Title:

Unlocking Data Insights in the South Pacific to Mitigate Impact of Climate Change and Sea Level Rise

Speaker:

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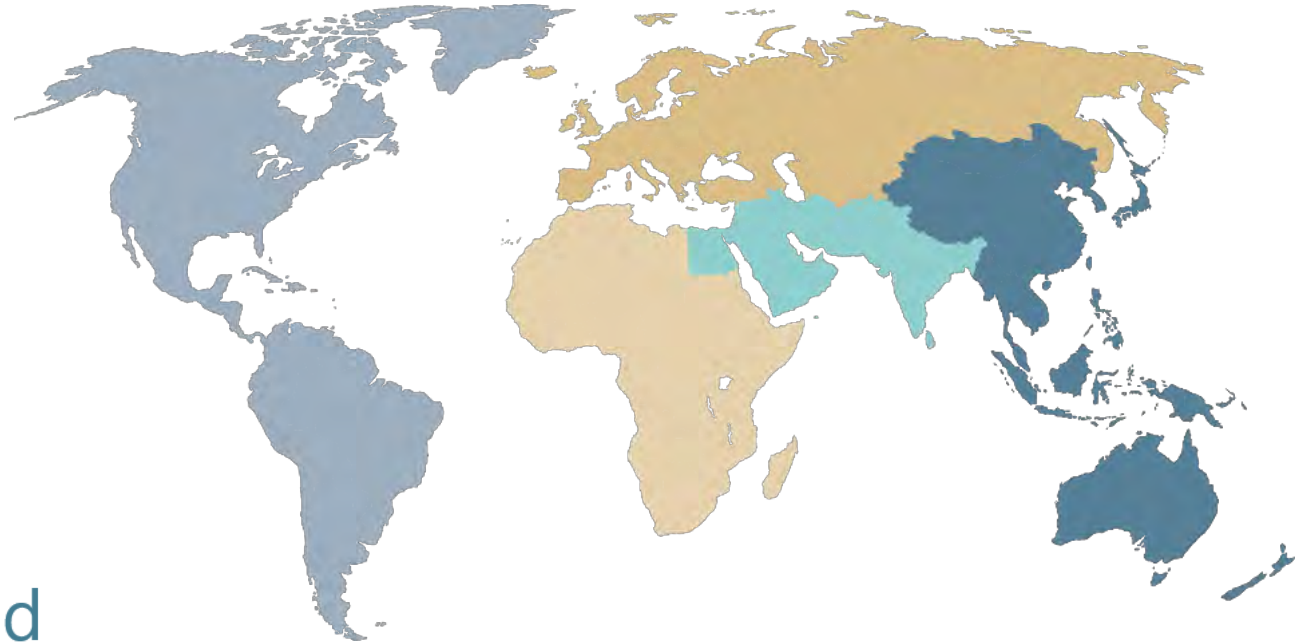
Hydrographic Business Development Manager
Fugro Australia
STAR Suva, November 19-22, 2019

We are Fugro



We acquire data of the Earth and its assets, we manage and analyse the data and we provide advice

proud to provide geo-intelligence and asset integrity solutions to contribute to a liveable world.

10,000 employees

169 offices

16 R&D centres

65 countries

5 regions

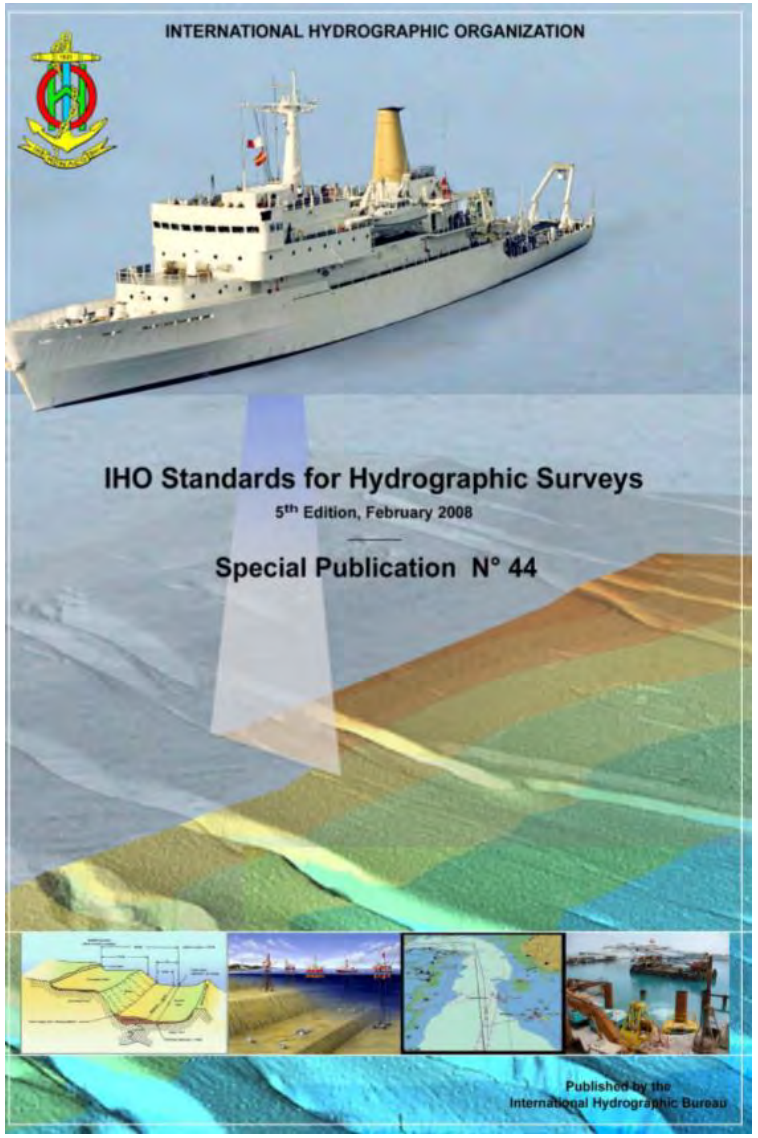
Definition of Hydrography

Hydrography is the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes, rivers and estuaries, as well as with the prediction of their change over time, in support of all marine activities.

Hydrography involves measuring the depth of the water and mapping the adjacent coastline. This is done with ships and boats operating echo sounders and sonars and using survey aircraft fitted with lasers. Useful data can sometimes be derived sometimes from satellite observations.

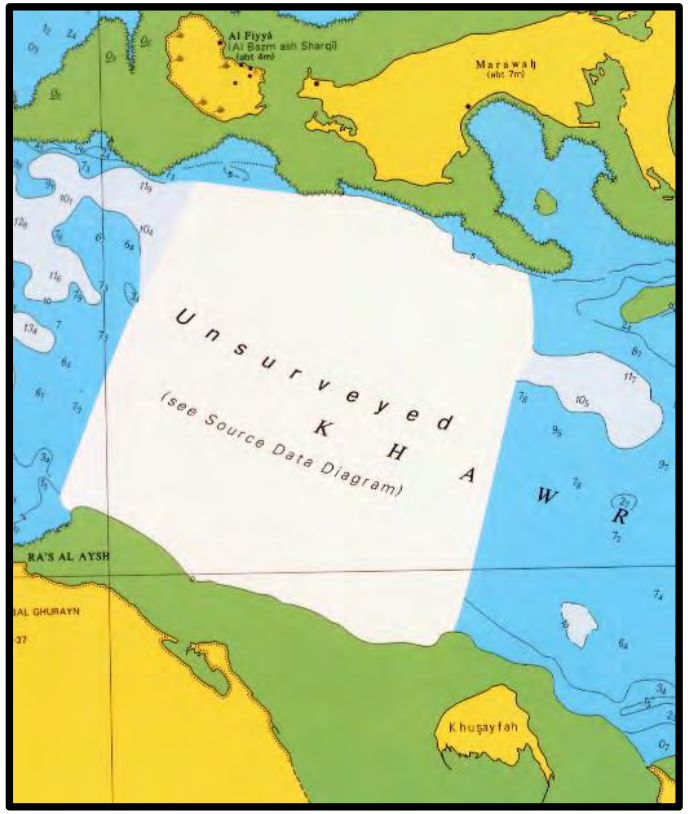
Hydrography also involves measuring the tide and the currents, seabed type, and coastal infrastructure including aids to navigation.

For many current applications, hydrographic surveys also require the measurement of the ground and infrastructure of the adjacent coastline for the purposes of understanding and managing the impact of the sea on the land, particularly for coastal zone management including the impacts of natural disasters and climate change.



