We will begin shortly.
Participants, kindly note the following for this seminar.

Please rename your Zoom name to: Name, Org or Project
(e.g. Las Fernando, ADB)

PLEASE TURN YOUR MIC OFF DURING THE PRESENTATION

RAISE HAND WHEN YOU WANT TO TALK

USE THE CHAT BOX FOR QUESTIONS/CONCERNS

WE HAVE A Q&A PORTION AFTER THE PRESENTATION

Pacific WASH Webinars

Building Water Resilience in a Changing Climate

17 November 2021

TA6551-REG: Strengthening WASH practices and hygiene behavioral change in the Pacific

TA9685-REG: Implementing a Differentiated Approach to Urban Development in the Pacific

Schedule

Allotted time	
5 min	**Introductions:** Emma Veve, Deputy Director General, Pacific Department, ADB Lusia Sefo-Leau CEO PWWA
35 min	**Presentations:** 1. Analytical Framework for Effective National Water Resources Management and SDG-6 – Bapon Fakhruddin 2. Impacts of climate change in Tonga- Elisiva Tapueluelu 3. Rarotonga Groundwater Resource Assessment – Chris Shanks
15 min	Discussion and Q&A
5 min	**Closing remarks** Karl Galing, ADB WASH Pacific Regional TA

Analytical Framework for Effective National Water Resources Management and SDG-6

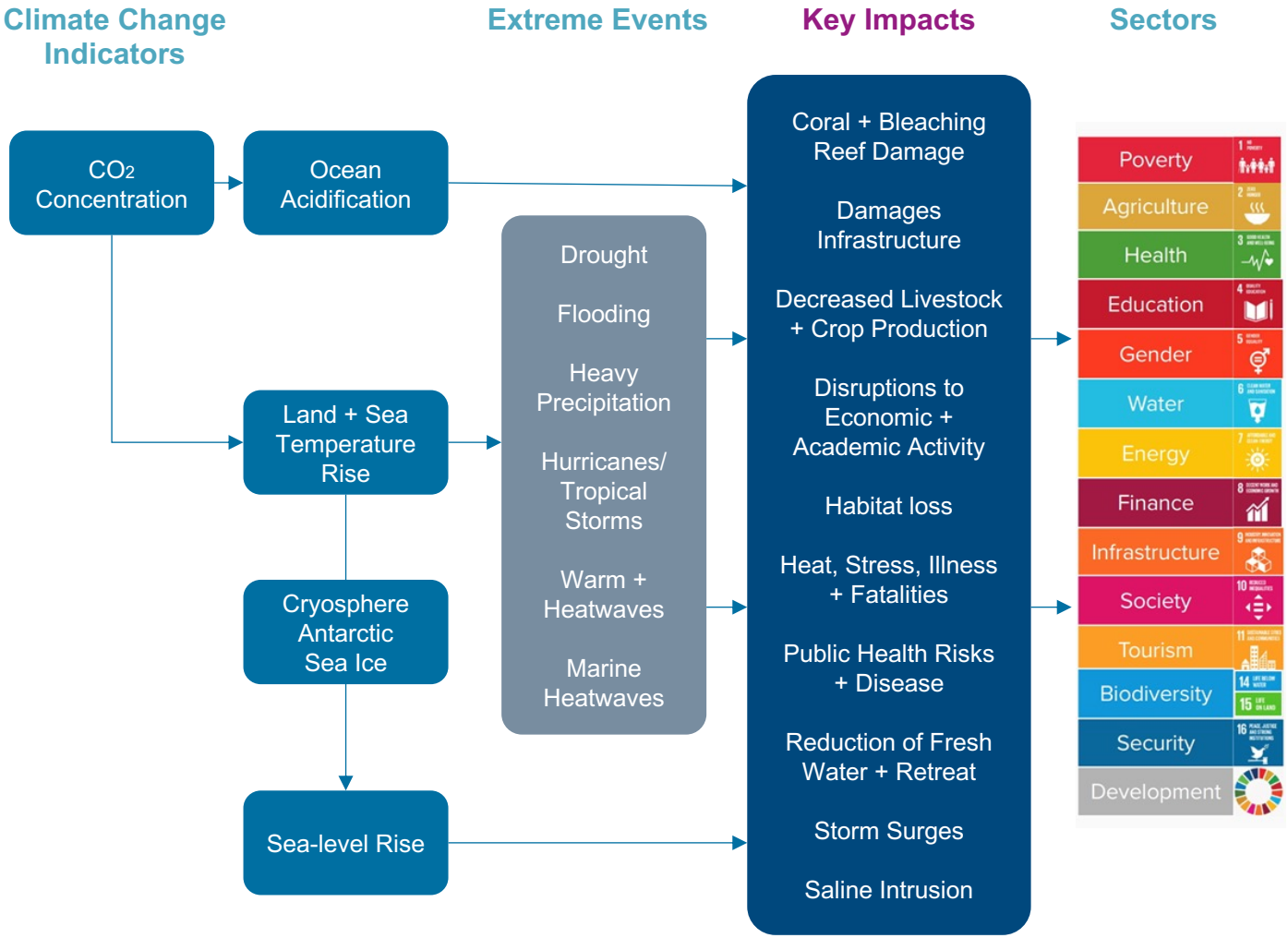
Bapon Fakhruddin, PhD

Tonkin+Taylor

Agenda

- Water and Climate challenges in Pacific
- Coherence in Policy, Plan and Strategy
- IWRM Analytical Framework
  - Conceptual Framework
  - Computational Framework
  - National Policy Objectives and Criteria
  - State Indicators (SIs)
  - Decision Support Indicators (DSIs)
  - Relationship between SIs and DSIs
- Example

Water resilience is the language of climate action



Water & Climate Challenges in the Pacific

- Due to demographic and climate change drivers –stress in water resources specifically fresh water extremely vulnerable
- Out of many climate risks identified are related to water and there is either “too much” or “too little” of it
- Water-Food-Environment Nexus- data ecosystem
- Inadequate quantity and quality and limited coverage of sewerage networks and wastewater treatment systems
- Rapid depletion of groundwater aquifers is leading to inequity in water access and saltwater intrusion

Policy, Plan and Strategy

Harmonise and align cross sectoral and interagency policies

Formulation, analysis + evaluation of alternative water management strategies for IWRM

Example- New Zealand

- Public Health Act, 1872
- Municipal Corporations Act, 1876
- Forests Acts, from 1874
- Local Drainage Acts and Empowering Acts
- Soil Conservation and Rivers Control Act, 1941
- Soil and Water Conservation Act, 1967
- Waters Pollution Act, 1953
- Town and Country Planning Acts, 1953/1977
- **Resource Management Act, 1991**
- Hazardous Substances and New Organisms Act, 1996
- Stockholm Convention on Persistent Organic Pollutants, 2001
- National Environmental Standard for Sources of Human Drinking Water, 2007
- NZ Standard on Flood Risk Management, 2008
- Waste Minimisation Act, 2008
- NZ Waste Strategy, 2010
- National Policy Statement on Urban Development Capacity, 2017
- Waste Minimisation (Microbeads) Regulation, 2017
- **National Policy Statement for Freshwater Management 2020 (Mfe, 2020)**

