Pacific Adaptation to Climate Change
Cook Islands, Fiji & Kosrae (FSM)

Developing underpinning information to support adaptation decision-making

National Institute of Water & Atmospheric Research (NIWA), NZ

NIWA
Taihoro Nukurangi

PACC Projects

- **Cook Islands:** Geospatial framework for climate change in the coastal zone of Mangaia Island.
- **Fiji:** Assessment of climate change on drainage network and infrastructure in the Tailevu/Rewa and Navua delta regions.
- **Kosrae, FSM:** Climate monitoring to underpin "climate proofing" decision-making and design

Providing evidence-based information to support climate risk management decision-making

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Cook Islands / Fiji: Objectives

- Develop baseline information necessary to support a risk-based approach to climate change adaptation.
- Assess how climate change and sea-level rise will impact:
  - on the frequency, magnitude and extent of coastal-related inundation along the village / harbour and airport shorelines of Mangaia Island.
  - on the agricultural drainage schemes in the Rewa and Navua deltas.
- Provide a sound, objective and evidence-based framework for developing climate change adaptation strategies.
- Demonstrate an approach that is scalable and can be transferred and applied to other areas in the Cook Islands / Fiji (or indeed other Pacific Islands).

Geospatial framework for climate change in the coastal zone of Mangaia Island

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Applied Geoscience and Technology Division (SOPAC)

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Project Components

- Data collection
  - Bathymetry
  - Topography
  - Wave and water levels
- Cyclone and swell climate modelling (waves and water levels) and extreme analysis
- Climate change impacts on waves and water levels (and resulting shoreline conditions)
- Tools for site specific assessment and guidance products to use and apply the information developed.

New wharf under construction

Water level (tides), water depth (marine charts) and wave conditions are essential information for new maritime and coastal infrastructure

Coastal Bathymetry / Topography Survey

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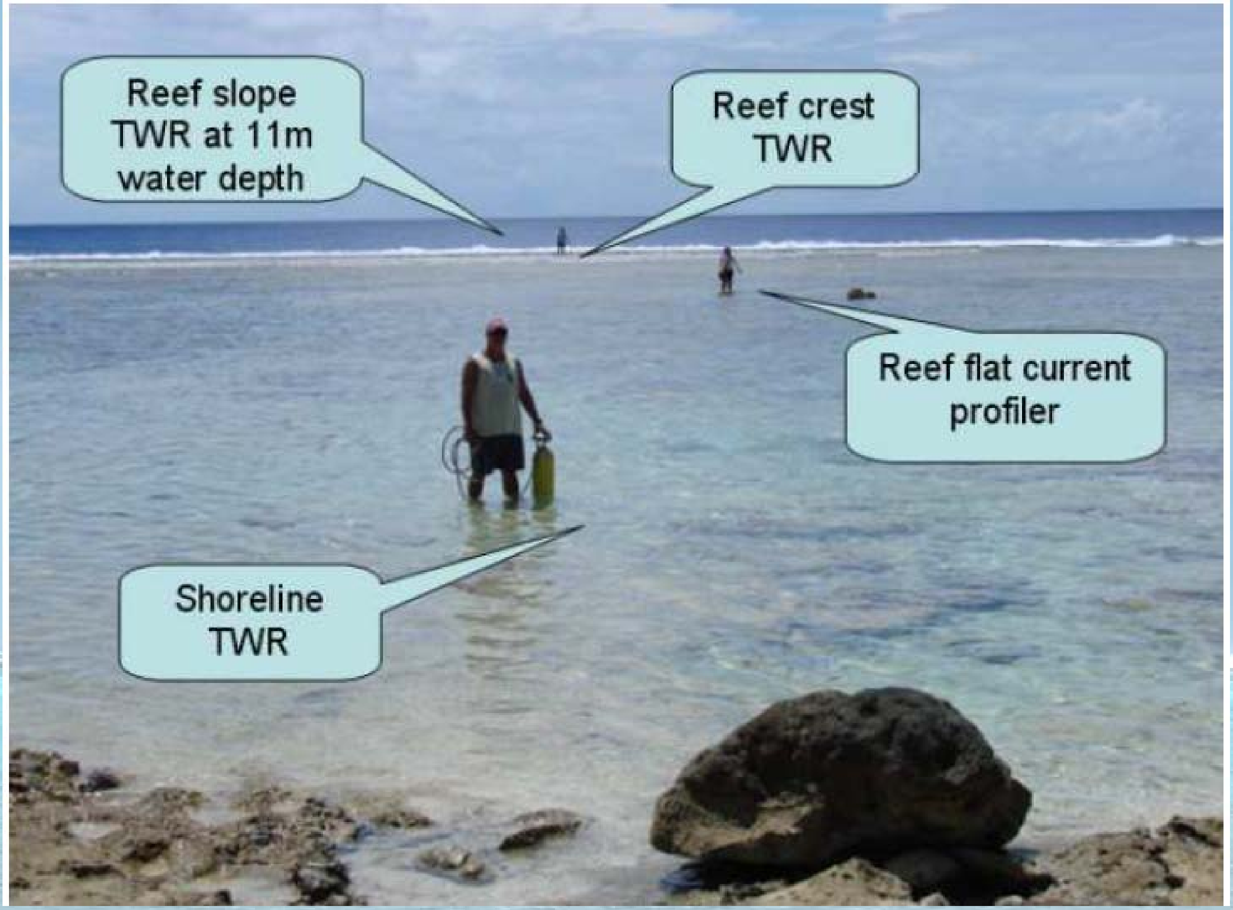
Waves and water levels



Tide and wave recorder (TWR)

