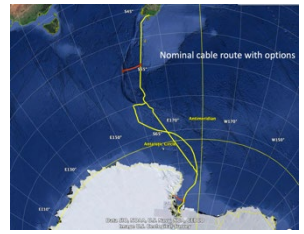
Raising funds

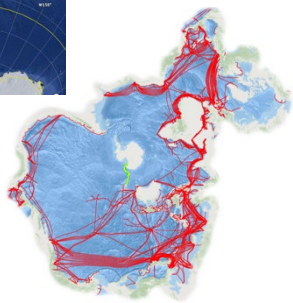


New Zealand – Chatham Islands

SMART + DAS + BUs/nodes

Under gov't review (MBIE)





Antarctica – NZ

Improve connectivity

SMART Cable

Workshops, NSF, NAS

Chile

Indonesia

In country development Ina-CBT

Single ended test systems underway

Follow with Makassar Strait, **with telecom**

Arctic Express

14,000 km

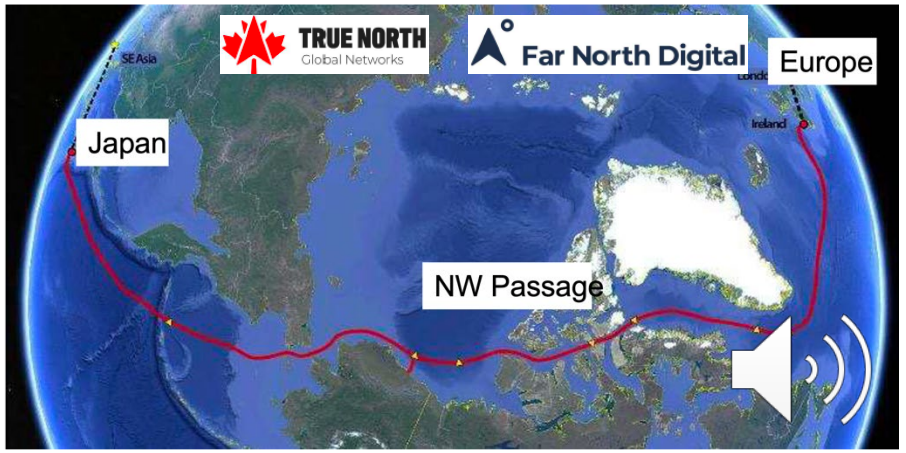
Low latency

Communities

Contract Q1 2022

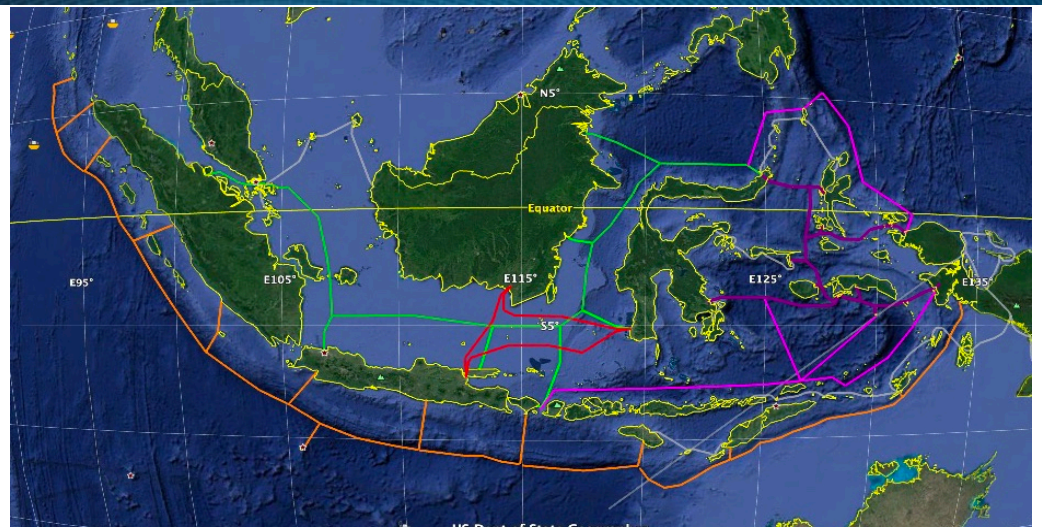
RFS Q4 2025

SMART integral



Earthquakes and Tsunamis – Indonesia

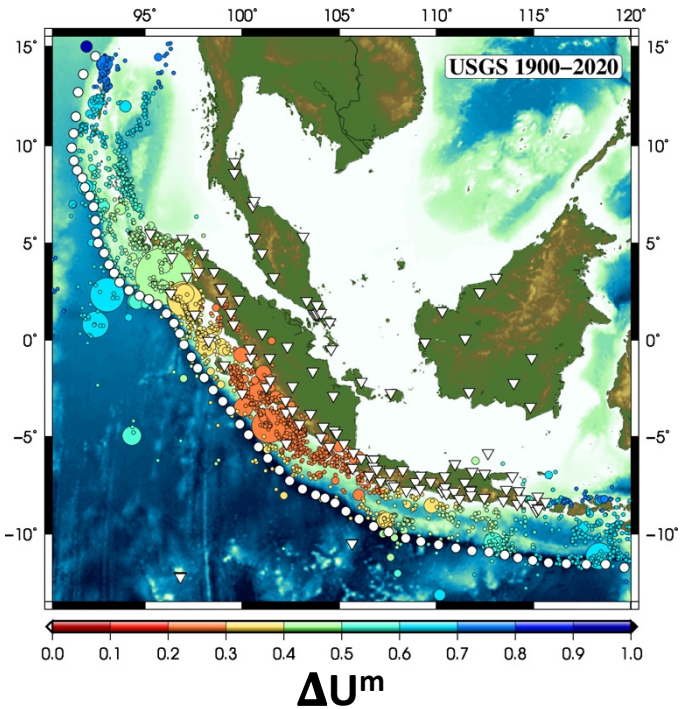