World wide status of Hydrography and Nautical Charting

In many parts of the World the quality and coverage of hydrographic surveys require significant improvement. (XVIIIth IHO Conference Resolution 2012)



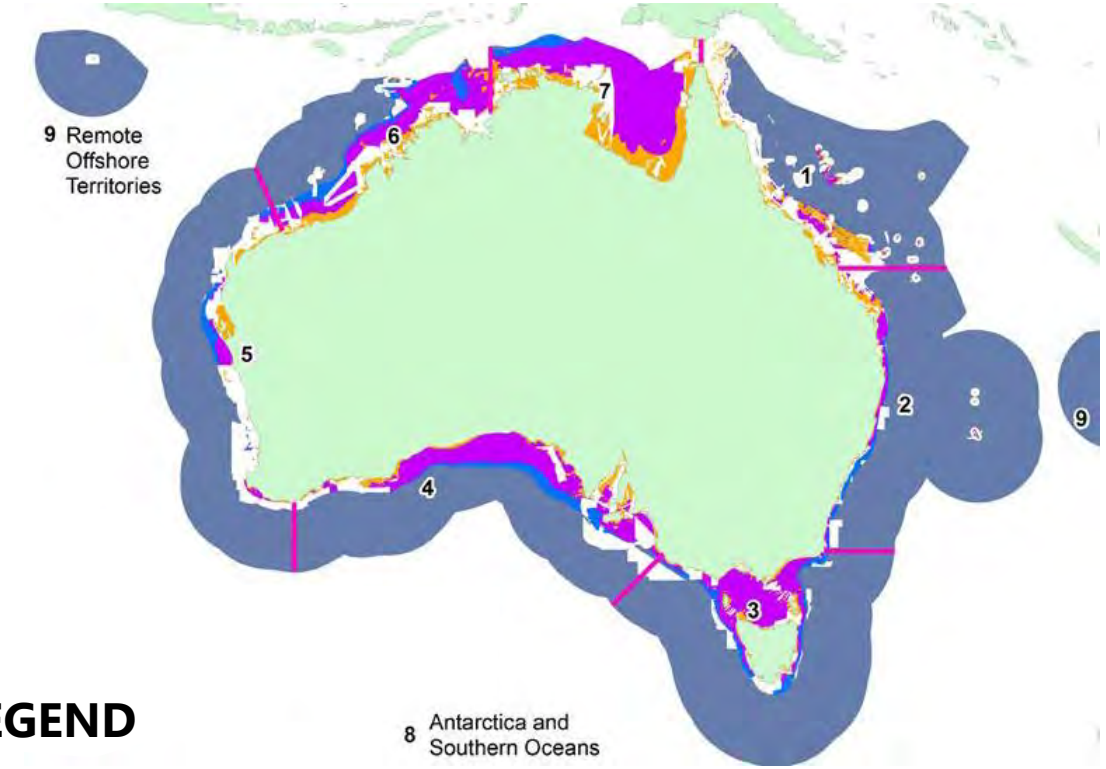
The coverage of survey data is particularly poor in the Caribbean, Indian and Pacific Oceans and the Polar regions, but all areas of the World are affected to some extent, including the waters of many, if not most, modern, developed States.

Almost none of the areas of responsibility of more than 150 States in the World with a recognised coastline is fully surveyed for depths or underwater hazards. This unsatisfactory situation must be recognized by all States with maritime interests and acted upon. Improving this unsatisfactory situation requires the involvement of every State with maritime interests. It is a collective problem.

An example from Australia

- Less than 10% of the World's coastal seas and oceans have been surveyed and charted to the same or better resolution than maps of the Moon and Mars. (International Council for Science - SCOR)

- Worldwide, the number of government survey vessels has declined by 35% in the last 30 years - contract surveys, improved equipment capability and other options have not filled the gap.



LEGEND

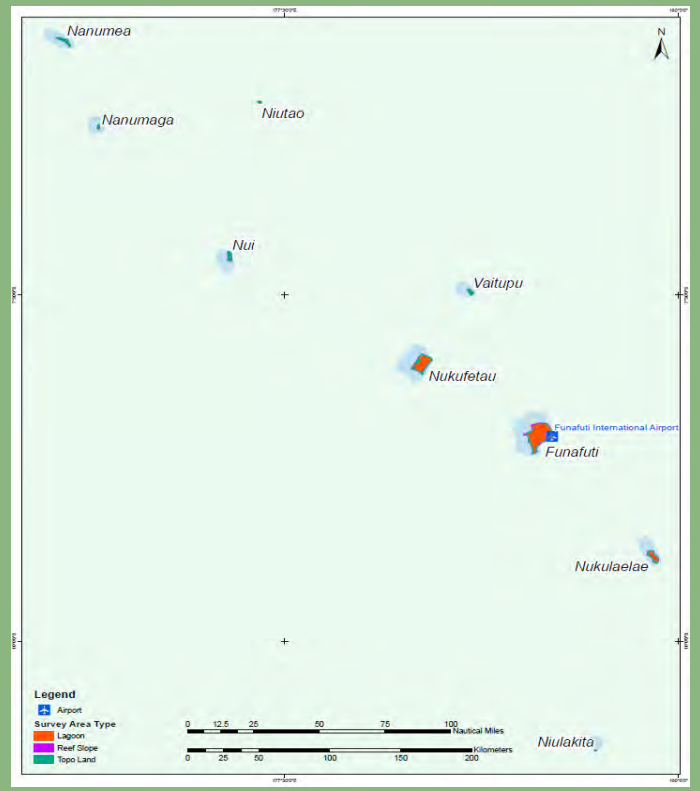
- Inadequately Surveyed 0-30m – 42% of total depth band is inadequately surveyed
- Inadequately Surveyed 30-100m – 69% of total depth band is inadequately surveyed
- Inadequately Surveyed 100-200m – 46% of total depth band is inadequately surveyed
- Inadequately Surveyed 200m-EEZ – 42% of total depth band is inadequately surveyed
- Land

Situation in Tuvalu

UN Secretary-General Antonio Guterras - May 2019

- **Tuvalu is the fourth smallest nation in the world**.
- comprised of nine atolls with inhabited islands on each and a total population of 10,640.
- total land area is approximately 26 km2 and Funafuti atoll serves as the national capital with half the nation's population, the only airport and the only point of entry for international shipping.
- country's remoteness, limited services, **small low lying islands** and potential exposure to infrequent but potentially **devastating tropical cyclones**, mean **Tuvalu is one of the most vulnerable countries in the world**.
- This is particularly so when viewed through the lens of climate change and sea-level rise impacts, which is enhancing the country's exposure to marine hazards.
- combined with considerable development challenges, a narrow resource base economy and chronic capacity constraints, the high levels of vulnerability to climate change impacts are likely to have severe long-term effects on sustainable development of the country.

Impact of climate change on low lying atolls



9 atolls of Tuvalu

- The threat of **ongoing sea level rise and changing incidence of severe tropical storms** means that Tuvalu's small low-lying islands are being subject to enhanced exposure to wave over topping events and the incidence of marine flooding and inundation.
- For example, in 2010, Cyclone Pam caused widespread damage through **wave overtopping and marine flooding** affecting some 30% of households nationally.
- Likewise, analysis of flooding of low lying land on the capital Funafuti, showed a combination of season and predicted high spring tide causes marine waters to infiltrate through the island causing **clear weather flooding** across large areas of the island.
- Between 1994 and 2012, **28 events** have been documented, five of which have occurred since 2010.
- This phenomenon occurs across many islands in the group and only increases in frequency, extent and severity of impacts due to ongoing sea level rise.

Hydrographic data is needed to plan and manage

Funafuti

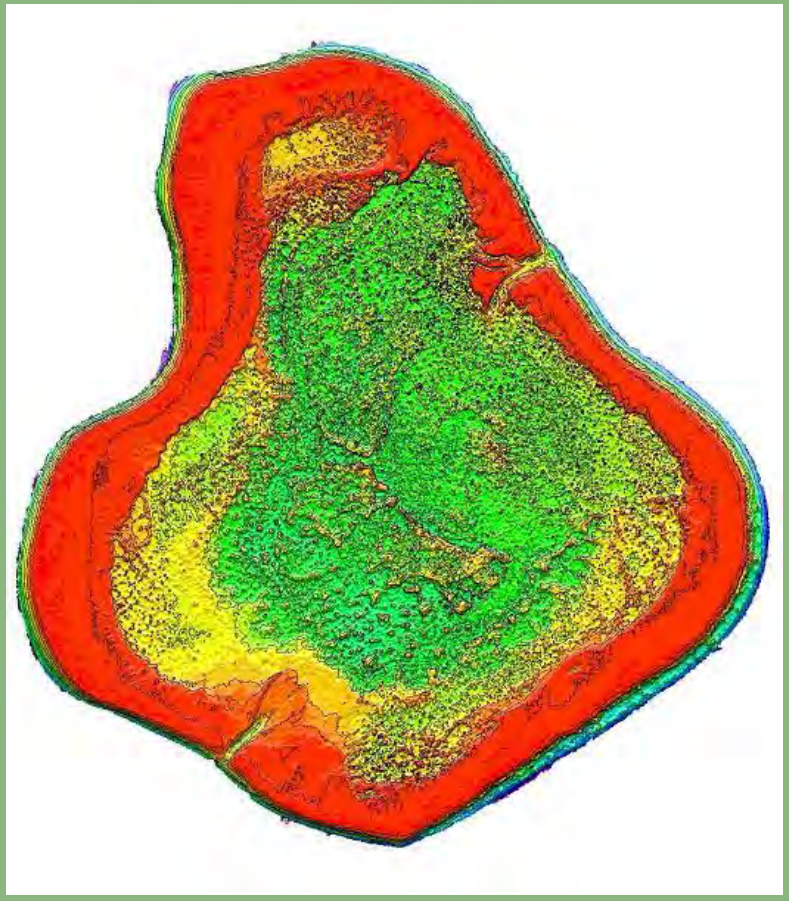
- To successfully model and thus assess the risks of either wave overtopping impacts or the gradually increasing inundation events in low lying areas, **high quality baseline data is required**.
- Detailed reef edge **bathymetry** (sea floor mapping <50m depth) **and accurate topography** (land elevation data) **is absent** in Tuvalu except for limited coverage in Funafuti.
- Without these fundamental baselines the relationship between water levels or wave dynamics and land cannot be accurately assessed.
- At one spectrum the international community has hugely increased its ability to measure sea level in recent years and trends are reported with sub-millimeter accuracy.
- Yet the crucial **relationship between land height in Tuvalu and sea level rise remains undefined** and we rely on anecdotes such as “low lying islands” and report average land elevation above average sea level for at best Fogafale Island.