Conceptual Framework

Step 1: Problem/Issues and possible measures

Step 2: Objectives and criteria

Step 3: Analysis conditions

Step 4: Strategy formulation

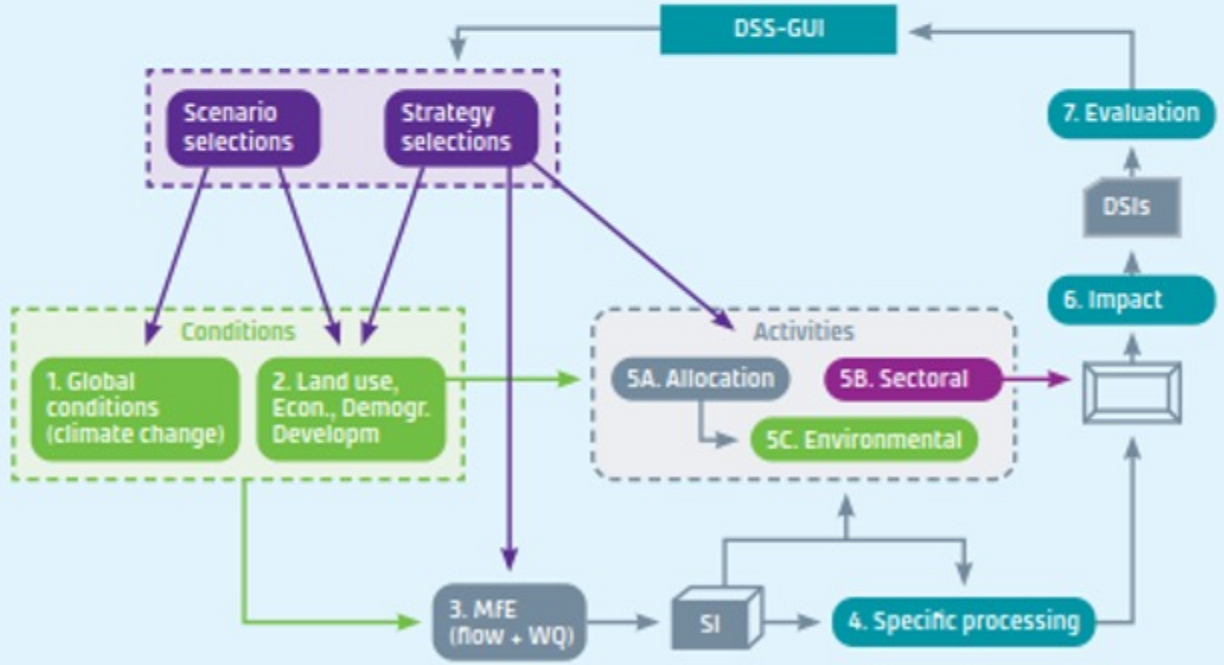
Step 5: Implementation assessment

Step 6: Evaluate strategy

Step 7: Presentation

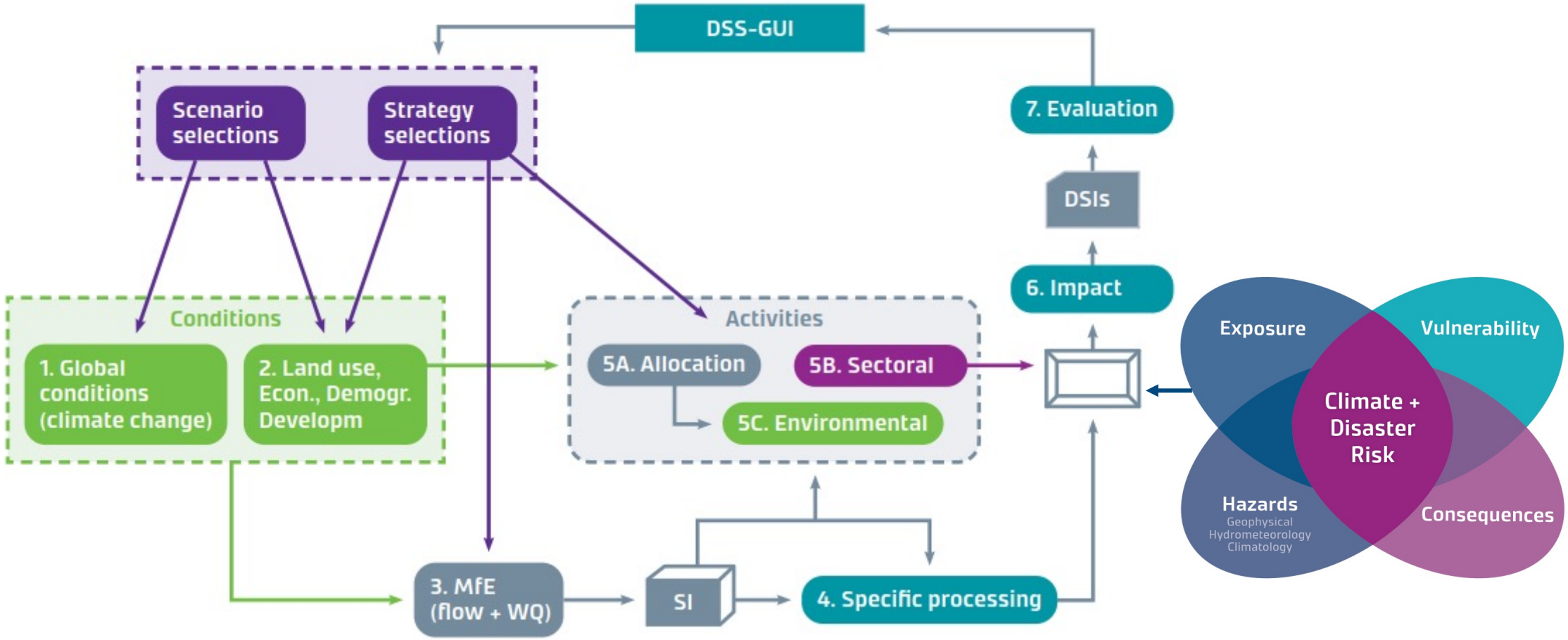
- Objectives
- Indicators
- Problems
- Measures
- Strategies
- Impacts
- CC Scenario's
- Consequences
- etc.

Computational Framework



Analytical Framework

Overall Architecture of Computational Framework



(Source: Fakhruddin 2019, ADB 2017)

National Policy Objectives + Criteria

- National policy objectives (i.e. MfE)
  - Economic development
  - Quality of life (incl. public health and safety)
  - Ecosystem sustainability
  - Recreation
  - Māori well-being and identification (Te mana o te wai)
- Criteria indicate in how far we are able to reach those objectives -> indicators
  - DSI: Decision Support Indicators
- To reach the policy objectives we like to have the natural resource system to be in a certain state, so they are able to provide their functions:
  - SI: State Indicators

State indicators

- The Watershed System performs multiple functions:
  - Flood regulation and drainage
  - Water retention and ‘production’ (supply of water)
  - Water quality
  - Waste-water management
  - Salinity control
  - Tide and storm surge regulation
  - Sediment transport and retention
  - Waste assimilation
- The State Indicators (SI’s) represent these functions is such a way that changes in these values can be assessed in terms of the DSI’s (the objectives)

State Indicators (SIs)- Examples

Flood Attenuation and Drainage	• Peak (annual, frequency) • Duration of submerged conditions above critical levels • Onset of flood • Recession of flood • Change in water level
Water Retention and Protection	• Usable groundwater recharge • Surface water stored in the floodplain during dry period • Soil Moisture • Surface water availability: minimum river flows • Water depth at critical river section

Decision Support Indicators (DSIs)

Economic development	• Gross Domestic Product (GDP) • Production in agriculture • Protection of assets
Māori	• Water quality • Iwi and hapu experience and observations
Recreation	• Swimmability • Fishing • Boating