Strawman SMART Cable scenario for Indonesia
Example of SMART seismic and tsunami simulations

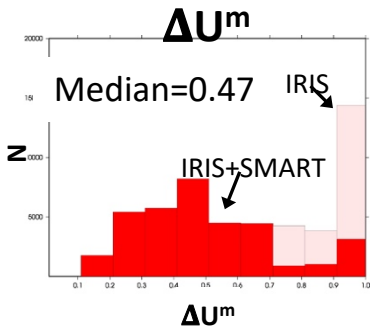


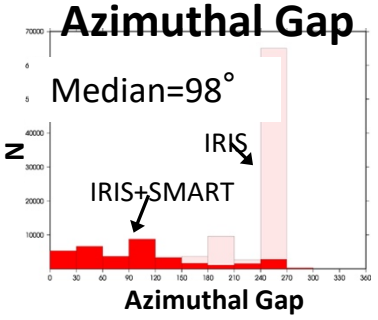
A. Salaree, et al., A numerical study of SMART Cables potential in marine hazard early warning for the Sumatra and Java regions, Pure and Applied Geophysics, submitted, 2021.

Improve geometry – Improve epicenter

ΔU^m - geometric parameter Good $0 < \Delta U^m < 1$ Bad

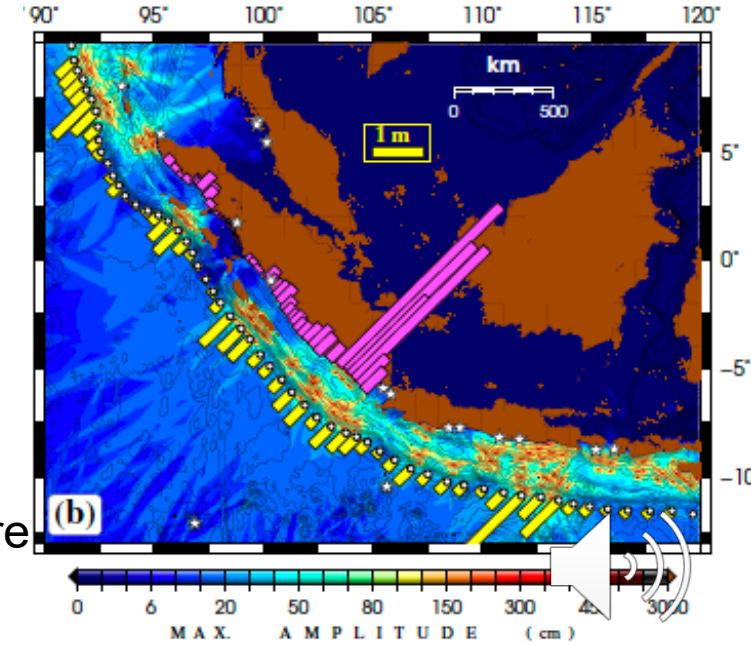






Landslides

- SMART cable (yellow dots),
- 52 landslide scenarios
- Bottom slope
- Acceleration
- Tsunami height at cable
- Tsunami height near shore