Current profiler

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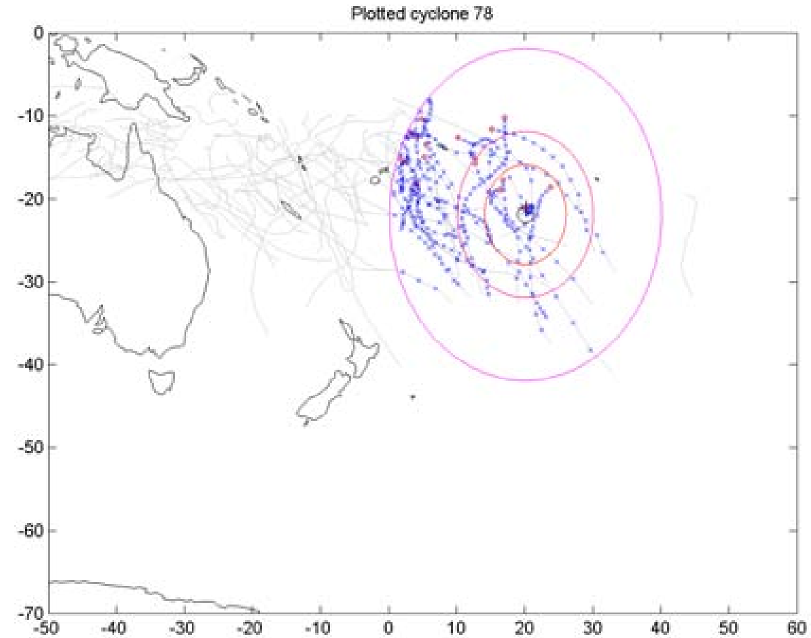
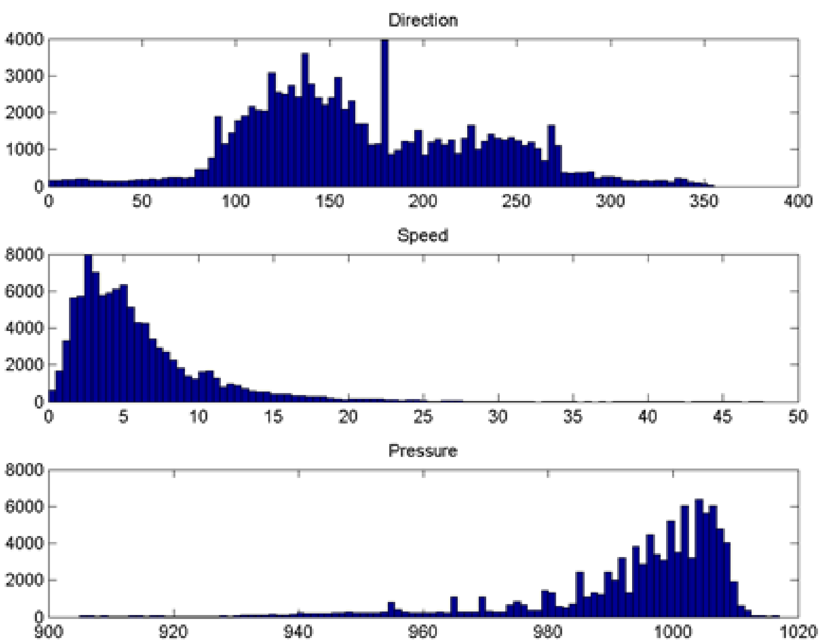
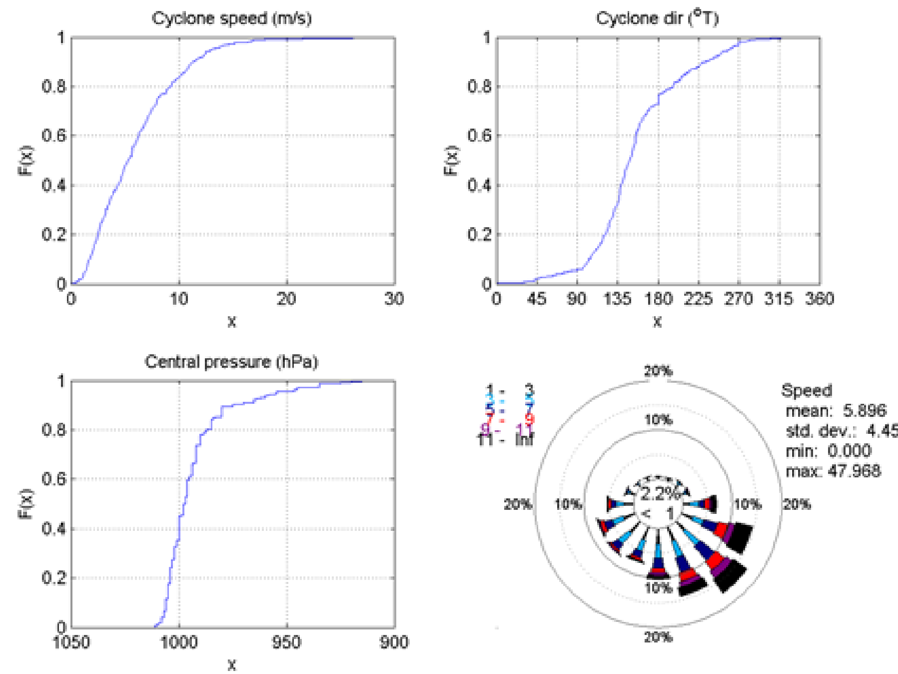
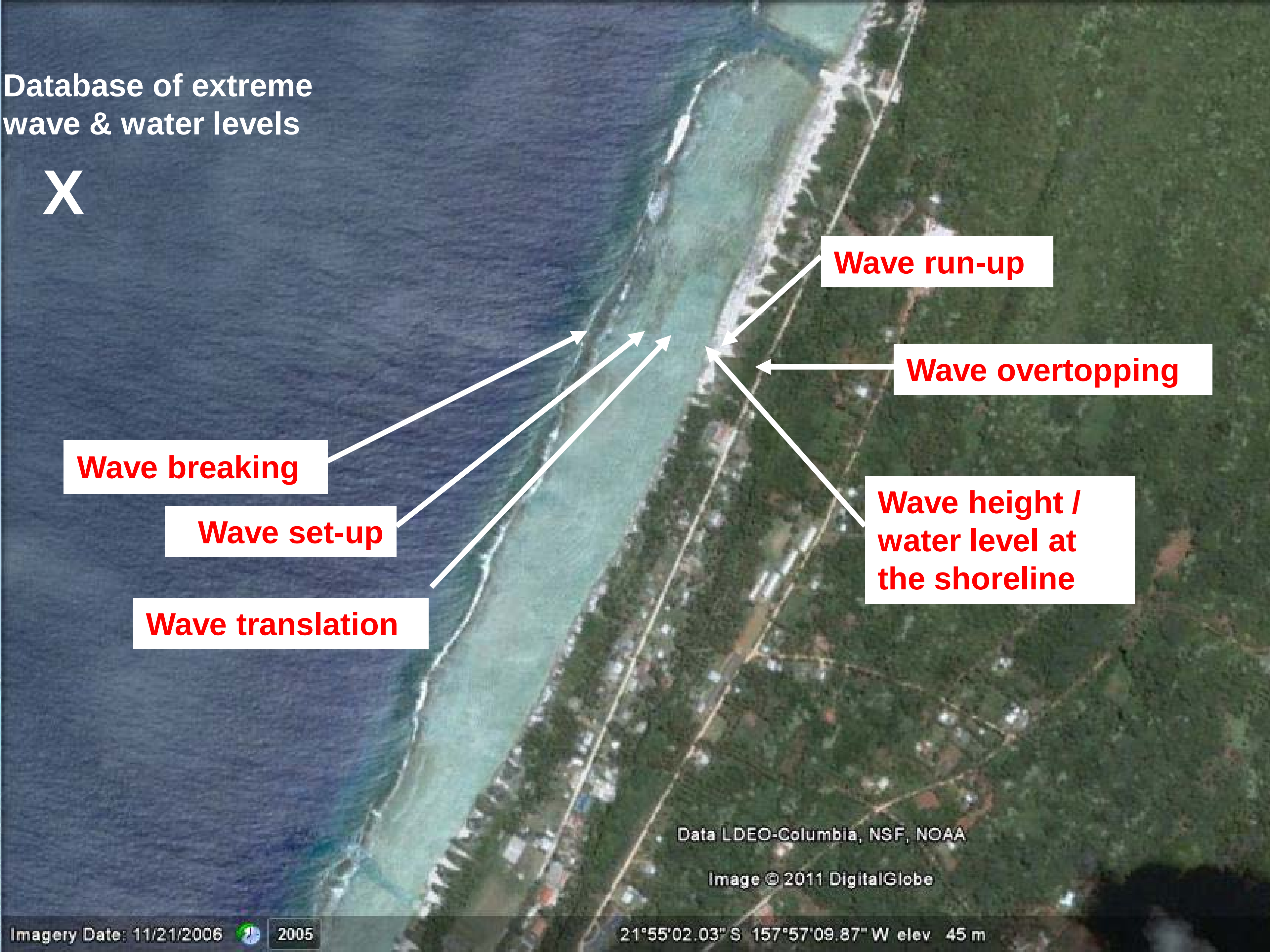