Assessment Framework			Decision Support Indicators (DSI)																				
			SDG Goals											Economic development		Ecosystem sustainability				Recreation	Māori well-being and identification
			SDG Target 6.1 - Access to water	SDG Target 6.2 - Sanitation and hygiene	SDG Target 6.3 – Water quality		SDG Target 6.4 – Water-use efficiency		SDG Target 6.5 – Integrated water resources management		SDG Target 6.6 – Protect and restore ecosystems	SDG Target 6.A – International cooperation	SDG Target 6.B – Paricipation of local communities								
			DSI-SDG1	DSI-SDG2	DSI-SDG3	DSI-SDG4	DSI-SDG5	DSI-SDG6	DSI-SDG7	DSI-SDG8	DSI-SDG9	DSI-SDG10	DSI-SDG11	DSI-ECD1	DSI-ECD1	DSI-ESS1	DSI-ESS2	DSI-ESS3	DSI-ESS4	DSI-REC1	DSI-MWI1
Code	Description	Unit	Indicator 6.1.1: Proportion of population using safely managed drinking water services.	Indicator 6.2.1: Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water.	Indicator 6.3.1: Proportion of wastewater safely treated.	Indicator 6.3.2: Proportion of bodies of water with good ambient water quality.	Indicator 6.4.1: Change in water-use efficiency over time.	Indicator 6.4.2: Level of water stress: freshwater withdrawal as a proportion of available freshwater resources.	Indicator 6.5.1: Degree of integrated water resources management implementation (0-100).	Indicator 6.5.2: Proportion of transboundary basin area with an operational arrangement for water cooperation.	Indicator 6.6.1: Change in the extent of water-related ecosystems over time.	Indicator 6.A.1: Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan.	Indicator 6.B.1: Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management.	National Income (GDP)	Protection of assets (property, infrastracture, economic value)	Ecosystem - Wetland	Ecosystem - Riparian Margin	Ecosystem - Homestead vegetation	Condition of aquatic habitat	Proportion of freshwater systems swimmable.	Te mana o te wai
Flood attenuation																							
FD1	Flood Protected Area	sqkm																					
FD2	Drainage congestion area	sqkm																					
FD3	Peak water level	mRL																					
FD4	Duration of flood	days																					
FD5	Onset of flood	days																					
Water retention																							
WR1	GW recharge	m^3																					
WR2	SW stored	m^3																					
WR3	Soil moisture	mm/m^2																					
WR4	Low flows	m^3/s																					
WR5	Water depth	m																					
WR6	Min. GW levels	mRL																					
Water quality																							
WQ1	Level of E.coli bacteria																						
WQ2	Level of toxic algae																						
WQ3	Nitrate-nitrogen level																						
Sediment transport/ retention																							
ST1	Sediment concentration capacity	mg/l																					
ST2	Floodplain sedimentation	mm/year																					
Waste assimilation																							
WA1	Flashing water required	m^3/s																					
WA3	Concentration of pollution																						
Provide water-related habitat																							
WH1	Wetland area	sqkm																					
WH2	Fish migration route length	km																					
WH3	Native species	#																					
Iwi and hapu experience																							
ME1	Positive experience	#																					

Relationship between SIs + DSIs

Simple example

Inputs: Strategies & Scenarios					Outputs: Change in State Indicators	OUTCOME: Ensure availability and sustainable management of water and sanitation for all												MfE goals	
						Target 6.1	Target 6.2	Target 6.3		Target 6.4		Target 6.5		Target 6.6	Target 6.a	Target 6.b	Economic Development	Swimmability	Te mana o te wai
Infrastructure Investment	Non-Structural Investment	Regulatory rules & regulations	Demand Management	Institutional arrangement		Indicator 6.1.1	Indicator 6.2.1	Indicator 6.3.1	Indicator 6.3.2	Indicator 6.4.1	Indicator 6.4.2	Indicator 6.5.1	Indicator 6.5.2	Indicator 6.6.1	Indicator 6.a.1	Indicator 6.b.1	GDP / Protection of assets	Proportion of freshwater systems swimmable	Cultural Health Index (CHI)
					Flood attenuation														
					Water retention														
					Water quality														
					Waste-water management														
					Salinity control														
					Tide and storm surge regulation														
					Sediment transport/ retention														
					Waste assimilation														
					Water-related habitats														
					Iwi and hapu experience														

Inputs: Strategies & Scenarios	Outputs: Change in State Indicators	OUTCOME: Ensure availability and sustainable management of water and sanitation for all											MfE goals		
		Target 6.1	Target 6.2	Target 6.3		Target 6.4		Target 6.5		Target 6.6	Target 6.a	Target 6.b	Economic Development	Swimmability	Māori well-being and identification
Infrastructure Investment **Central Interceptor (CI)**		Indicator 6.1.1	Indicator 6.2.1	Indicator 6.3.1	Indicator 6.3.2	Indicator 6.4.1	Indicator 6.4.2	Indicator 6.5.1	Indicator 6.5.2	Indicator 6.6.1	Indicator 6.a.1	Indicator 6.b.1	GDP / Protection of assets	Proportion of water systems swimmable	Te mana o te wai
	Flood attenuation				%			1-100					$$		
	Water retention			%				1-100							
	Water quality				%			1-100						%	CHI
	Waste-water management			%				1-100	%				$		
	Salinity control														
	Tide and storm surge regulation														
	Sediment transport/ retention														
	Waste assimilation														
	Water-related habitats							1-100		sqkm					
	Iwi and hapu experience							1-100							CHI

Alternative Strategies example

Alternative Strategies	Outcomes	Target objectives	Qualitative Impact Assessment			
			Cost	Ease to implement	Peoples interest	Env. Implication
Orange Strategy: Balance surface and groundwater development	Balance shear of water and provide safety to the people	Food security, and Environment	M	M	H	M
Green Strategy: Live with flood and demand management	Meet demand for environment and people and Increase efficiency in water use	Environment and Quality of live	L	H	L	H
Red Strategy: Full development	Maximize agriculture production and reduce vulnerability	Economic and Food security	H	M	H	L
Do nothing			-	-	L	L

Thank you

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TONGA WATER BOARD

IMPACT CLIMATE CHANGE

BACKGROUND

- Tonga one of the 52 Small Island Developing States (SIDS) is highly susceptible to the impact of climate change and disasters due to its geographical, geological, and socio-economic characteristics

- Climate change and natural disasters pose severe adverse threats on the environment, the people of Tonga, and their livelihoods

- Scientific findings revealed that these impacts would be exacerbated by future climate change.

CLIMATE CHANGE IMPACT

- Cyclones are the most frequently occurring disaster in Tonga; average 1.3 tropical cyclones affect Tonga per year
- The worse cyclone disaster in Tonga occurred in 1982; killed 6 people and affected 146,512.
- Additional to cyclone is natural hazards in Tonga include earthquakes and volcanic activity. Tonga lies in close proximity to the Aust. & Pacific tectonic plates in the most seismically active regions in the Pacific
- Tonga is vulnerable to tsunamis most recent in September 2009, killed 9 people when waves 6-17 m high affected areas 600m inland and destroy many villages; total cost of US$9.5 million.
- Climate pattern is highly vulnerable to the effect of El Nino, generally occurs once every three to seven years and always coincides with drought incidence.