Who will use the data?

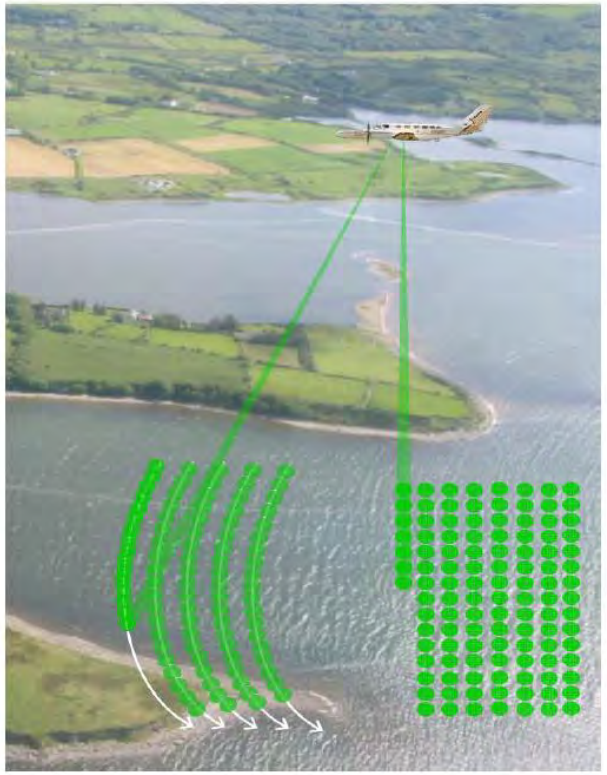
Tuvalu for UNDP

- This long standing gap in baseline data, hampers empirical understanding of sea level rise impacts and thus scientific reporting, undermines the design of adaptation response and prevents the confident use of tools such as hydrodynamic modelling.
- This data will become a crucial baseline to inform all aspects of development, infrastructure planning, adaptation, safe navigation, etc.
- **The Tuvalu Government's Lands and Survey Division (LSD)** has the main in-country spatial data use and processing capacity and works closely with the **Secretariat of the Pacific Community (SPC)** who have the mandate to provide ongoing regional spatial data support, back up and analysis.
- These groups along with the **TCAP (Tuvalu Coastal Adaption Project)** Management Unit and its host department the CCPDCU (Climate Change Policy and Disaster Coordination Unit – Tuvalu Government) would be the immediate beneficiaries.

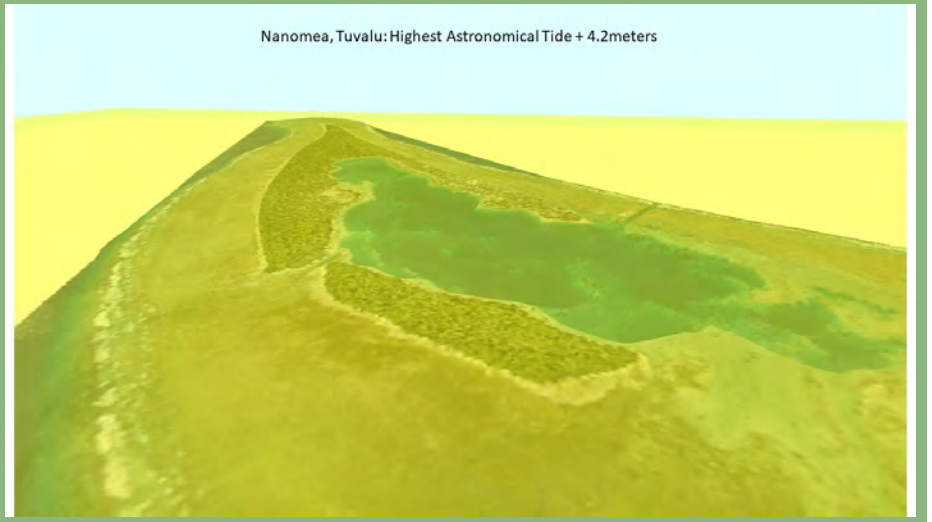
How to collect the data?



- **Airborne Lidar Bathymetry** Survey commissioned by UNDP and executed by SPC
- Acquire airborne lidar coverage of shallow water bathymetry (0 – 50m) depth as conditions allow. (Full coverage of lagoon, submerged reef and ocean side reef edge and drop-off environments on all nine atolls).
- Acquire airborne LIDAR coverage of all land forms across all nine atolls' islands, including intertidal reefs and sand flats and ephemeral features such as sand banks, etc.
- Approx **13 flights** to conduct the survey in May 2019



Hydrographic data has been collected and analysed



Modelling for Tuvalu

- Fugro will merge ALB data, SPC tide modelling and existing multibeam surveys to generate accurate sea-level rise models for all 9 Atoll locations.

- Modest sea-level rise of 0.5 meters to the current high tide values will bring daily threats to the existing beaches and water into the tree line

- 1 meter sea-level rise brings seawater into the lower lying regions currently dry year round.

- 4-meters of sea-level rise and this section of Nanomea Island will be completely underwater.

Hydrographic data has been collected and analysed

Modelling for Tuvalu

- Sea-level rise for the low-lying townships of Tuvalu face risks on a regular basis
- Modest sea-level rise (0.5 to 1 meter) at the township of Nanomea will effect the residents daily
- 2-3 meters of sea level rise will leave the township underwater
- Combine this climate induced sea level rise with increased storm activities, knowledge of regions most at risk is imperative for focused plans for defence

Marshall Islands – on the back of Tuvalu deployment

Marshall Islands for SPC funded by WB

- Republic of Marshall Islands is located in the North West Pacific (~171E, ~7N).
- Majuro, the main atoll has a narrow emerged land area of 9.7 square kilometre and a lagoon about 295 km2.
- The three adjacent islets located on the eastern coast of Majuro, Delap-Uliga-Djarrit (DUD), is densely populated with a population of about 20,000 people compared to the population of the whole atoll ~28,000.
- Geomorphological mapping of Majuro by NOAA in January 2012 indicates that the atoll structure is likely to include coral reef and hard bottom (e.g. solid substrates: bed rocks, boulders, reef building organism, reef rubble, etc…), unconsolidated substrate (e.g. unattached or uncemented particles: sand, sea-grass) as well as artificial features such as submerged wrecks, piers).
- Added to this, the geographical location of Majuro makes its population and infrastructure exposed to the impacts of natural hazards such as typhoons, waves from extra-tropical storms and drought.