- Developing Information on:
  - Extreme waves and swell
  - Extreme water levels
  - Wave run-up
  - Wave overtopping
- How these will change with climate change






Database of extreme
wave & water levels
X
Wave run-up
Wave overtopping
Wave breaking
Wave set-up
Wave height /
water level at
the shoreline
Wave translation
Data LDEO-Columbia, NSF, NOAA
Image © 2011 DigitalGlobe
Imagery Date: 11/21/2006
2005
21°55'02.03" S 157°57'09.87" W elev 45 m

Input data

1. Select location

See Map

Location on Tarawa: OCEAN SHORE: South coast

2. OCEAN shoreline: Reef flat characteristics

HELP

Ocean shore reef flat width (m):	400	m
Level of landward edge of reef:	1.44	(m rel. to UoH datum)
Average reef flat level:	0.54	(m rel. to UoH datum)
	0	Not required
Level of the top of any beachrock:	0.00	(m rel. to UoH datum)

Enter additional ocean-shore reef flat information:

Wave breaking location:	Reef edge brim - Default
Angle of reef face slope (1 in x):	1 in 6
Ocean side reef flat characteristics:	75%-100% sand

3. OCEAN shoreline: Beach / seawall characteri

HELP

Shoreline type:	Sloping (revetment) seawall	
Seawall crest level:	3.735	(m rel. to UoH datum)
Seawall (revetment) slope (1 in x):	1.5	
Seawall crest width:	0.65	m
Seawall (revetment) armouring:	Concrete filled mattress	
Revetment crest wall:	Yes	

Results: Ocean shoreline

Timeframe: Tibu-toru (2036-2060) **Baseline (present) year:** 1980-1999 average (IPCC)

Emission Scenar A1FI (high) **Sea-level rise magnitude:** 0.35 m

Select results to sho Changes in mean overtopping discharge

Compare to overtopping safe limits for: Danger to vehicles (low speed)

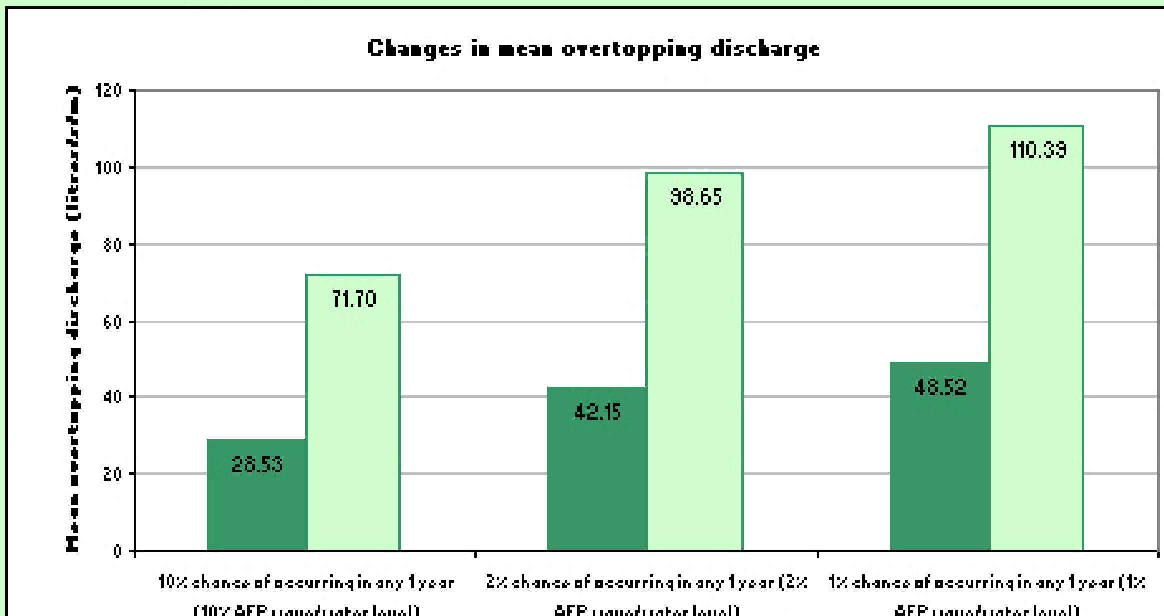
Changes in mean overtopping discharge

Results in litres per second per metre of seawall

	Present day	Tibu-toru (2036-2060)		% increase
10% chance of occurring in any one year:	28.53	71.70	l/s/m	151.3%
Danger to vehicles (low speed):	No	Yes		
2% chance of occurring in any one year:	42.15	98.65	l/s/m	134.0%
Danger to vehicles (low speed):	Yes	Yes		
1% chance of occurring in any one year:	48.52	110.39	l/s/m	127.5%
Danger to vehicles (low speed):	Yes	Yes		

Ocean shoreline Changes in mean overtopping discharge

Maximum values from all joint probability combinations



Plot description

This figure shows how the mean wave overtopping of seawall structures will change due to climate change. The dark green bars show the mean overtopping rates for the present day with the light green bars showing the equivalent overtopping levels for the selected future timeframe and emissions scenario. The mean overtopping rates are the maximum values for all wave and water level joint combinations, for the 10% annual

Outputs

- Design wave and water level conditions (all islands)
- Calculator tools to enable site specific assessments to be easily made.
- Framework for using and applying the information
- Inundation extent maps to help inform land use planning