SOURCE OF WATER AND ITS CHALLENGES

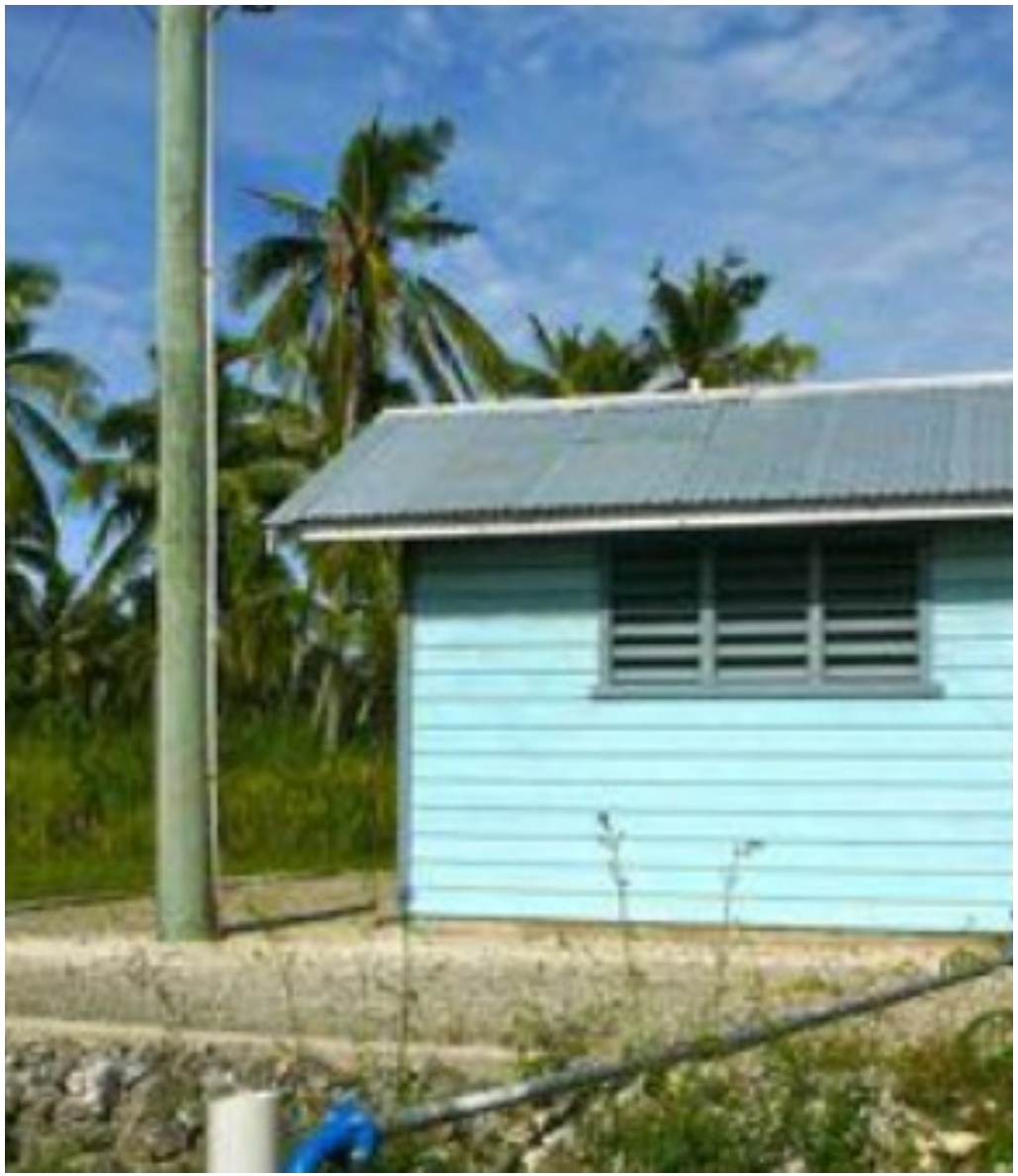
- Fresh water for Tonga is either rainwater harvesting or extraction from a thin freshwater lens within the highly porous limestone substrate.
- Groundwater is used domestically for cooking, bathing, food preparation, plants, animals, sewerage, and general cleaning.
- It is piped to homes, government buildings, business, industry, and tourist accommodations by Tonga Water Board (TWB)in the urban centers of Nuku'alofa.
- Many villages outside of these centers have their own water system administered by water communities.
- TWB water supply is metered at each property; most villages are currently introducing individual meters
- Each Island within each group has vary water resource issues and concerns depending on population pressure, demand, the quality and quantity of water supply, local geology, agricultural and sanitation practices, and extraction standards.

SOURCE OF WATER AND ITS CHALLENGES

- Water use for agricultural purposes is not documented, and water drawn from village water supply system is not metered.
- Numbers of bores are operating in Tongatapu or in the other island groups is unknown, as is the extracted volume.
- Tonga does not have centralized reticulated sewerage system. All wastewater is managed by on-site system, with supervision by the Ministry of Health (MOH) when resources permit.
- Wastewater management is in the hands of the community.
- Poorly constructed or inappropriate sanitation system are common, resulting in the potential for pathogen introduction into the surrounding environment, including groundwater system.

SOURCE OF WATER AND ITS CHALLENGES

- No information database or data-exchange system on water resources is available for water resource assessment and monitoring; nor is a national hydrological network.
- Water resources are currently managed by a number of institutions, some of which deal with specific or general monitoring
- Disaster or emergencies that could affect water resources in Tonga include chemical pollution from pesticides, fertilizers, and oil and industrial components and extreme weather events such as cyclones, earthquakes, drought and flooding.
- Beach mining for sand and aggregates (dead coral) have also increased the impact of storm on coastal areas.
- Economic impact of inundation has also affected town and allotments resulting in the abandonment of homes and crops



WAY FORWARD

- Tonga National Disaster Management Plan; in additional to National Emergency Management Committee (NEMC); National Disaster Management Office (NEMO) to detail disaster management mechanisms.
- Demand for management measures, water supply augmentation, drought vulnerability assessment and climate forecasting can all help toward greater disaster preparedness.
- Institutional and regulatory support is required to effectively prepare for and manage disaster and to reduce the impact of climate variability of freshwater resources.
- Legislative has been introduced that support a sustainable approach it requires approval and funding allocation for implementation (perspective TWB)
- Village water supply committees require financial and technical assistance in addition to and on-the job training to establish and maintain their water supply system.