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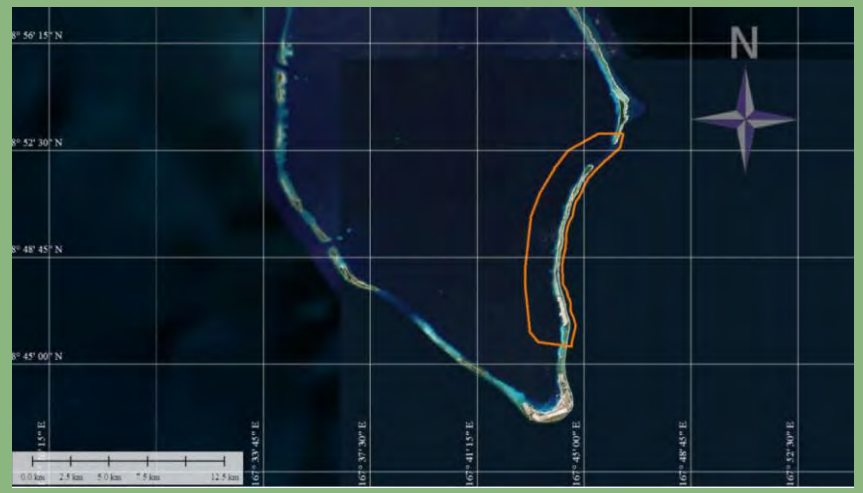
Marshall Islands – integrated coastal risk management



Marshall Islands for SPC funded by WB

- As part of a World Bank financed **Pacific Resilience Project II**, the Government of RMI in partnership with SPC is undertaking an integrated coastal risk management work aiming at assessing the risk inherent to natural hazards on Majuro.
- The risk information will fed into a cross-sectoral approach to enhance sustainable planning and strengthen disaster response capacity.
- **The goal is to support sustainable planning in RMI based on scientifically sound information.**
- The main objectives of the project are:
  - To enable country stakeholder to make informed coastal management decision
  - To enhance disaster preparedness and response
- Expected results:
  - Hazard assessment in key areas of Majuro
  - Risk assessment of priority assets
  - Setup a coastal management monitoring program
  - Provide stakeholder with a decision making tool to support sustainable development.

Samoa – an example from 2015

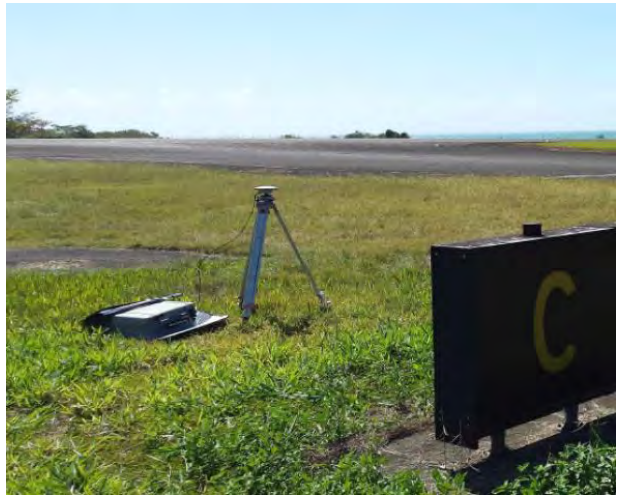
Samoa for MNRE

- **Climate change** in Samoa relates to the **nature and frequency of extreme events** (e.g. tropical cyclones, drought)
- impacts may be exacerbated by sea-level rise.
- Sea-level rise will increasingly affect Samoa through events such as flooding, coastal erosion and damage to coastal infrastructure.
- In Samoa **70%** of the population lives within **1 km of the coast** and critical infrastructure (e.g. hospitals, schools, port facilities, power plants, airports, and tourist infrastructure) are also located in this zone.
- **Eighty percent** of the 403 km long coastline is sensitive or highly **sensitive to erosion, flooding or landslides** and weather- and climate-related extreme events (e.g. tropical cyclones, storm surges, droughts) and natural disasters threaten Samoa's development.
- Rapid economic and urban growth predominates in the coastal areas, increasing the exposure of people and assets to climate-related hazards.

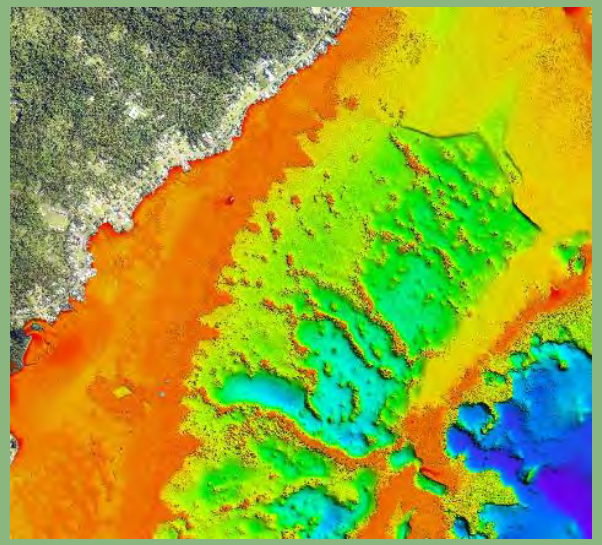
Samoa – Ridge to reef project -

Samoa for MNRE

- effects of sea-level rise are incremental over time and tropical cyclones are of pressing concern.
- cyclones cause massive coastal erosion, endanger life and well-being, and damage infrastructure, agriculture, reefs, fishing and tourism.
- climate modelling indicates more El Niño like conditions under global warming scenarios, and hence the potential for an increase in the intensity and frequency tropical cyclones in the Samoan region, increasing damage, the costs, and the frequency of emergency repairs.



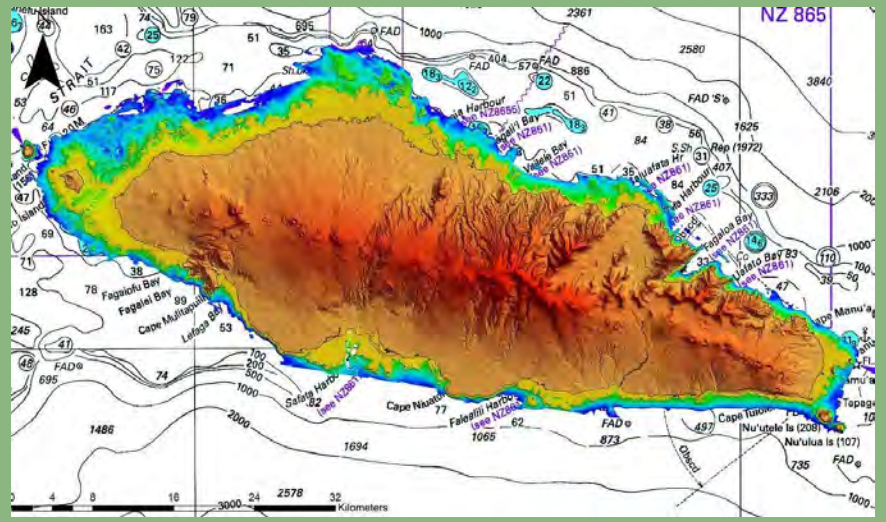
Samoa



Samoa for MNRE

- report by **Samoa's Second National Communication (SNC)** to the United Nations Framework Convention on Climate Change
- **by 2050 sea level** is likely to have increased by **36 cm**, rainfall by 1.2%, extreme wind gusts by 7% and maximum temperatures by 0.7C.
- observed long-term trend in relative sea level for Apia is 5.2mm/yr. But maximum hourly sea level is increasing by approximately 8 mm/yr, a rate far in excess of the observed local and global trends in mean sea level.
- For Apia an hourly sea level of 1.8m above mean sea level is currently a 100-year event, however it will likely be at least a four-year event by 2025.
- Climate change and climate-induced disasters will cause instability in food production and water availability, affecting income generating activities for communities and the country at large.
- With the projected likely increases of climate stresses in the coming decades, including cyclones, prolonged droughts, extreme flooding, storm surges and high sea levels, Samoa must urgently consider suitable technologies that will aid its adaptation efforts in safeguarding vital infrastructure.
- The vulnerability of the sector is high because of sea level rise, cyclones, flooding and wave actions.

Samoa



Upolu Samoa for MNRE

- The bathymetry and elevation data within this project is to be procured under the "**Pilot Program for Climate Resilience** (PPCR)" – **Enhancing** the **Climate Resilience** of Coastal Resources and Communities (ECR) (P126596).
- The ECR project development objective is to support coastal communities to **become more resilient** to climate variability and change.
- ECR will **reduce the vulnerability** of Samoa's population and natural environment to climate risks, and enhance the capacity of natural systems and coastal communities to recover from impacts (chronic and acute) associated with climate change and extreme weather events.
- To support this objective, ECR will:
  - develop and implement immediate and urgent project based activities to adapt to climate change and climate variability;
  - protect life and livelihoods of the people, infrastructure and environment;
  - incorporate adaptation measures and goals into national and sectoral policies and development goals; and
  - increase awareness of climate change impacts and adaptation activities in communities, civil society and government.