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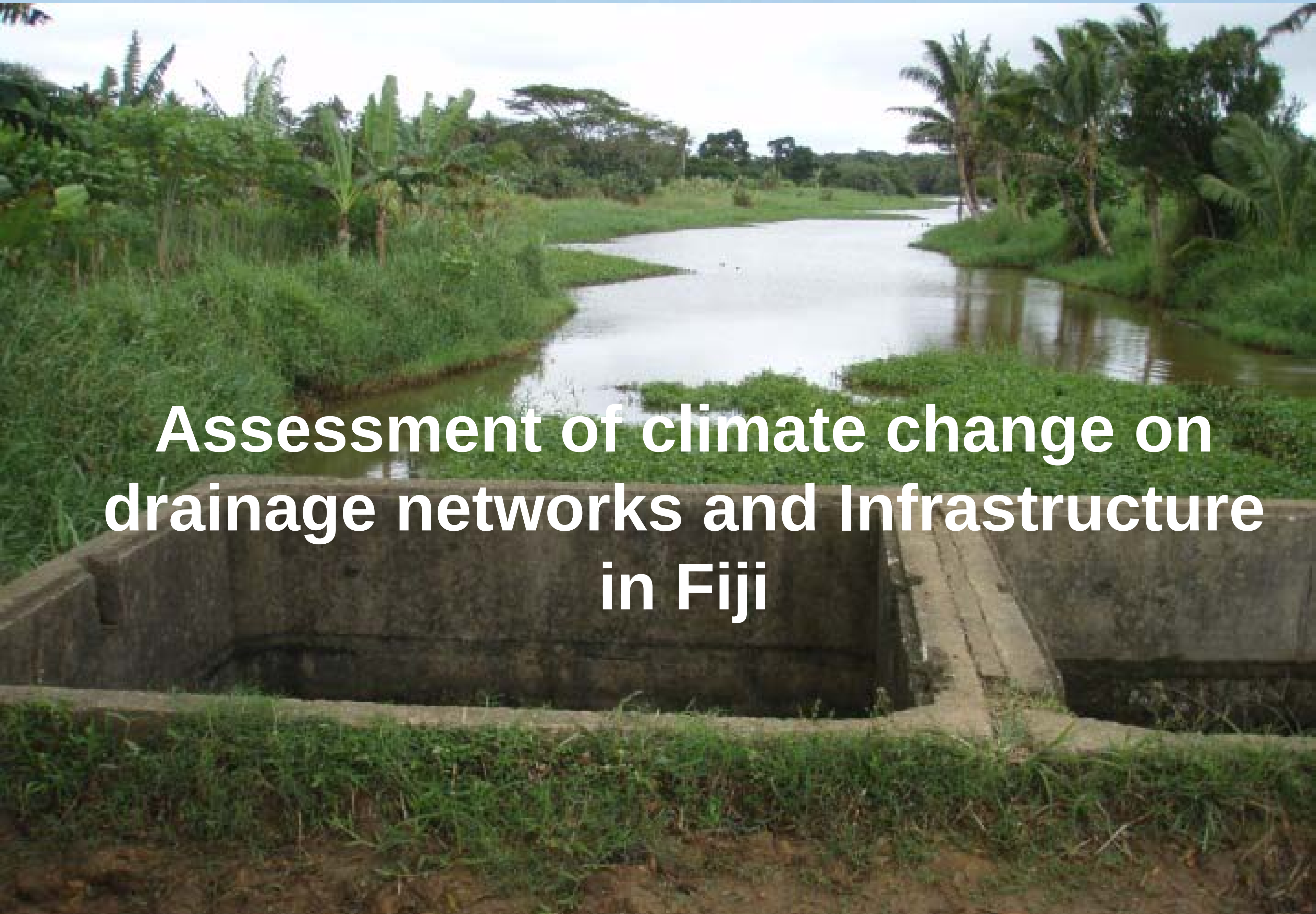

Assessment of climate change on drainage networks and Infrastructure in Fiji

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MWH.
BUILDING A BETTER WORLD

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agresearch

FNU FIJI NATIONAL UNIVERSITY

Project Components

- Climate change
  - Extreme rainfall
  - Sea level rise and extreme water levels
- Field topography and bathymetry data collection
- Hydraulic (drainage) modelling
- Socio-economic community vulnerability assessment
- Options development and appraisal
- Tools and guidance products to use and apply the information developed.

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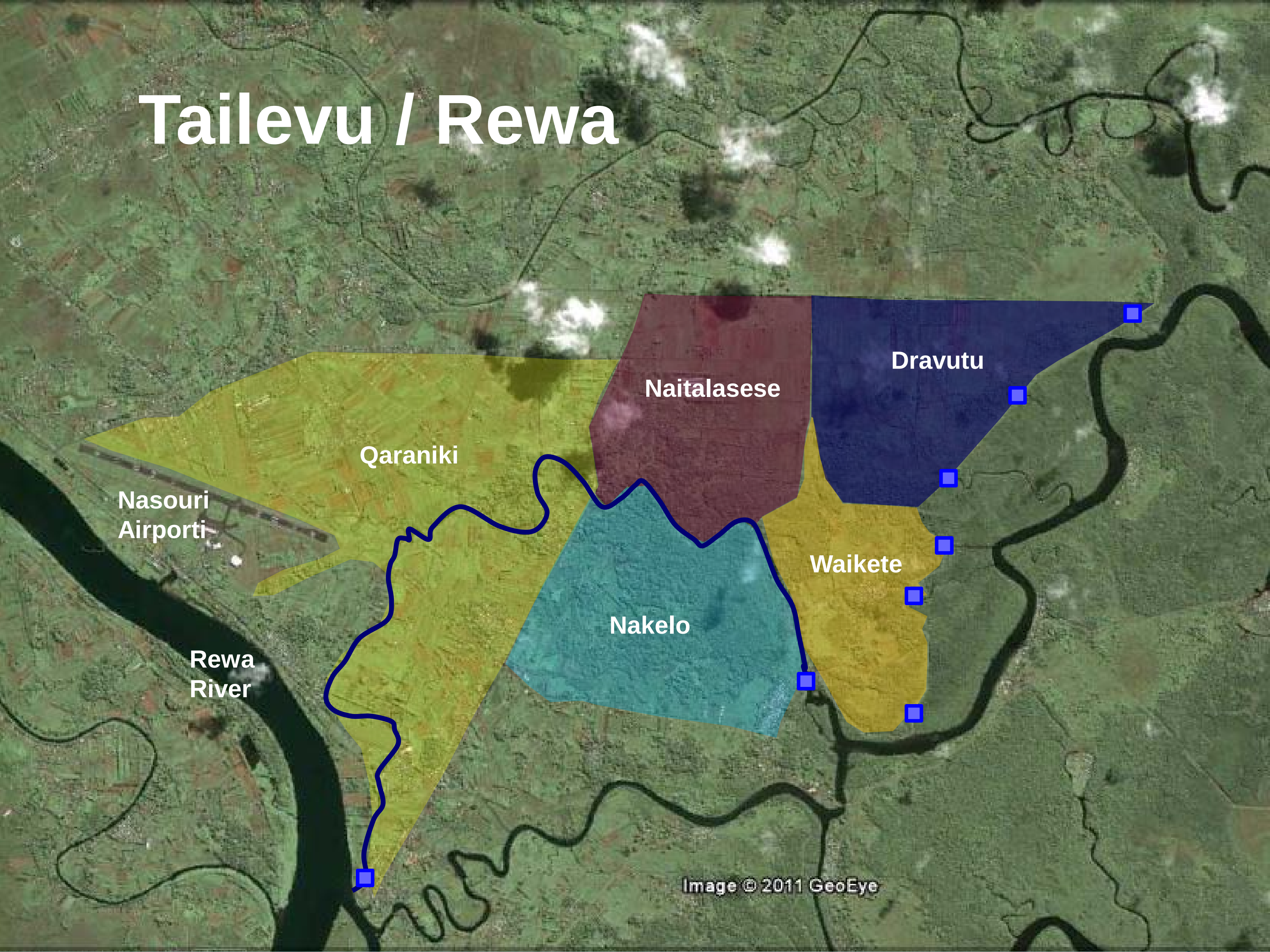
Nadi
Tailevu /
Rewa
Suva
Navua