SMART Cables – Moore Foundation Project

LEAD

PI Bruce Howe
University of Hawai'i at Mānoa

FUNDING: 2022 – 2026, $7M

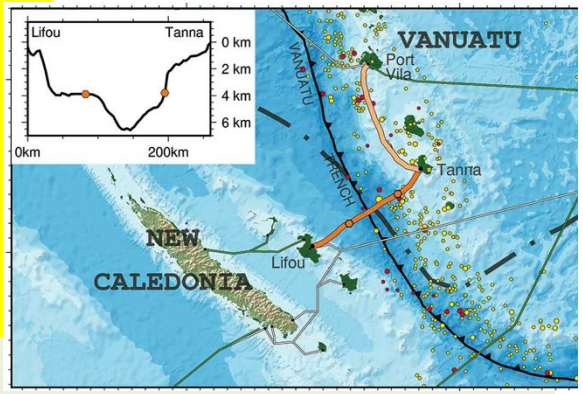
GORDON AND BETTY MOORE FOUNDATION

COLLABORATORS

University of Hawai'i at Mānoa
Univ Texas Austin
Louisiana State University (LSU)
University of Otago, NZ
National University of Vanuatu (NUV)
Pacific Community (SPC)
California Institute of Technology
Subsea Data Systems

French Institute for Research and Sustainable Development (IRD)
Vanuatu Meteorology and Geohazards Department (VMGD)

GNS New Zealand – Bil Fry
International Tsunami information Center – Laura Kong



GOAL:

SMART cables become the world standard, leading to a global network for sustained ocean observation, geophysical study of earthquakes, and earthquake and tsunami warning in a world with rising sea levels.

Objectives:

- **Lay groundwork for science and early warning use by simulations of the observing system before deployment, data analysis after deployment, and sustained scientific operation.**
- **Apply results to the modest-scale 300 km Vanuatu-New Caledonia system and extract scientific results from this active tectonic subduction zone and dynamic ocean region. Demonstrate SMART earthquake and tsunami early warning.**
- **Establish the international project office for Joint Task Force Scientific Monitoring And Reliable Telecommunications cables to facilitate adoption of scientific sensors in all new telecommunications cables to reach a global scale.**

Concluding Remarks - ICG PTWS

- SMART systems becoming reality
- WG2 Task Team: Integrated PTWS Sensor Networks for Tsunami Detection and Characterisation:
  - Continue to work together
  - Need to coordinate these activities ith other ICGs, internationally, etc., and include SMART cables
- UN Decade Tsunami Programme – SMART will be participating as an endorsed Project, affiliated with Tsunami Programme and GOOS
- PTWS Medium-term Strategic Plan – improve multi-hazard risk modeling (time, distance, populations, infrastructure), refine time/distance observational requirements to meet needs

Recommendations- ICG PTWS

For:

- ICG/PTWS
- TOWS-WG Inter-ICG Task Team on Tsunami Watch Operations

To:

- Encourages the JTF SMART Cables to continue its activities to promote current and future projects for “wet demonstrators,” pilots, and operational SMART cable systems;
- Promotes the concept of SMART cables to facilitate related projects and deployment of SMART cables;
- Instructs IOC to actively participate as a full member in the JTF to deploy SMART cables for ocean observations and disaster risk reduction, and that the IOC, ITU, and WMO collaborate together toward this end
- Encourages IOC Member States to endorse ITU WTSA-20 SMART Resolution => contact ITU focal points in your countries
- Consider? submission of standalone IOC resolution on SMART - similar to ITU WTSA-20? To be proposed by Member States for IOC EC (June 2022)