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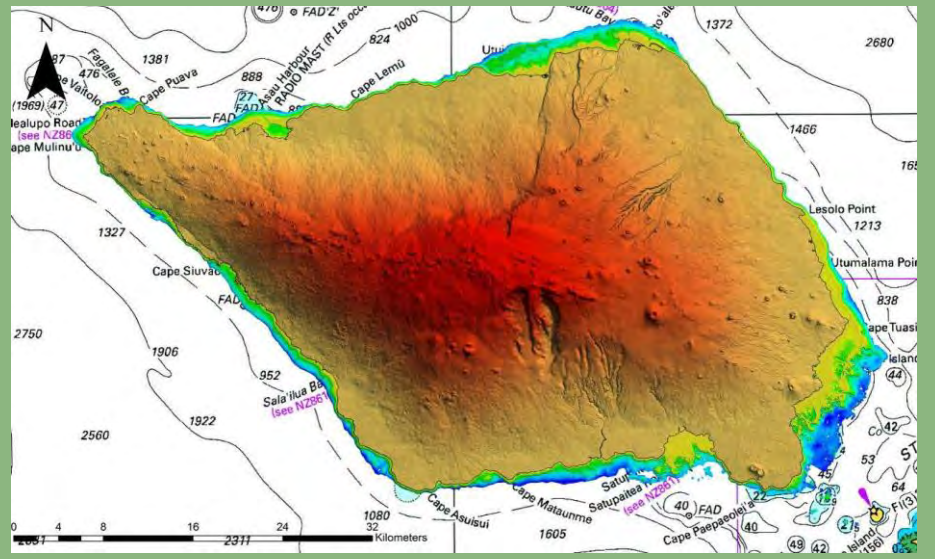
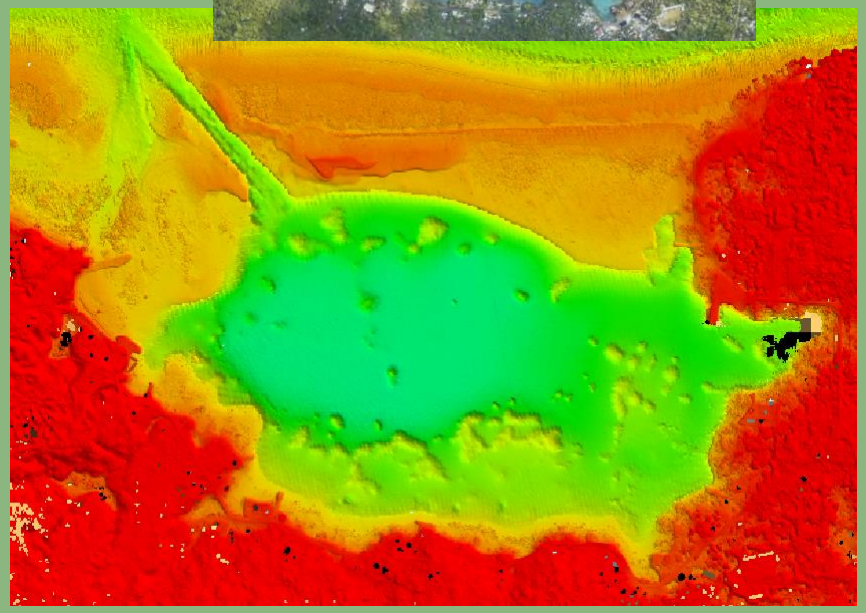
Samoa



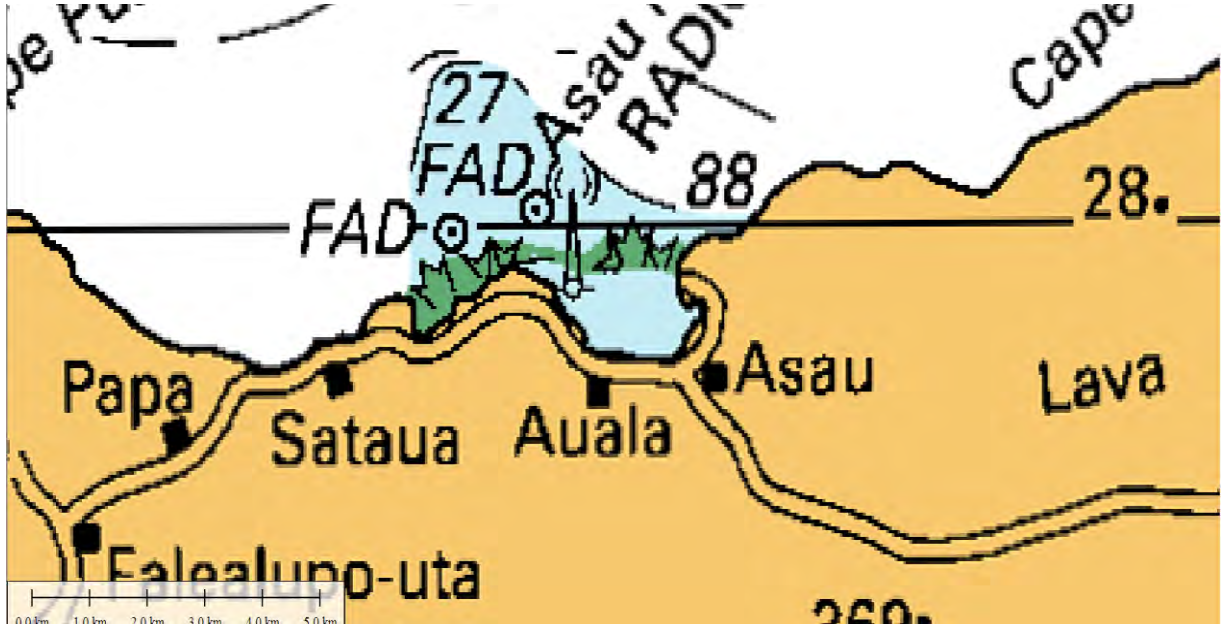
Savaii Samoa for MNRE

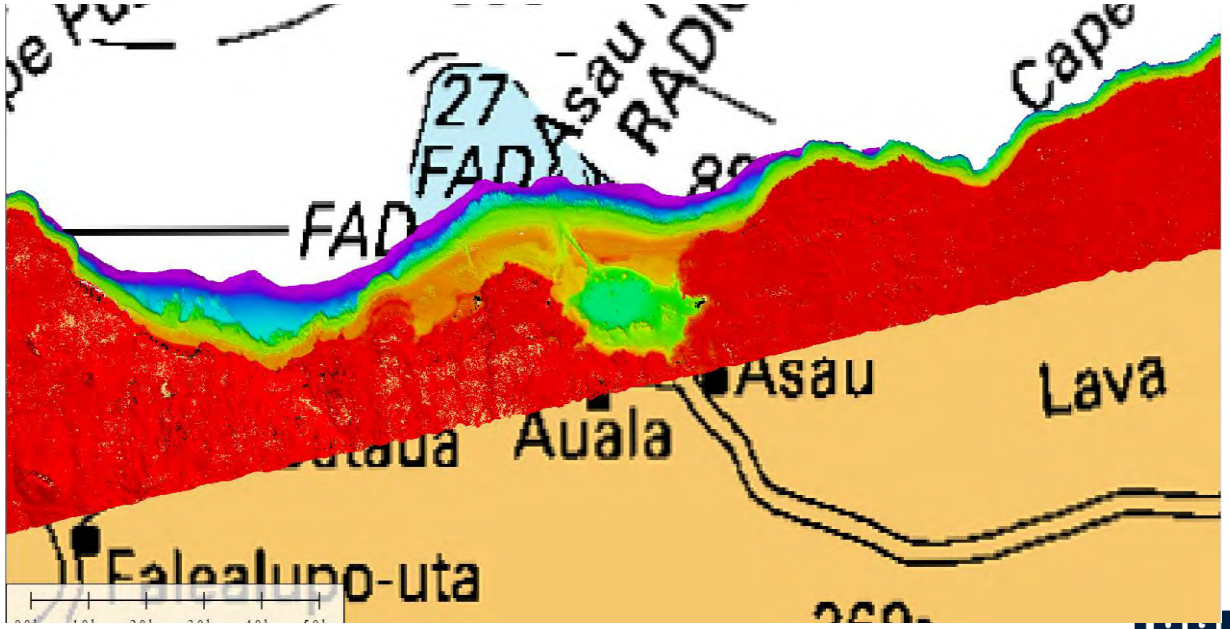
- nature of the climate risk and exposure of critical infrastructure, particularly in **Apia**, requires more detailed modelling to understand storm surge and flooding.
- project will strengthen the provision of climate and other relevant data and information.
- includes activities to increase public awareness of climate change issues and to improve the availability and use of data for risk analysis, hazard mapping and knowledge sharing.
- provision of data (bathymetric, topographic, ecological) for spatial hazard mapping
- a number of programs underway or in the pipeline in Samoa that would benefit from bathymetric data.
- **infrastructure, planning and coastal zone management projects can use bathymetry to understand how climate change impacts** will be felt – at a high level of accuracy and detail.
- detail is needed when considering impacts from storm surge (caused by cyclones and stronger winds) as well as flooding.