Tailevu / Rewa



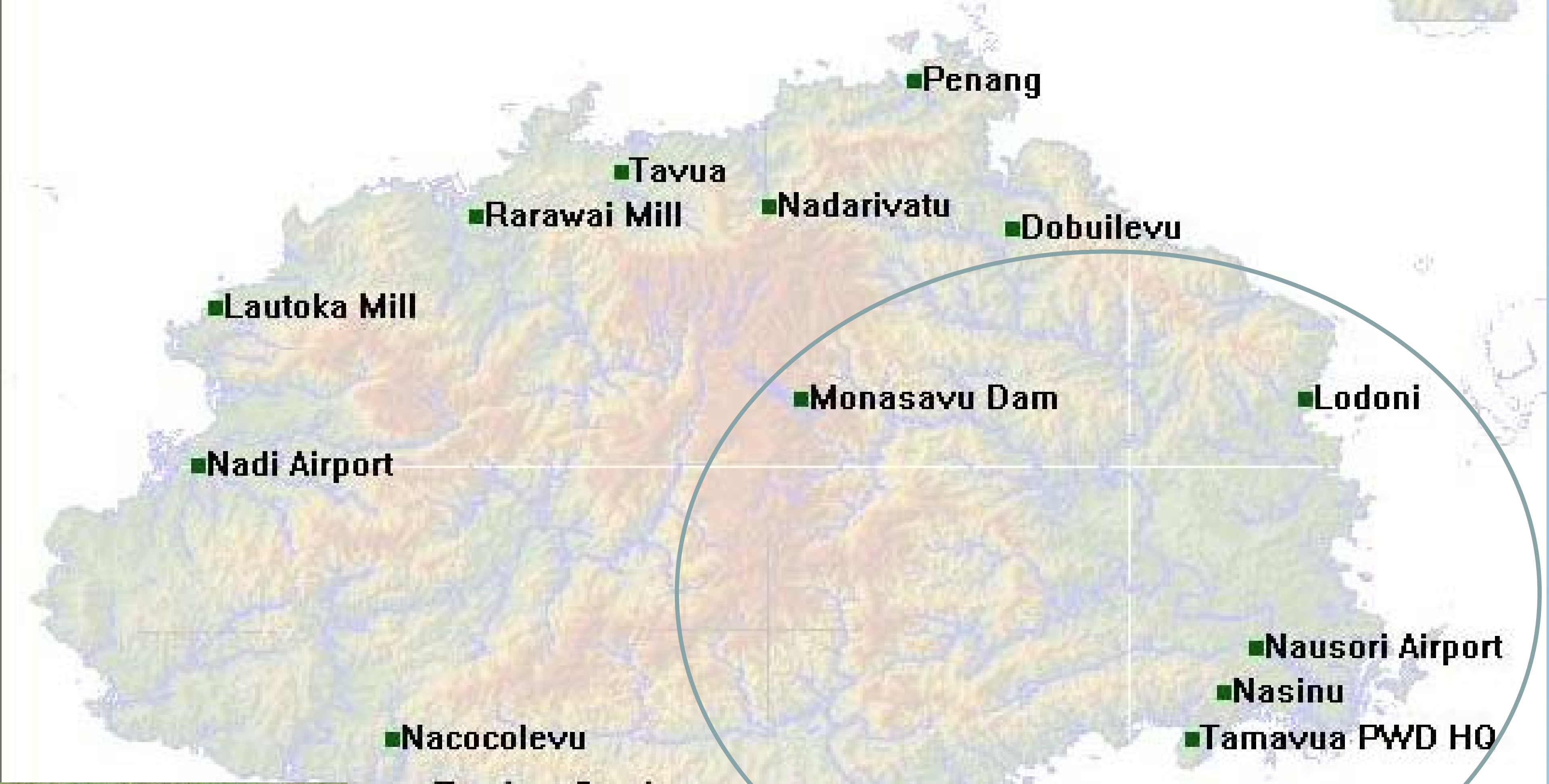
Existing drainage guidelines

- Based on:
  - Sugar cane – 360 mm of rain / 3 days
  - Horticulture (Maize) – 100 mm of rain / 24 hours

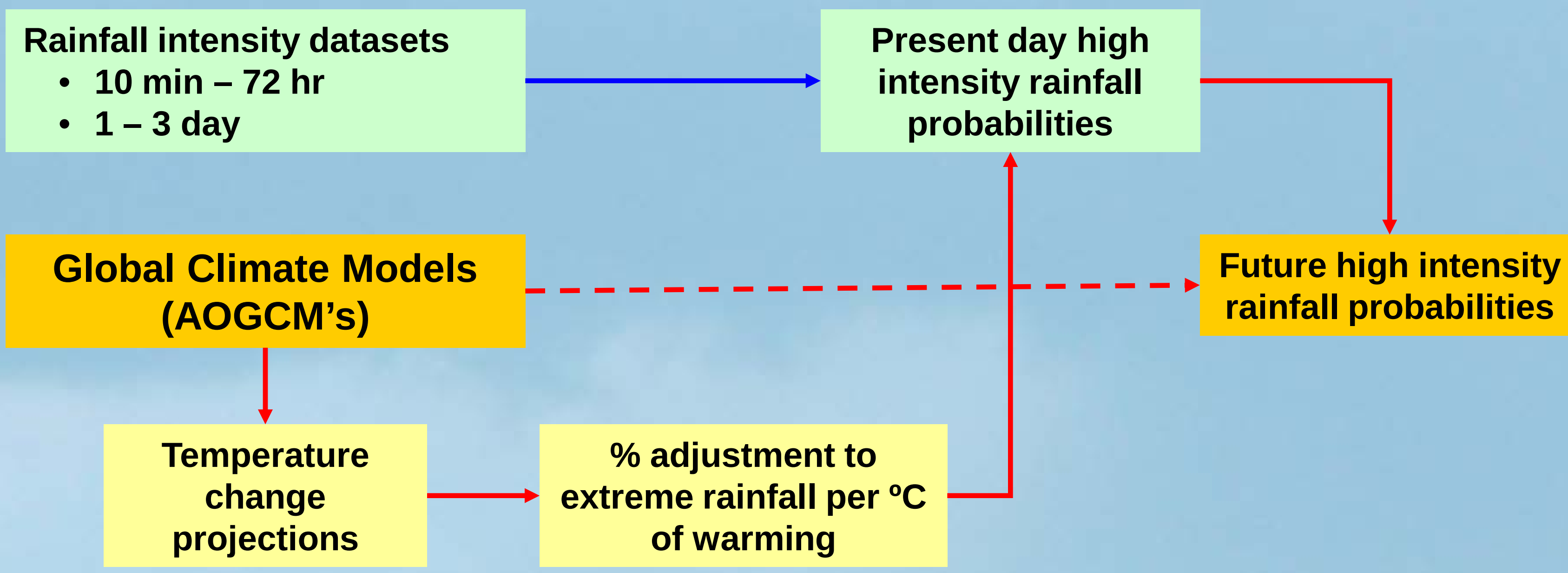
- Focus now on:
  - Dalo (Taro)
  - Cassava
  - Kumala (Sweet potato)

Data collection

- Land levels
- Drainage levels
- River cross-section and flood plain levels
- Monitor water levels at some outlets
- Hydrology data
- Bathymetry (seabed) data