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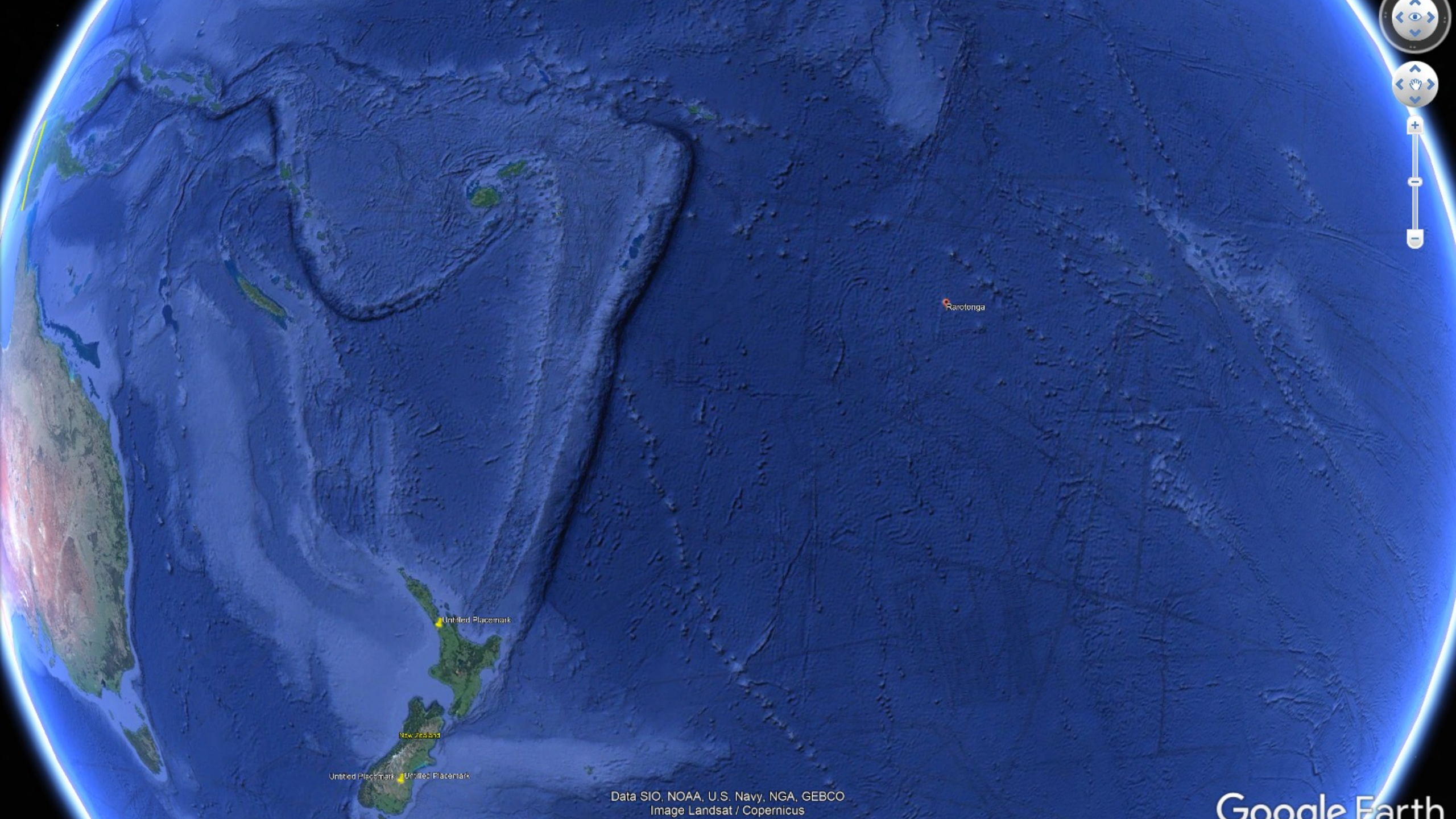
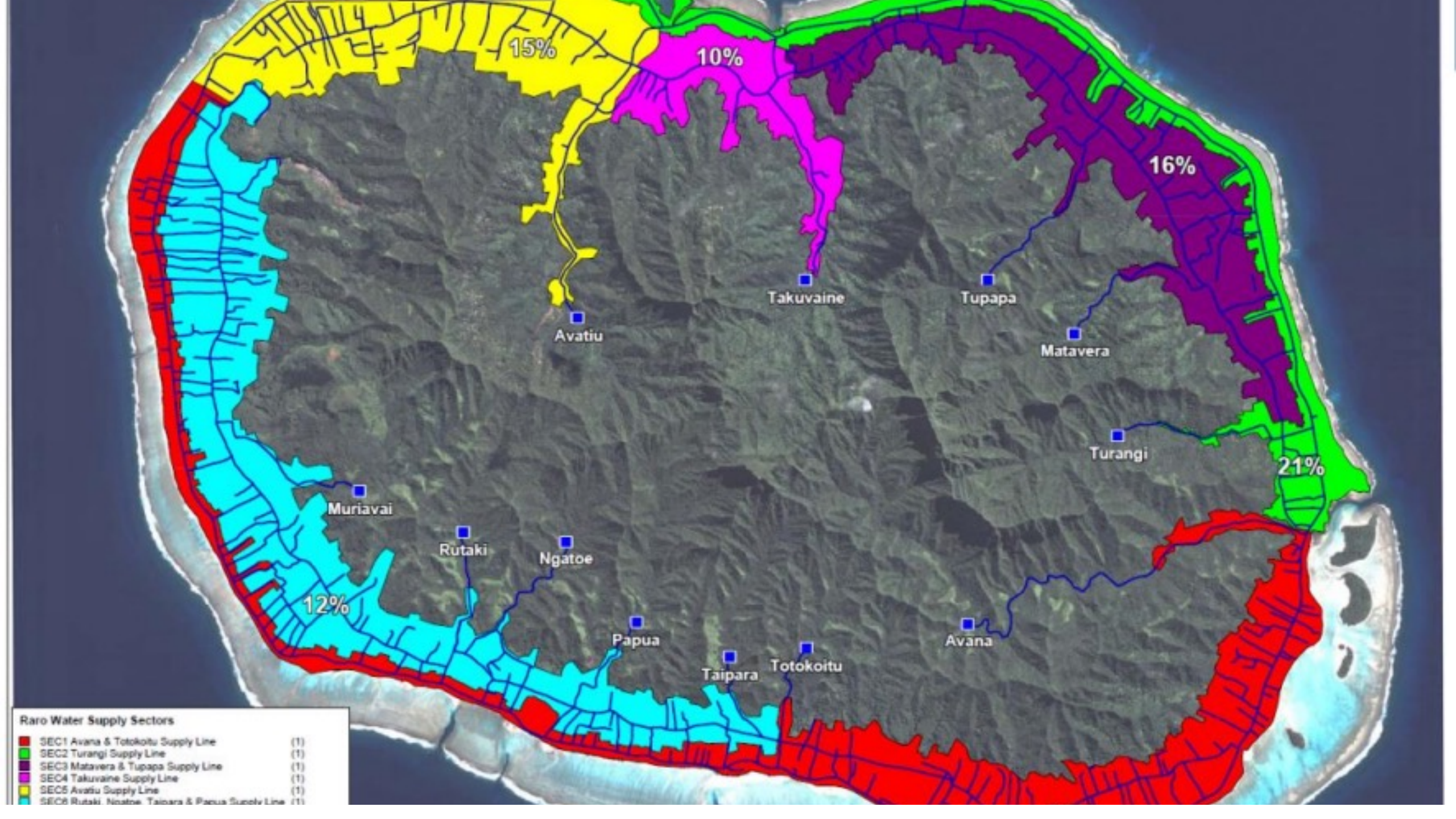
Rarotonga Groundwater Resource Assessment

Chris Shanks - Environmental Scientist (Hydrogeology)


Rarotonga
Untitled Placemark
New Zealand
Untitled Placemark
Untitled Placemark
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth


Avarua
Matavera
Arorangi
Ngatangiia
MOTUTAPU
ONEROA
KOROMIRI
TAAKOKA
Muri
Ngatangiia Harbour
Rutaki Passage
Papua Passage


15%
10%
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Avatiu
Takuvaine
Tupapa
Matavera
Turangi
Muriavai
Rutaki
Ngatoe
Papua
Taipara
Totokoitu
Avana
Raro Water Supply Sectors
SEC1 Avana & Totokoitu Supply Line (1)
SEC2 Turangi Supply Line (1)
SEC3 Matavera & Tupapa Supply Line (1)
SEC4 Takuvaine Supply Line (1)
SEC5 Avatiu Supply Line (1)

Key Background

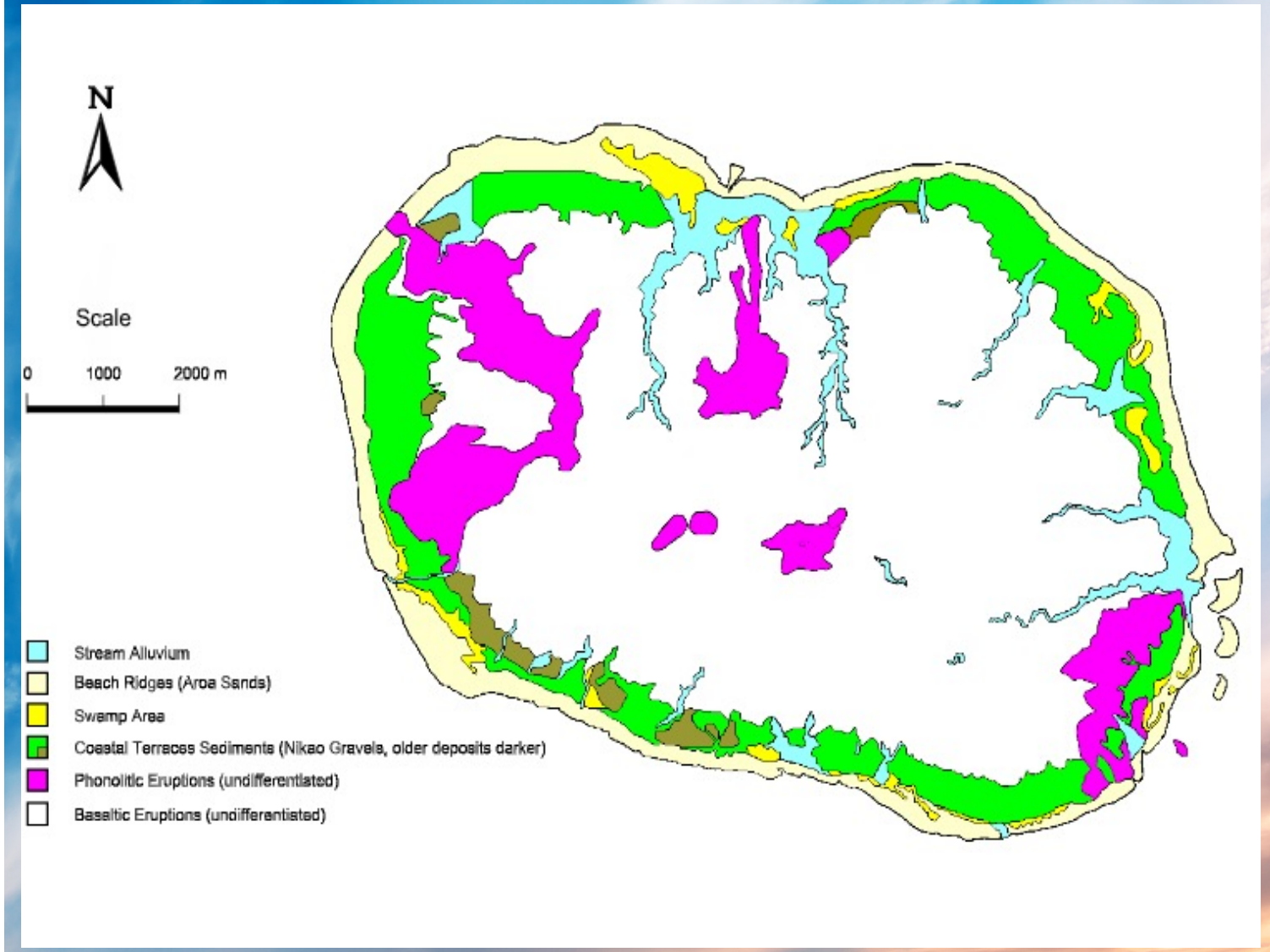
- Aging network infrastructure (un-metered, lots of leakage)
- Tourism vs dry season
- Little or no storage on eastern side of the island
- Smaller streams/rivers on the eastern side = less resilient (heavy reliance on Avana)
- No treatment
- Heavy rain = shutdowns due to high turbidity

