Tour de l'IGS – International GNSS Service

**5th Stop Virtual Workshop - 14 Feb 2023 UTC**

Pacific Community
Communauté du Pacifique

# Pacific Sea Level and Geodetic Stations for Natural Hazards

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Herve Damlamian, Andrick Lal

GEM
Geoscience, Energy and Maritime Division

PGSC
Pacific Geospatial and Surveying Council

Australian Government
Bureau of Meteorology

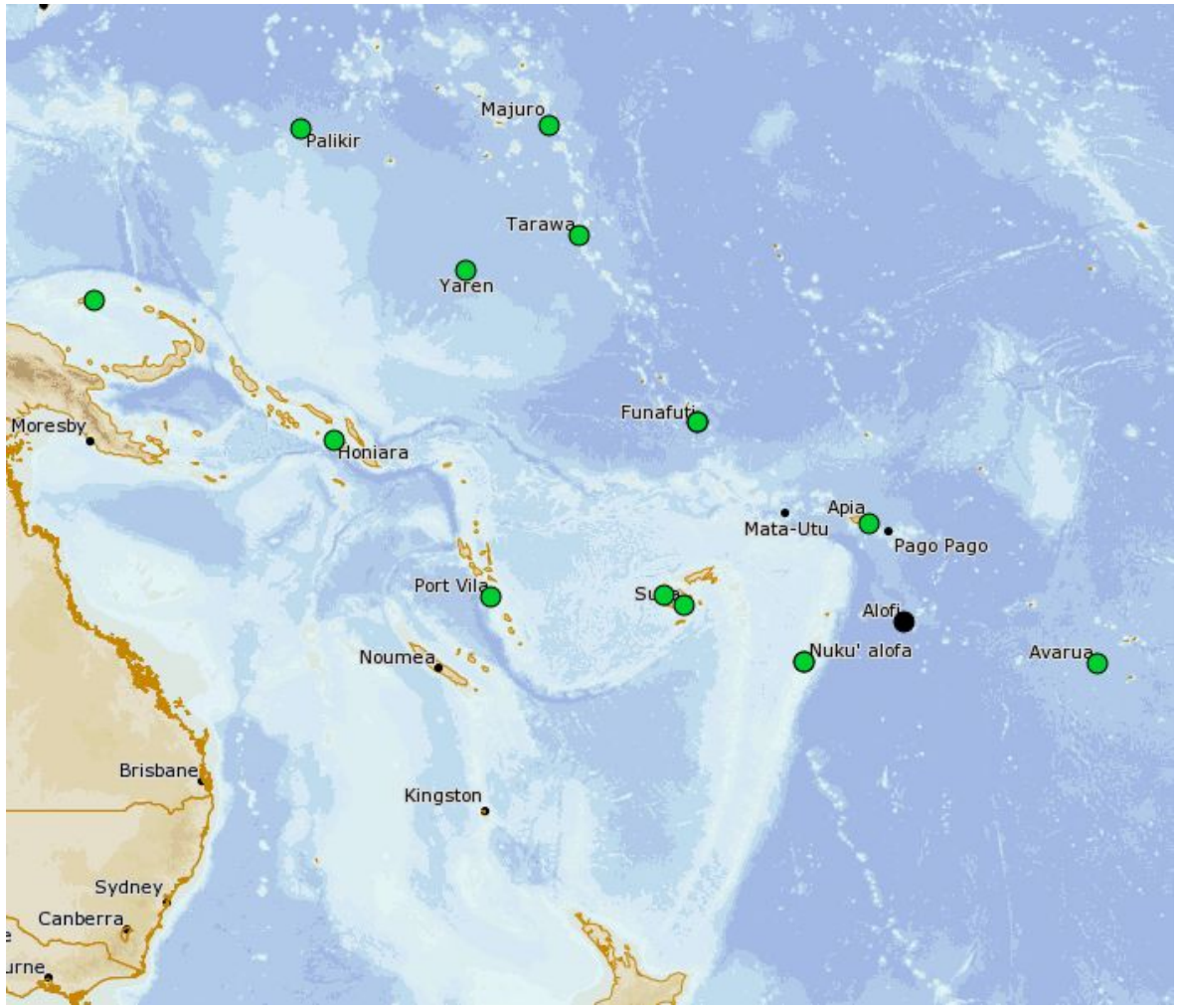
Australian Government
Geoscience Australia

Climate and Oceans Support Program in the Pacific

Australian Aid

# Pacific Sea Level & Geodetic Monitoring Stations

1. Cook Islands
2. Federated States of Micronesia
3. Fiji - Lautoka
4. Fiji - Suva
5. Kiribati
6. Marshall Islands
7. Niue
8. Nauru
9. Papua New Guinea
10. Samoa
11. Solomon Islands
12. Tonga
13. Tuvalu
14. Vanuatu