Samoa

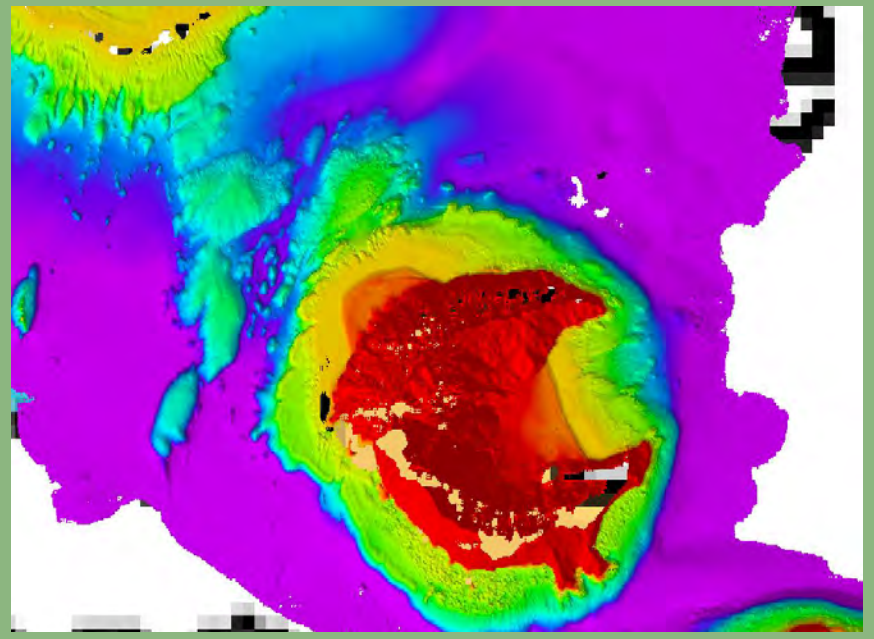


Asau Harbour, Samoa

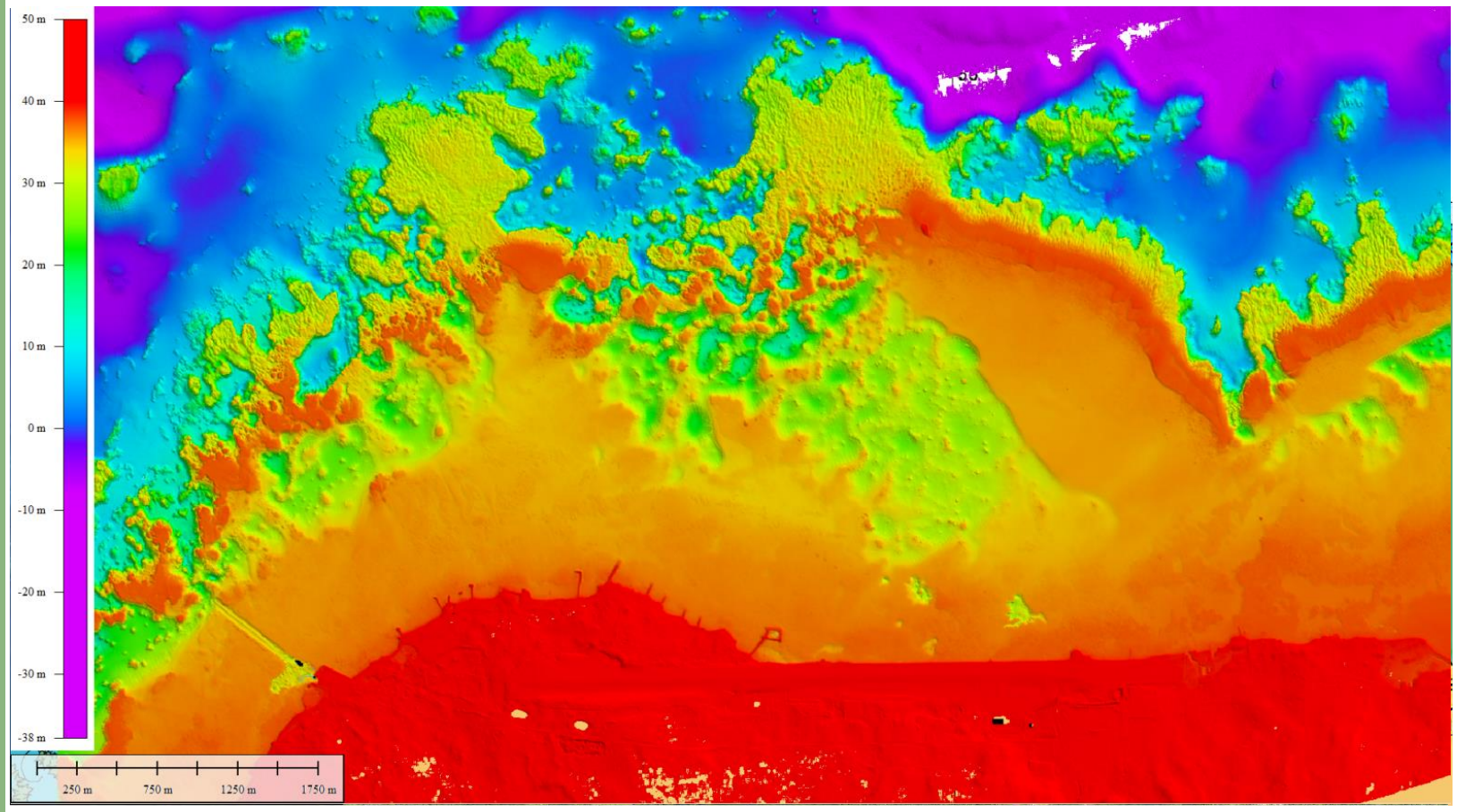




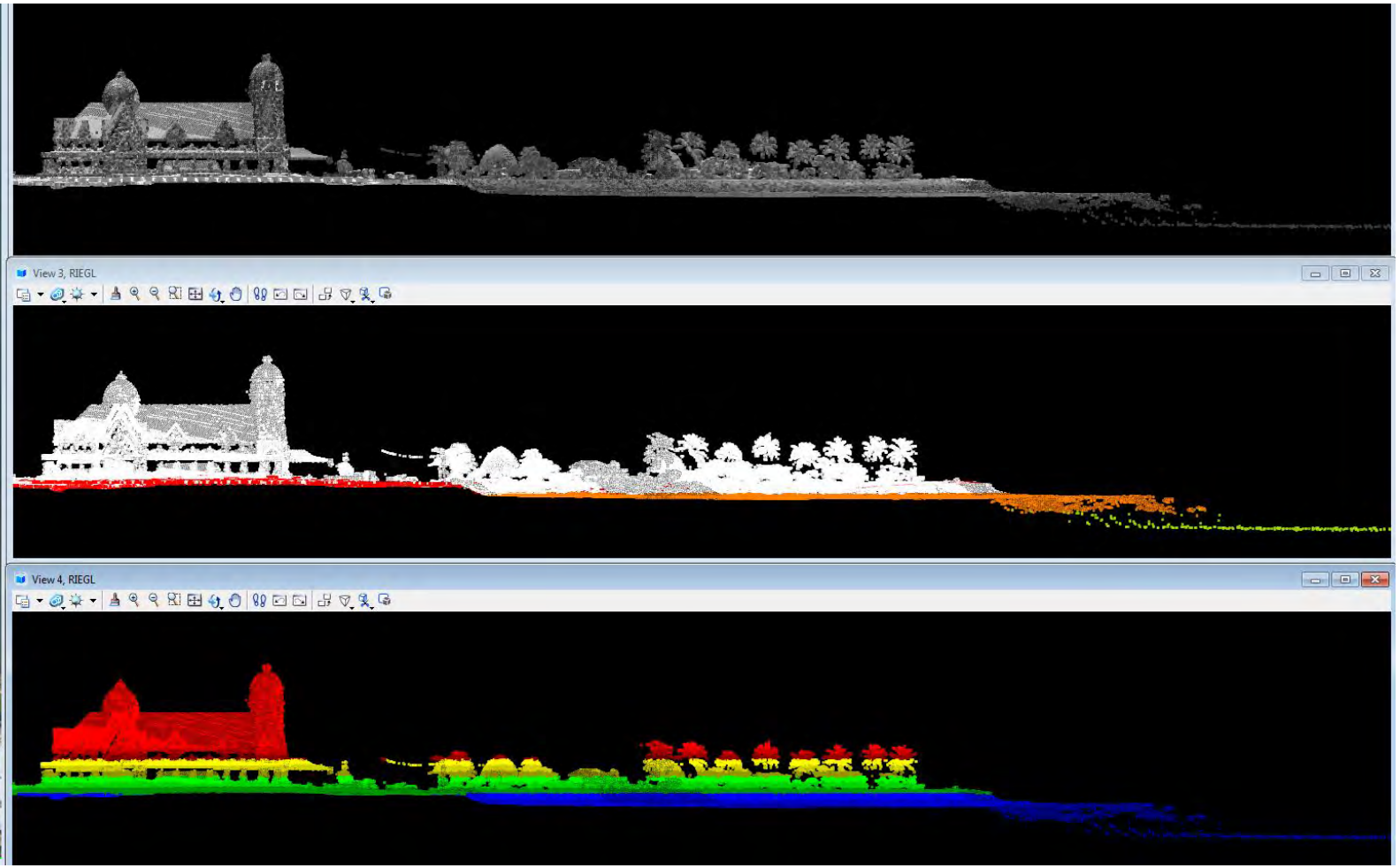
Samoa



Savaii Samoa for MNRE



Samoa



Savaii Samoa for MNRE

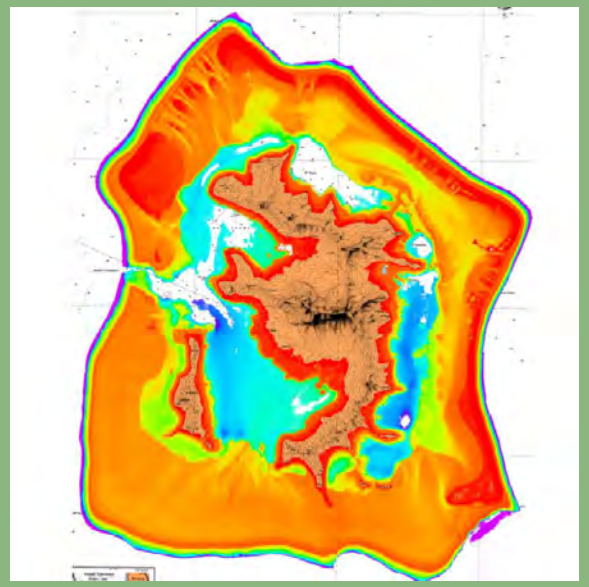
Samoa

Sea level rise modelling – without valid data

Mean Sea Level +2m

Sea level rise modelling – with valid high resolution geographic data

French Polynesia - 2015



Bora Bora

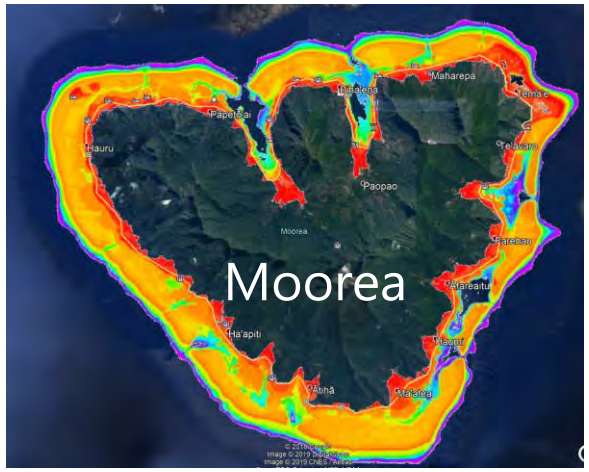
Survey of Moorea, Tahiti and Bora Bora.

For the **Hydrographic and Oceanographic Service of the Navy (SHOM), in partnership with Service de l'urbanisme (SAU)**.

Additional areas collected for Direction de l'Equipement (DLE), Université de Polynésie Française (UPF) and University of California Santa Barbara (UCSB).

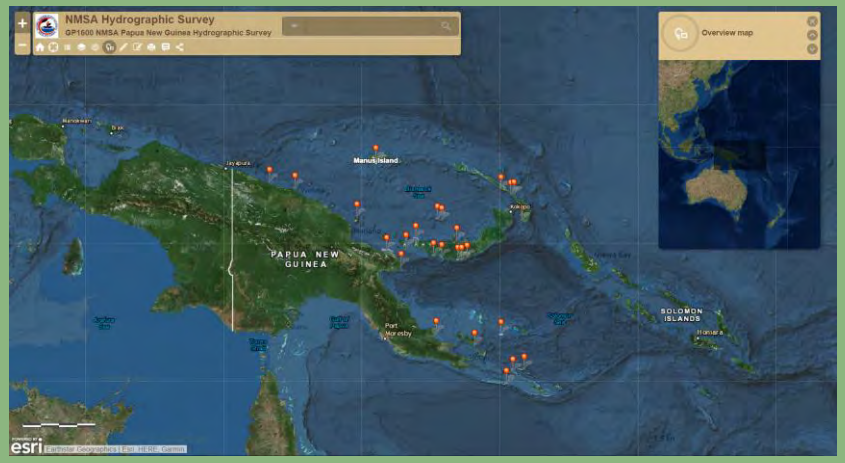
The objective of the **first Airborne LiDAR survey** to be conducted in French Polynesia was to **obtain bathymetric and topographic data for SAU** to integrate into risk prevention plans when environmental occurrences, such as cyclones.

To meet the requirements of the topographic service management infrastructure, topography and land transport (DITTT) of the Government of New Caledonia French Polynesia, and the National Institute of geographic and forest information (IGN).