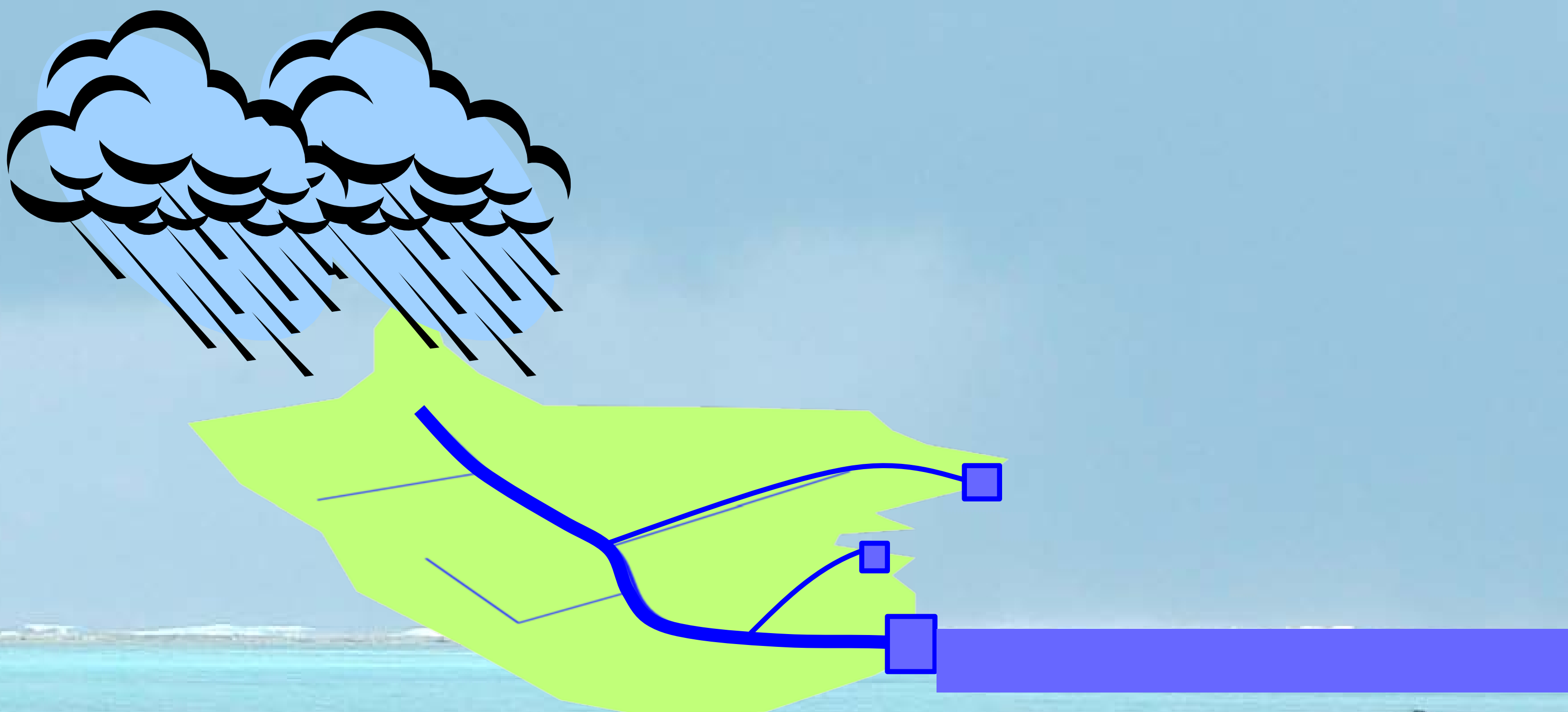

Penang
Tavua
Rarawai Mill
Nadarivatu
Dobuilevu
Lautoka Mill
Monasavu Dam
Lodoni
Nadi Airport
Nausori Airport
Nasinu
Tamavua PWD HQ
Nacocolevu
Tambua Sands
Tokotoko (Navua)

Rainfall intensity change



- Temporal and spatial scale issues
- Important large scale issues include deficiencies in simulating:
  - Tropical precipitation
  - The El Niño Southern Oscillation (ENSO)
  - The Madden-Julian Oscillation (a 30-90 day variation in tropical winds and rainfall).

Drainage modelling



Input data

1. Select location

Tarawa

2. Enter future climate change criteria

Emissions scenario:

NIWA Report: High (A1FI)

Future timeframe comparison:

2090s (2080-2099)

3. Enter rainfall duration to plot

24 hr

Results: Depth – Duration – Frequency

Present day (mm) **Based on data analysed between:** 1971-1994

Assumed to be representative of the period 1980-1999

ARI (year)	AEP (%)	10 min	20 min	30 min	1 hr	2 hr	6 hr	12 hr	24 hr	48 hr	72 hr
2	50%	19.1	29.3	36.8	49.6	63.6	100.1	115.9	128.3	149.6	163.4
5	20%	24.8	38.5	46.5	63.3	81.7	133.5	157.1	175.4	203.1	220.7
10	10%	28.5	44.6	52.9	72.4	93.7	155.6	184.4	206.6	238.5	258.7
20	5%	32.1	50.4	59.0	81.1	105.1	176.9	210.6	236.6	272.5	295.1
50	2%	36.7	57.9	66.9	92.3	120.0	204.3	244.4	275.3	316.4	342.2
75	1.3%	38.7	61.3	70.4	97.3	126.5	216.4	259.3	292.3	335.7	362.9
100	1%	40.1	63.6	72.9	100.8	131.1	224.9	269.8	304.3	349.4	377.5

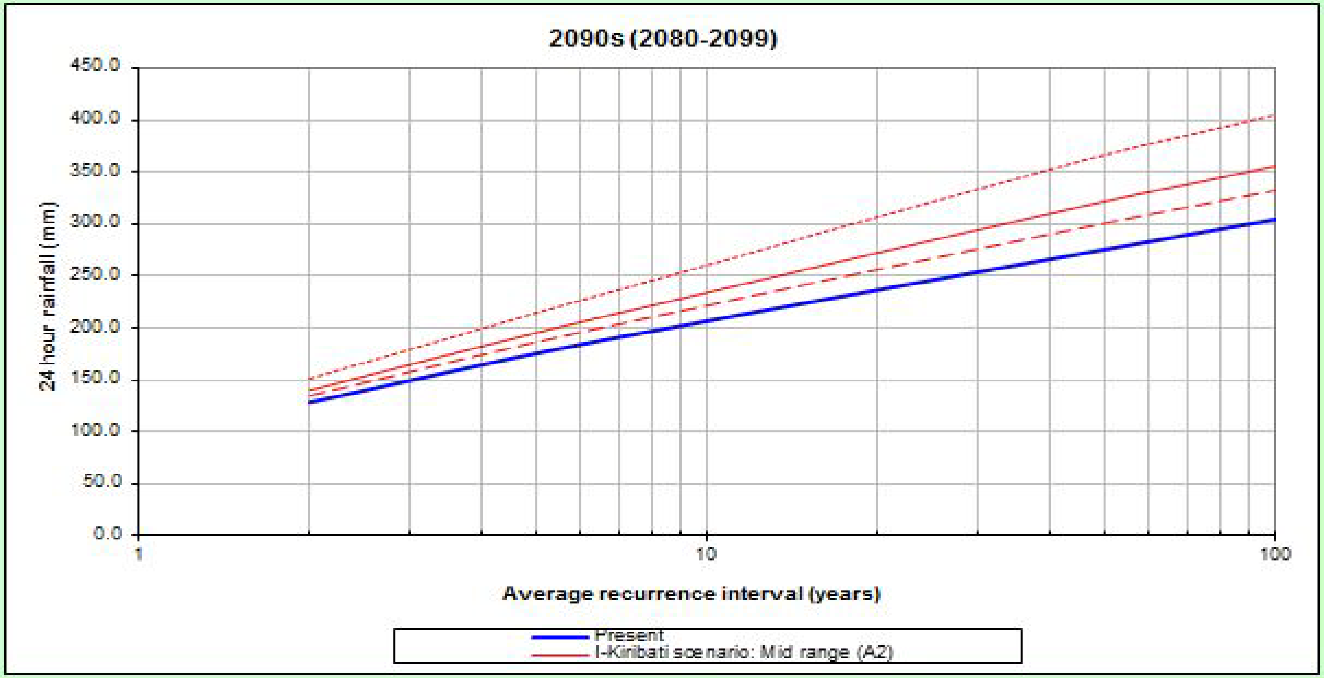
Future timeframe: 2090s (2080-2099) **Emission scenario:** NIWA Report: High (A1FI)