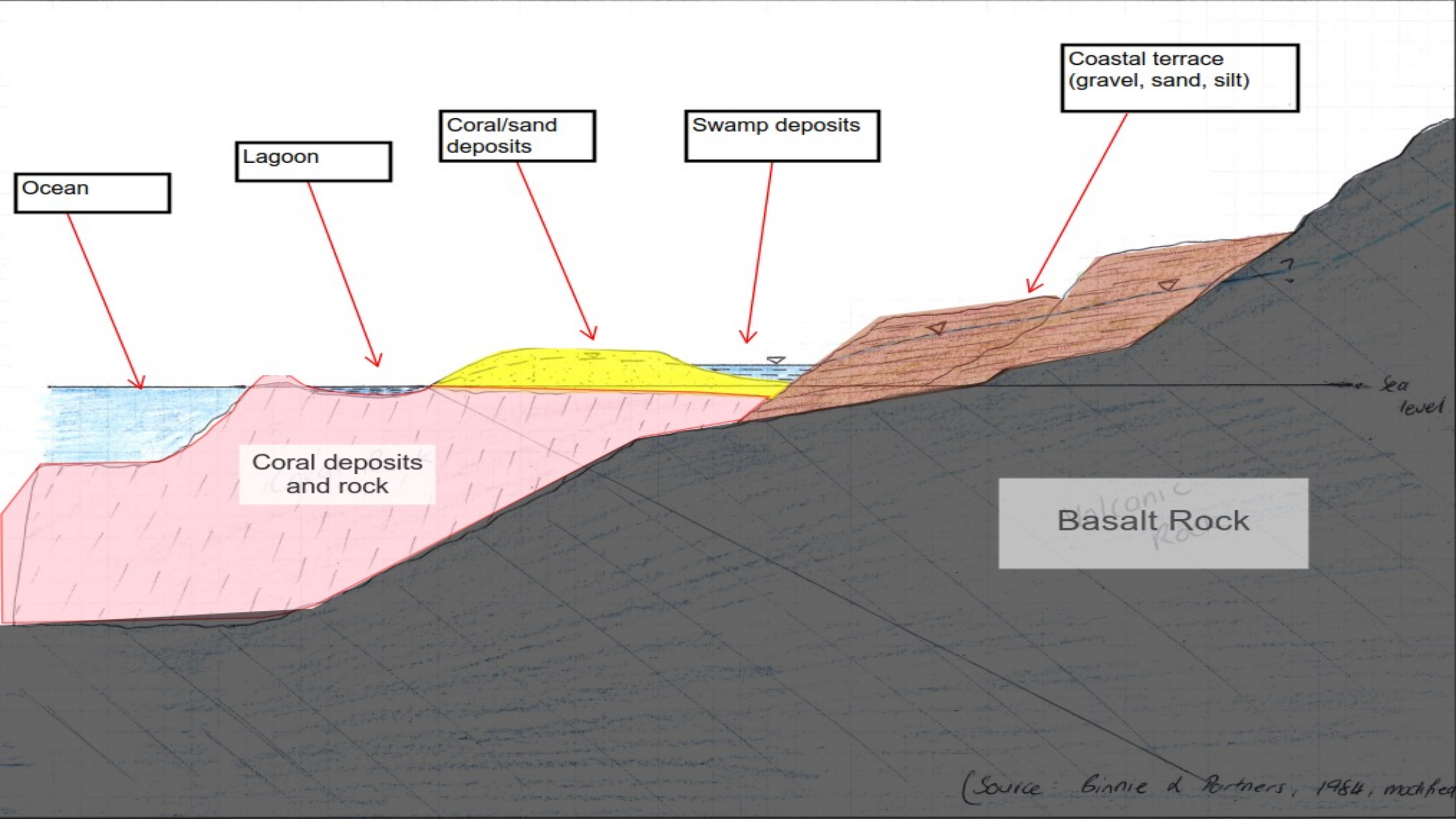
Project objectives

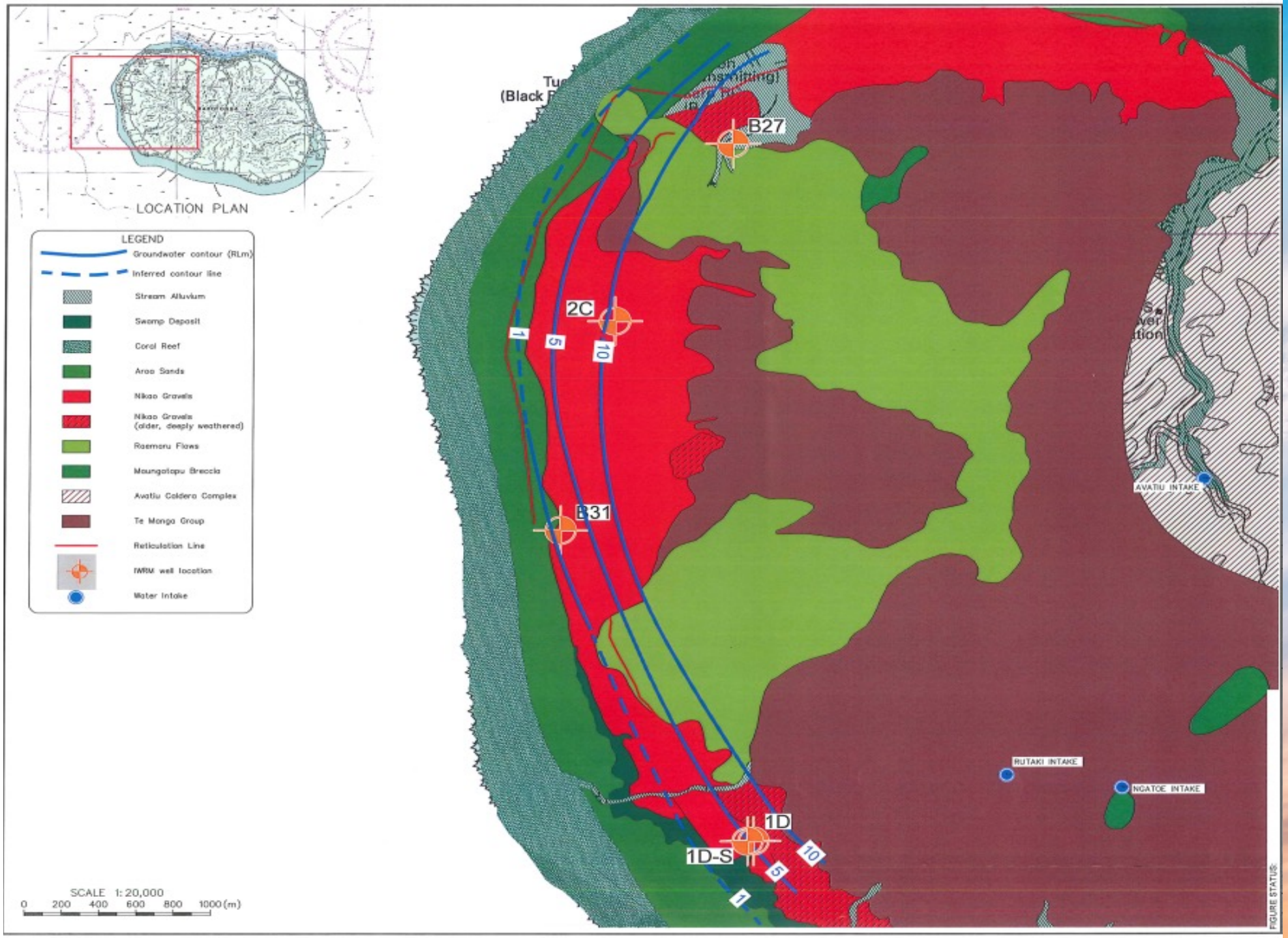
- Improve water security
- Assess groundwater resource potential on the eastern side of the island (5 investigation wells)
- Rehabilitate and reinstall monitoring wells

Geology

- Volcanic, with coastal terraces, beach ridges and a barrier reef (coral)
- Basalt rock generally low-yielding (not particularly fractured)
- Coastal terraces (Nikao Gravels) highly variable
- Beach ridges more consistent, but subject to saline intrusion

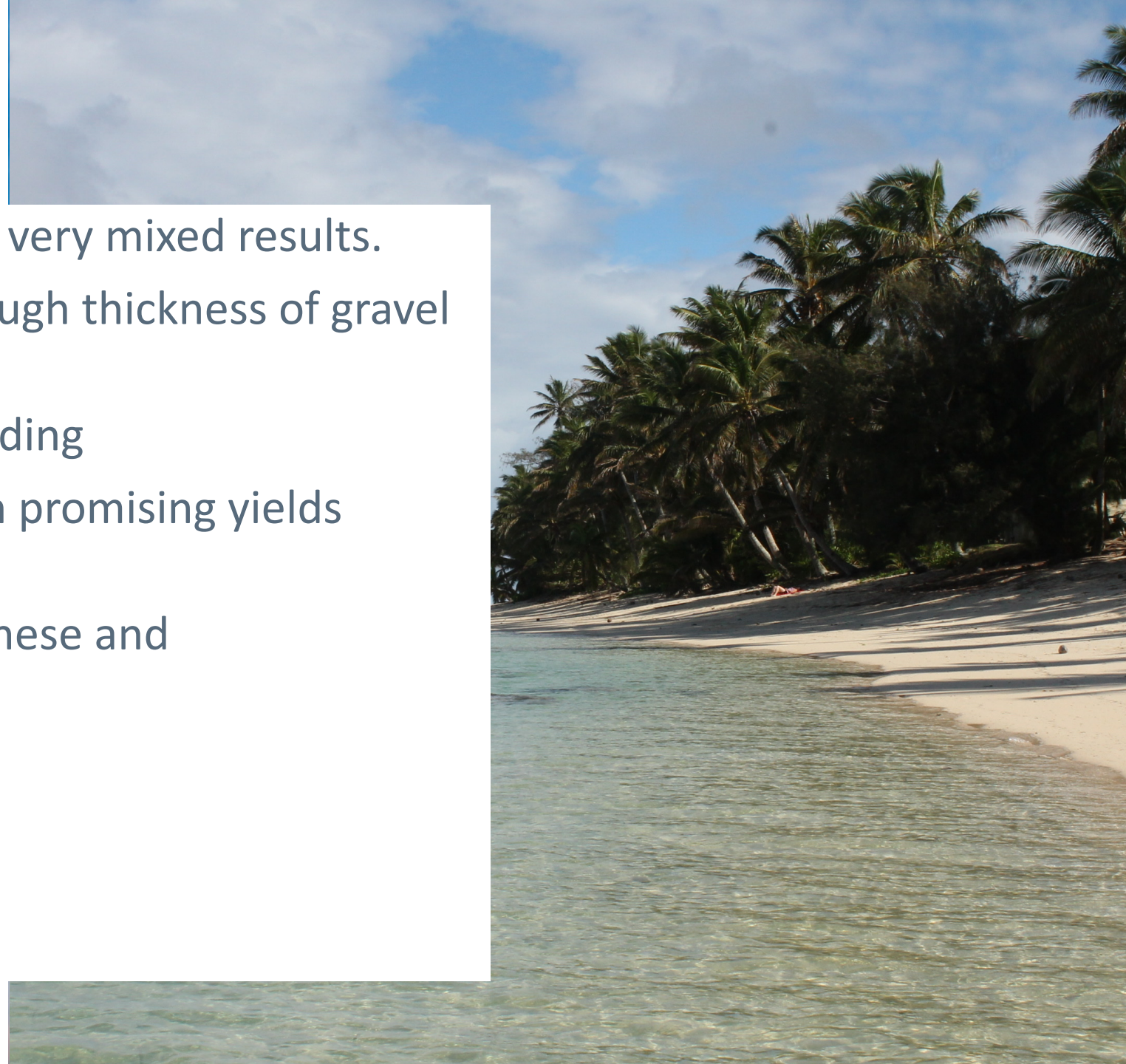



Coastal terrace
(gravel, sand, silt)
Swamp deposits
Coral/sand
deposits
Lagoon
Ocean
Sea
level
Coral deposits
and rock
Basalt Rock
(Source: Binnie & Partners, 1984, modified


LOCATION PLAN
LEGEND
Groundwater contour (RLm)
Inferred contour line
Stream Alluvium
Swamp Deposit
Coral Reef
Arao Sands
Nikao Gravels
Nikao Gravels (older, deeply weathered)
Raemaru Flows
Maungatapu Breccia
Avatiu Caldera Complex
Te Manga Group
Reticulation Line
IWRM well location
Water Intake
B27
2C
B31
1D
1D-S
1
5
10
AVATIU INTAKE
RUTAKI INTAKE
NGATOE INTAKE
SCALE 1:20,000
0 200 400 600 800 1000 (m)
FIGURE STATUS:

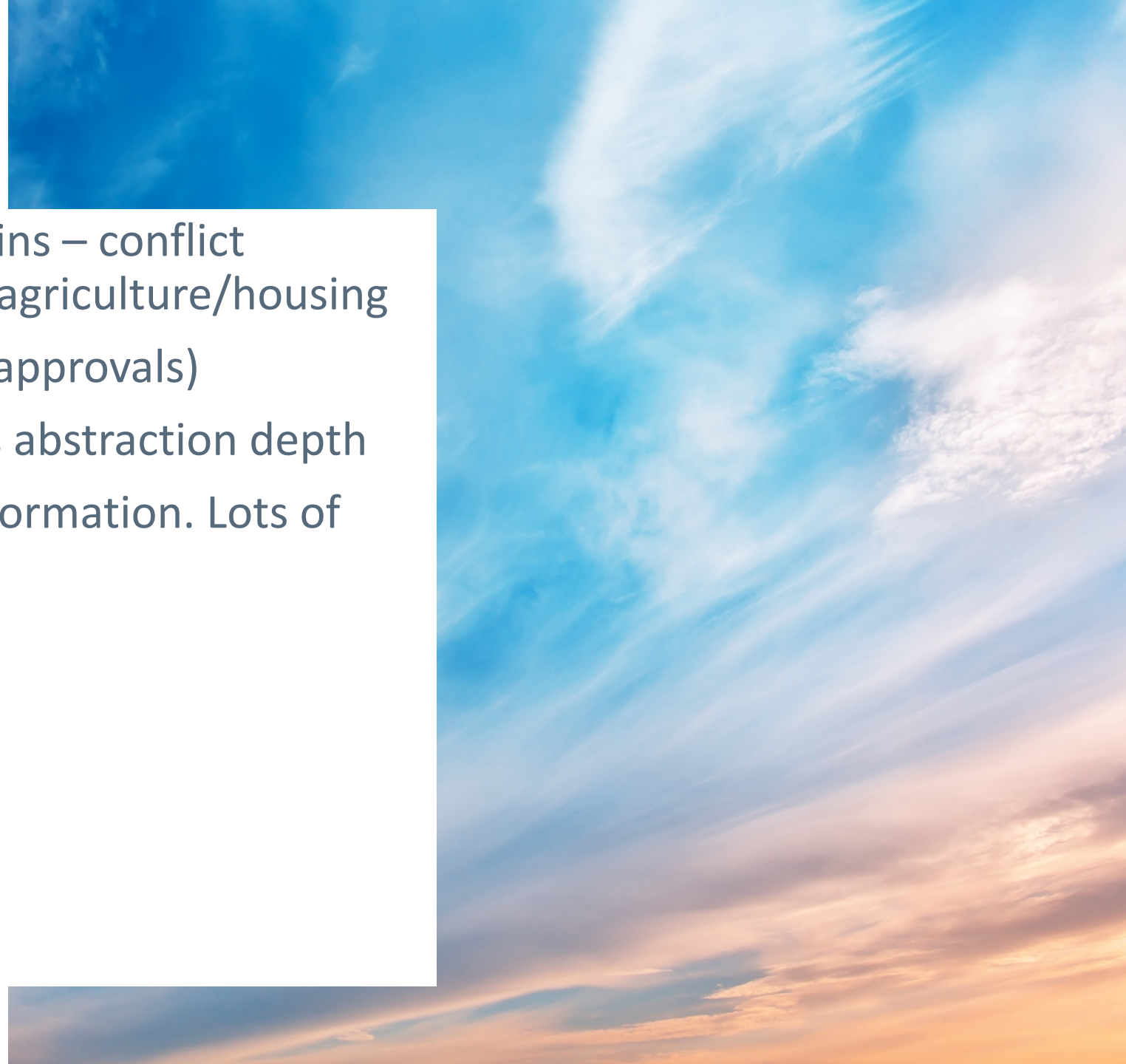
Results

- Targeted the Nikao gravels, with very mixed results.
- Mostly struggled to achieve enough thickness of gravel before hitting basalt rock
- Mostly fine-grained and low yielding
- One bore identified an area with promising yields (approx.400m^3/day?)
- Poor water quality (iron, manganese and bacteriological)



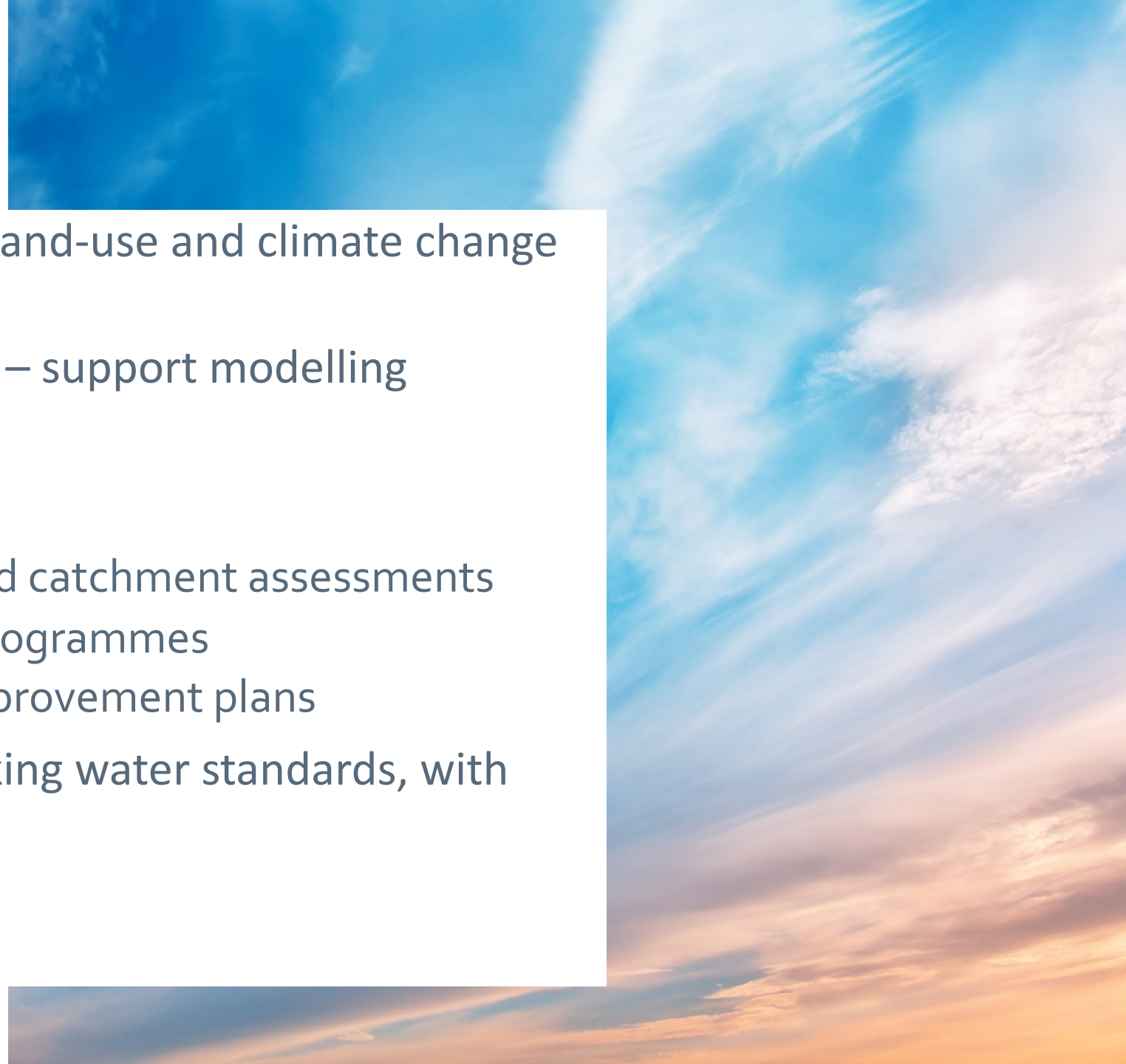
Challenges

- Limited space on the coastal plains – conflict between source protection and agriculture/housing
- Land ownership (difficult to get approvals)
- Saline intrusion at depth – limits abstraction depth
- Limited local-scale geological information. Lots of high-level assessments



Reflections

- Competing objectives between land-use and climate change (coastal retreat)
- Long-term monitoring networks – support modelling
- Local-scale geological mapping
- Source management planning:
    - Source protection zones and catchment assessments
    - Source water monitoring programmes
    - Long-term strategy and improvement plans
- NZ regulatory reform (new drinking water standards, with focus on catchment planning).



Discussion and Q&A

Thank you.