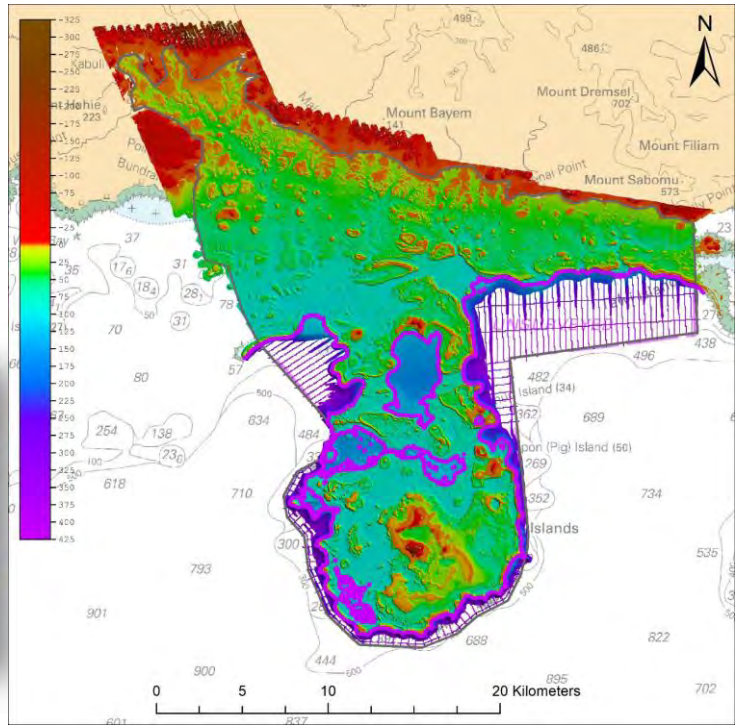
Moorea

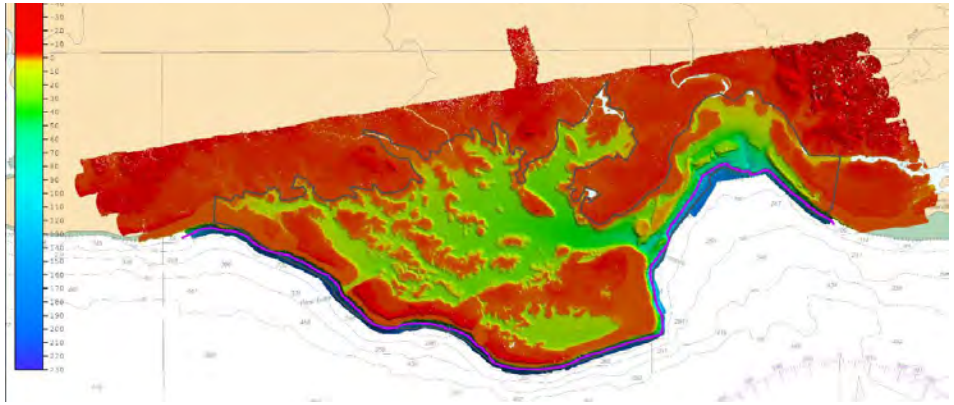
PNG - 2017



28 areas surveyed for NMSA

Using a combination of ALB and MBES





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Economic benefits of hydrographic surveys

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- Economic benefits of better hydrography - For most ships, **30 cm extra depth** shown on a chart allows at least **2,000 tonnes more cargo** to be carried (typical tonnes per centimetre tables)
- Financial studies show that the **cost:benefit ratio** for national investment in hydrography and nautical charting can be better than **1:10** (Coochey, Australia 1992; Brinkman & Calverley, Canada 1992; APEC, 2002)
- - Passengers from a typical modern cruise ship spend over $250,000 in port every day (Cruise Line International Association, 2010)
- Mankind is turning increasingly to the sea for additional resources.
- **Over 95% of world trade is carried by sea**.
- Ships are getting bigger and more numerous.
- Markets for mariculture, offshore energy and structures continue to increase.
- The **lack of up to date maps and charts introduce significant risks to the environment**, to prosperity and to ultimate success.
- Would governments plan to build cities without basic maps?