ARI (year)	AEP (%)	10 min	20 min	30 min	1 hr	2 hr	6 hr	12 hr	24 hr	48 hr	72 hr
2	50%	26.7	40.4	49.9	66.1	83.0	126.1	143.4	155.8	177.4	192.0
5	20%	34.5	53.1	63.5	85.4	108.9	173.4	202.3	221.9	253.4	273.0
10	10%	39.7	61.7	72.8	98.9	126.9	208.3	243.7	270.7	309.8	334.5
20	5%	44.7	70.3	81.6	111.7	144.8	241.7	286.6	320.6	367.7	396.6
50	2%	51.2	80.8	93.4	128.8	167.3	285.0	340.9	384.0	441.4	477.3
75	1.3%	54.0	85.4	98.2	135.7	176.4	301.8	361.7	407.7	468.3	506.1
100	1%	56.0	88.7	101.7	140.6	182.8	313.7	376.3	424.5	487.3	526.5

Plot: Depth – Duration – Frequency

○ **Plot selected scenario only** ◉ **Plot all 3 scenarios for selected timeframe**

This figure shows the depth of rainfall expected for the present day (blue line) and selected future timeframe and emission scenario(s) (red line) for a selected rainfall duration and location in Kiribati (on the Y-axis), for a range of different average recurrence intervals (from 2 to 100 years or 50% to 1% Annual exceedance Probability, AEP) along the X-axis. The scale on the x-axis is logarithmic.



Socio-economic vulnerability assessment

- Develop an understanding of the communities or elements within communities that are more susceptible to climate-related risks and how these vulnerabilities may change over time.
- Develop an understanding of the underlying causes of community vulnerability and establish the relative significance of rainfall, inundation and other climate risk-related vulnerability within this wider community vulnerability context.
- Reduce barriers to inter-generational adaptation planning
- Contribute to helping empower community leaders to develop effective risk reduction and adaptation options and strategies
- Ensure that identified adaptation options can be effectively implemented and that they do not exacerbate vulnerabilities in any way.

Photograph: P Nunn

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Outputs

- New drainage design guidelines
- Calculator tools to enable climate change impacts of extreme rainfall, drainage & coastal defence performance to be assessed
- Options assessment and appraisal process including socio-economic inputs
- Increased capacity within LWRM to apply the process in other locations.

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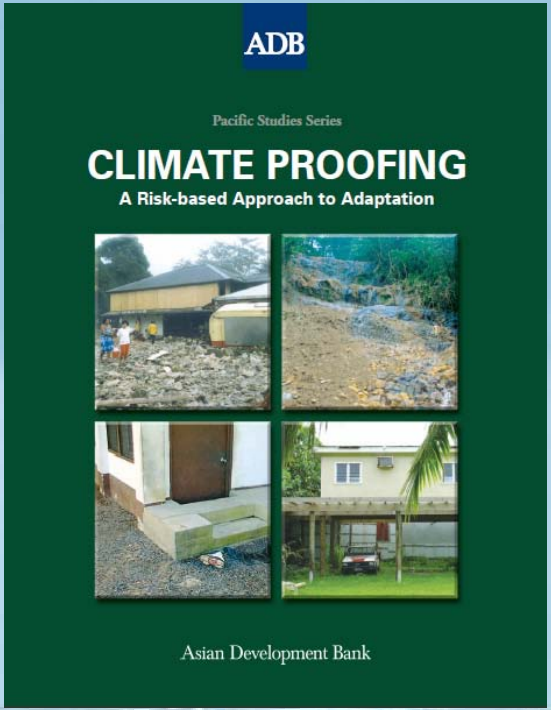
Climate monitoring to underpin "climate proofing" decision-making and design

Climate proofing information



ADB climate proofing project:

- Extreme rainfall amounts
- Sea levels
- Extreme winds

BUT for Kosrae data gaps

- Lack of data on high intensity (e.g. short very heavy duration rainfall)
- No sea level data

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Rain-gauge network

Existing rain gauge network:

- 6 hourly amounts recording at airport
- Daily amounts read manually at Lelu and Utwe

Planned:

- New automatic rain gauge recording rainfall amounts every 10 minutes at the airport

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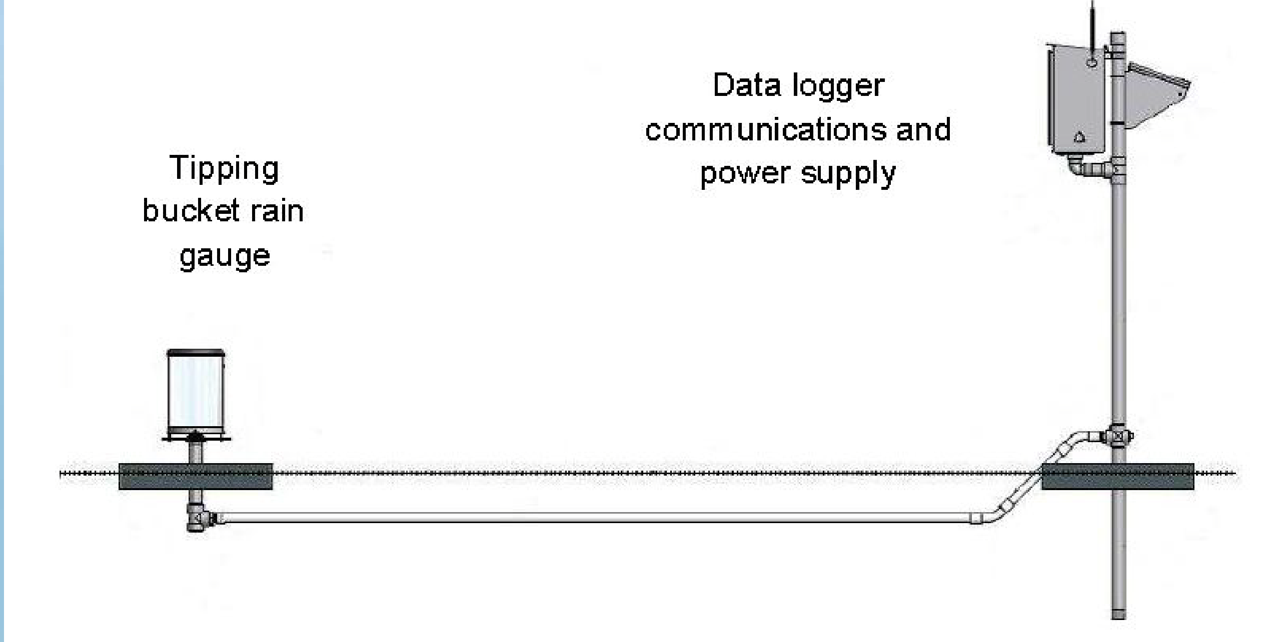
Data logger
communications and
power supply
Tipping
bucket rain
gauge