Survey of Nadi in June 2019

for Fiji Airports

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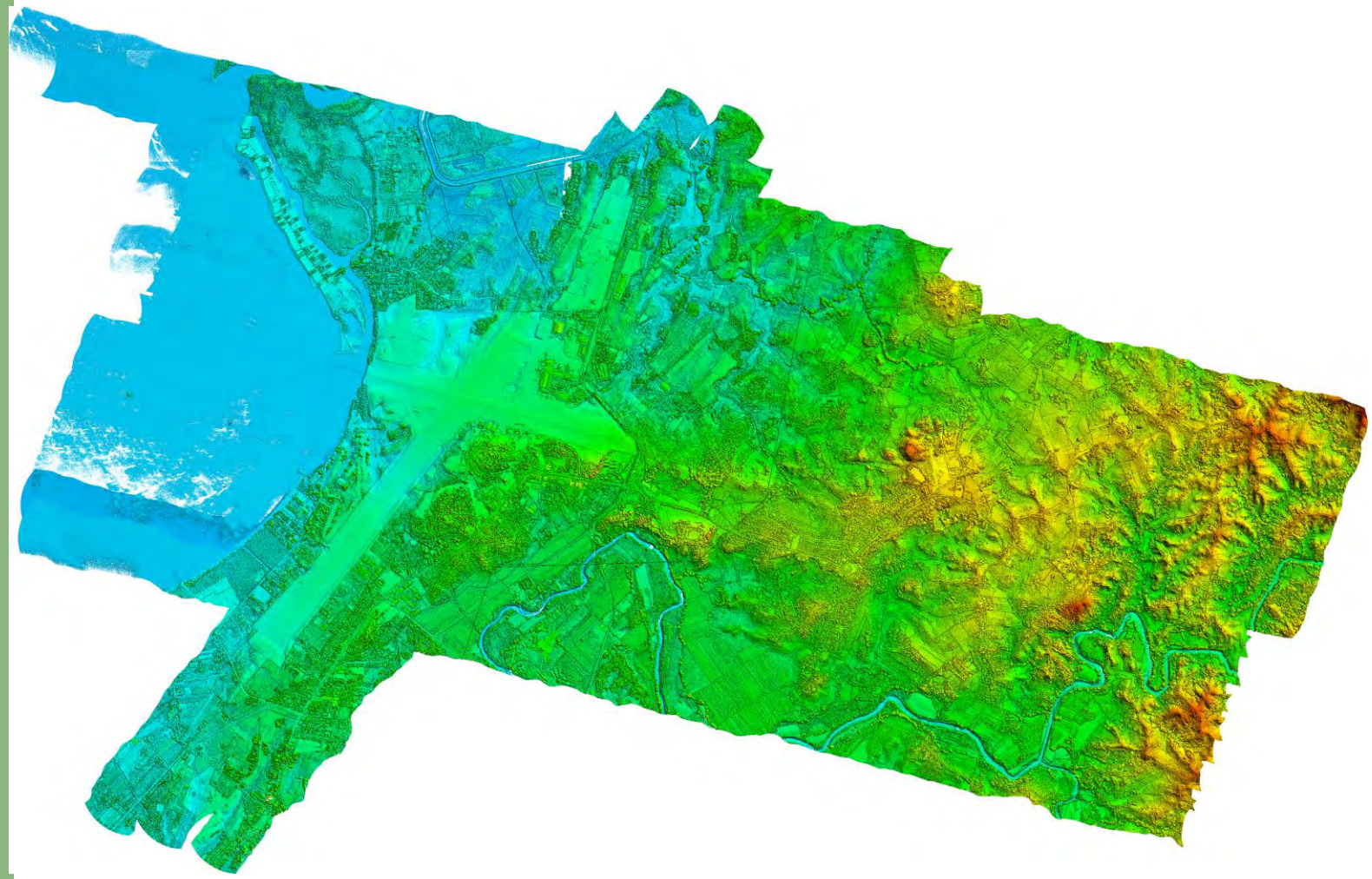

Pilot ALB survey in Fiji – June 2019

data collected off Nadi

available for research and analysis

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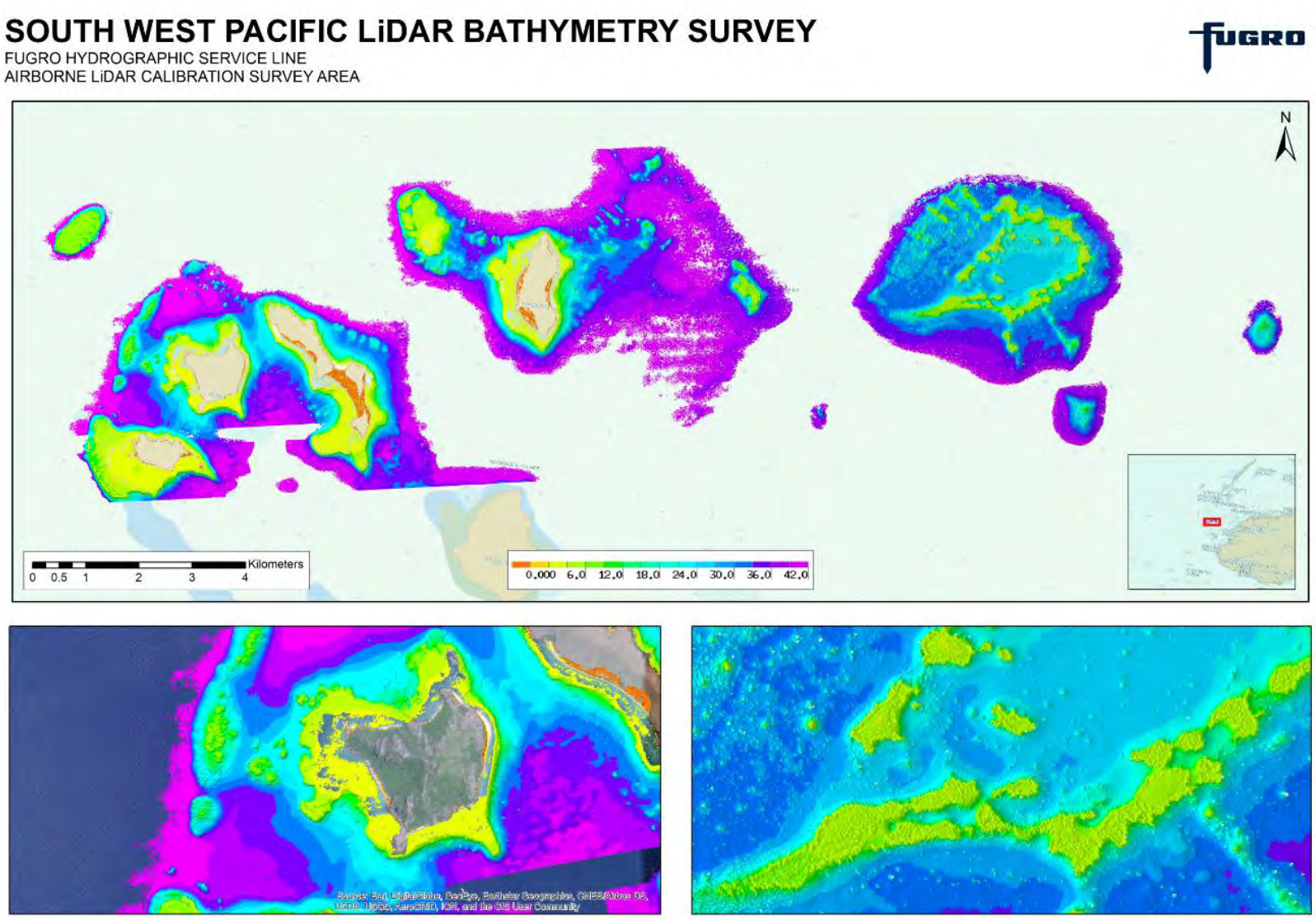

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A dedicated data collection campaign is required in the Asia and Pacific region to provide the necessary data to support planning and coastal adaption

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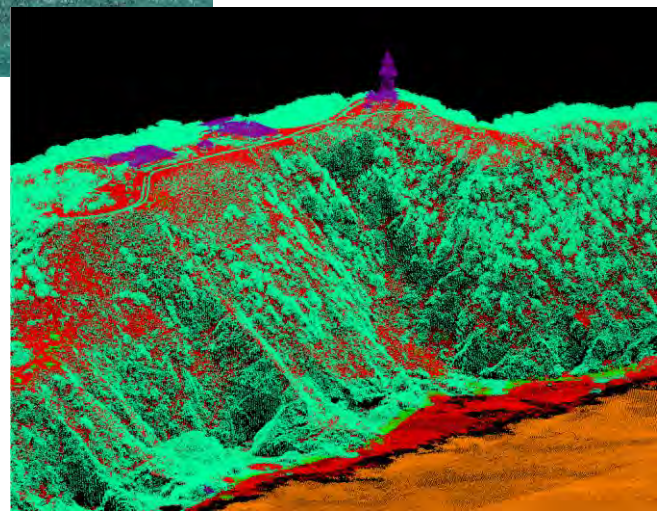


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