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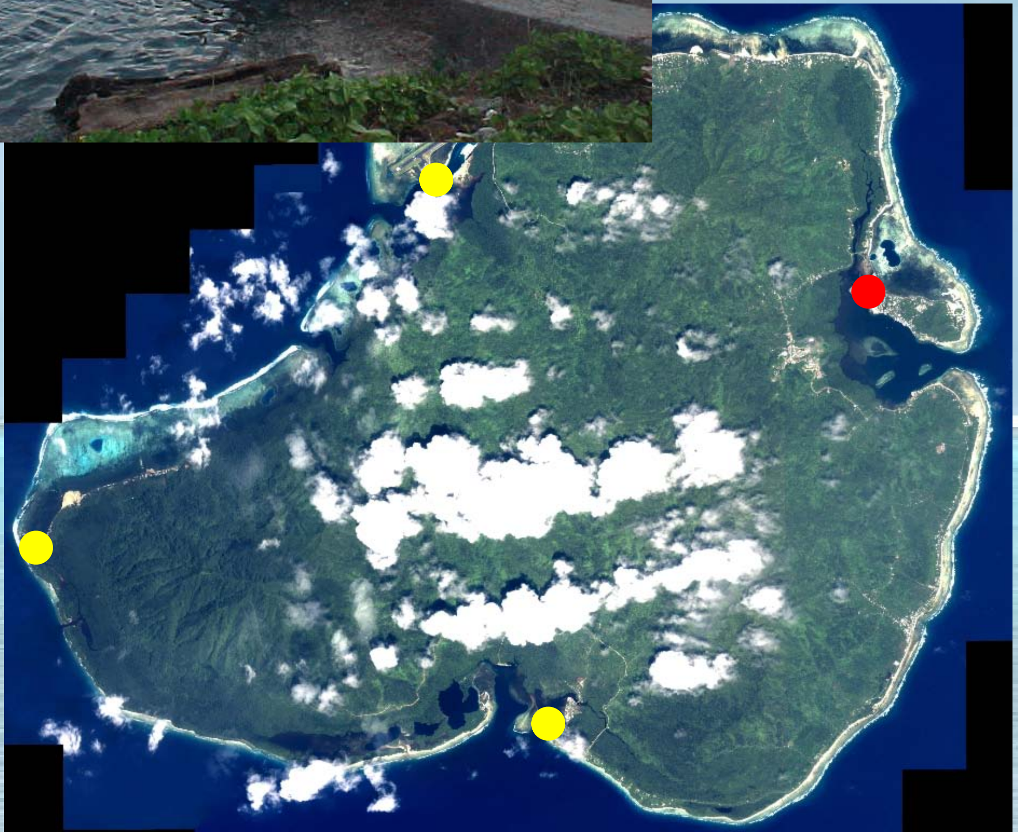
Sea-level information



- No sea levels have been recorded at Kosrae
- A stilling well for a sea-level recorded was installed in 2000 in Lelu Harbour

Planned:

- New water level recorder at Lelu (permanent)
- Temporary water level recorder rotated between at Okat, Utwe and Walung (10 months each)
    - Assess sea-level variability around Kosrae

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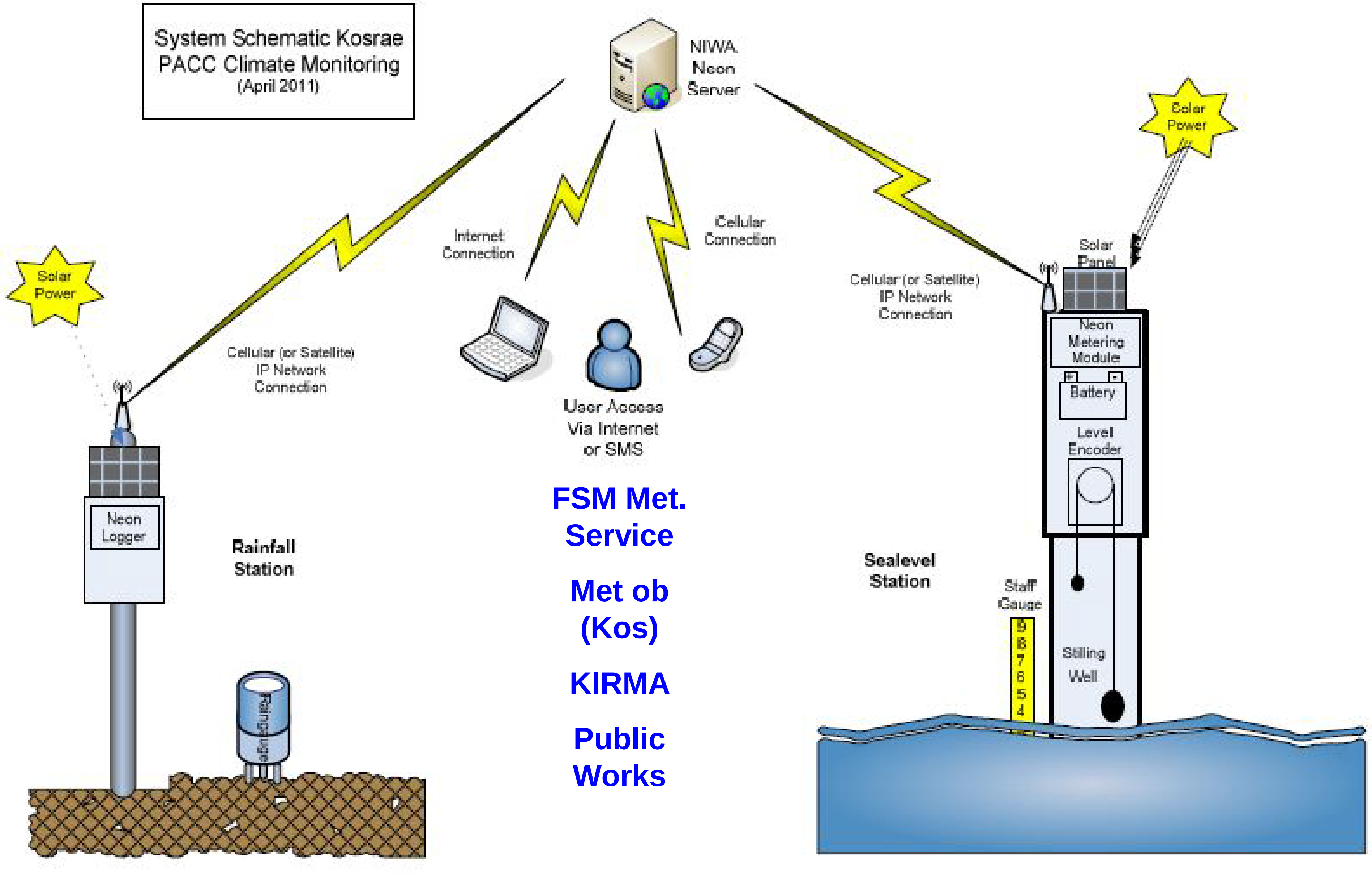
Data availability and use



FSM Met. Service

Met ob (Kos)

KIRMA

Public Works

Meitaki Maata,

Vinaka vakalevu &

Kula ma lulap

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