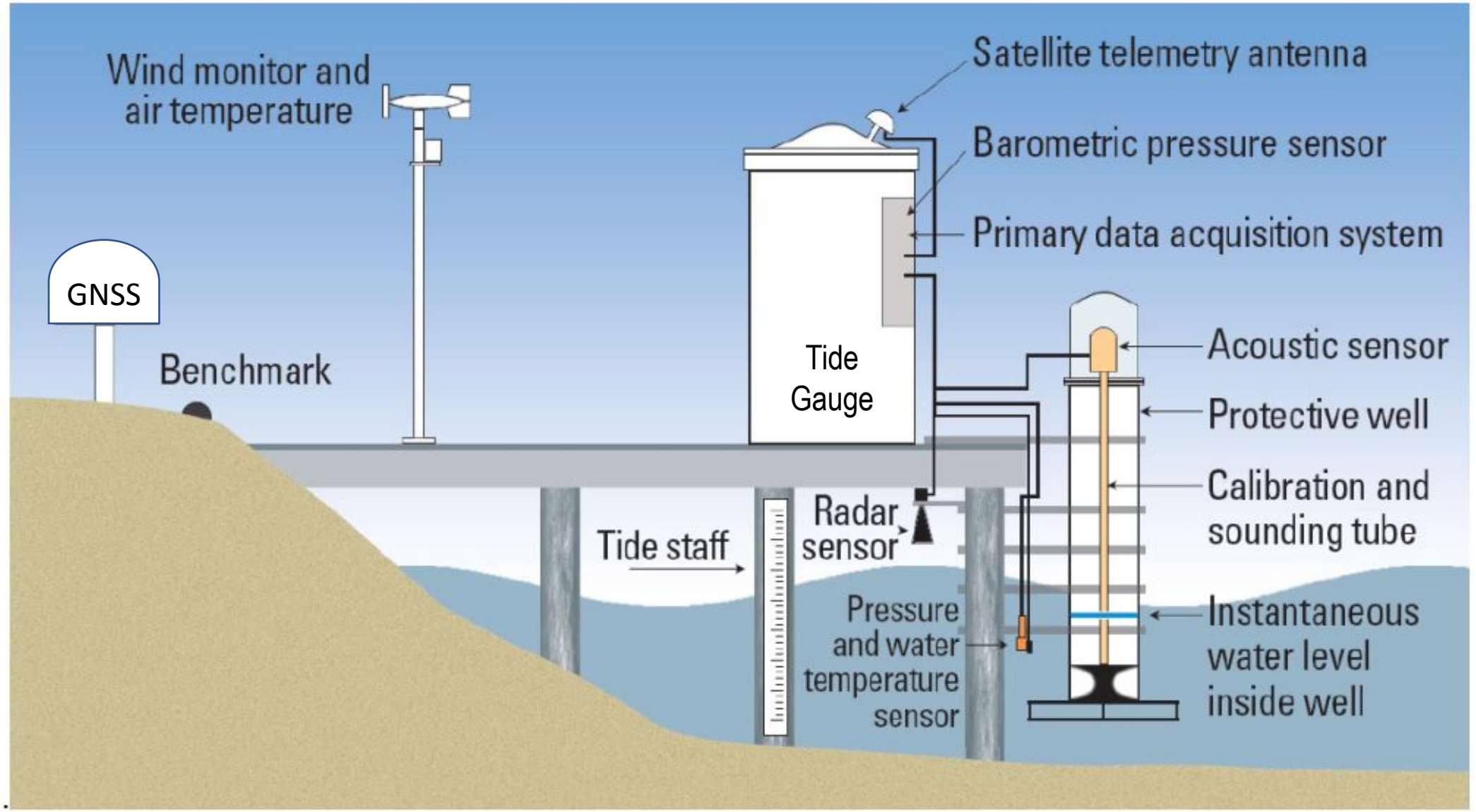

Began in 1991 as an Australian response to concerns raised by the member countries of the South Pacific Forum over the potential impacts of global warming on climate and sea levels in the Pacific.

Australia has been supporting 13 Pacific Island countries (PICs) to measure, record and analyse long-term sea level and land motion for over 25 years. This is known as the Pacific Sea Level and Geodetic Monitoring (PSLGM) project funded by Australian Aid under the Climate and Oceans Support Program in the Pacific (COSPPac).

The sea level data is collected continuously at one or two tide gauges and land motion data is collected continuously at one or two Global Navigation Satellite System (GNSS) stations in each of the 13 PICs.

Primary goal “to generate an accurate record of variance in long-term sea level for the Pacific and to establish methods to make [these] data readily available and usable by Pacific Island Countries

# Sea Level and Geodetic Monitoring Station



# Sea Level Monitoring Station – Tide Gauge

Kings Wharf, Suva Tide Gauge Station


Queens Wharf, Lautoka Tide Gauge Station

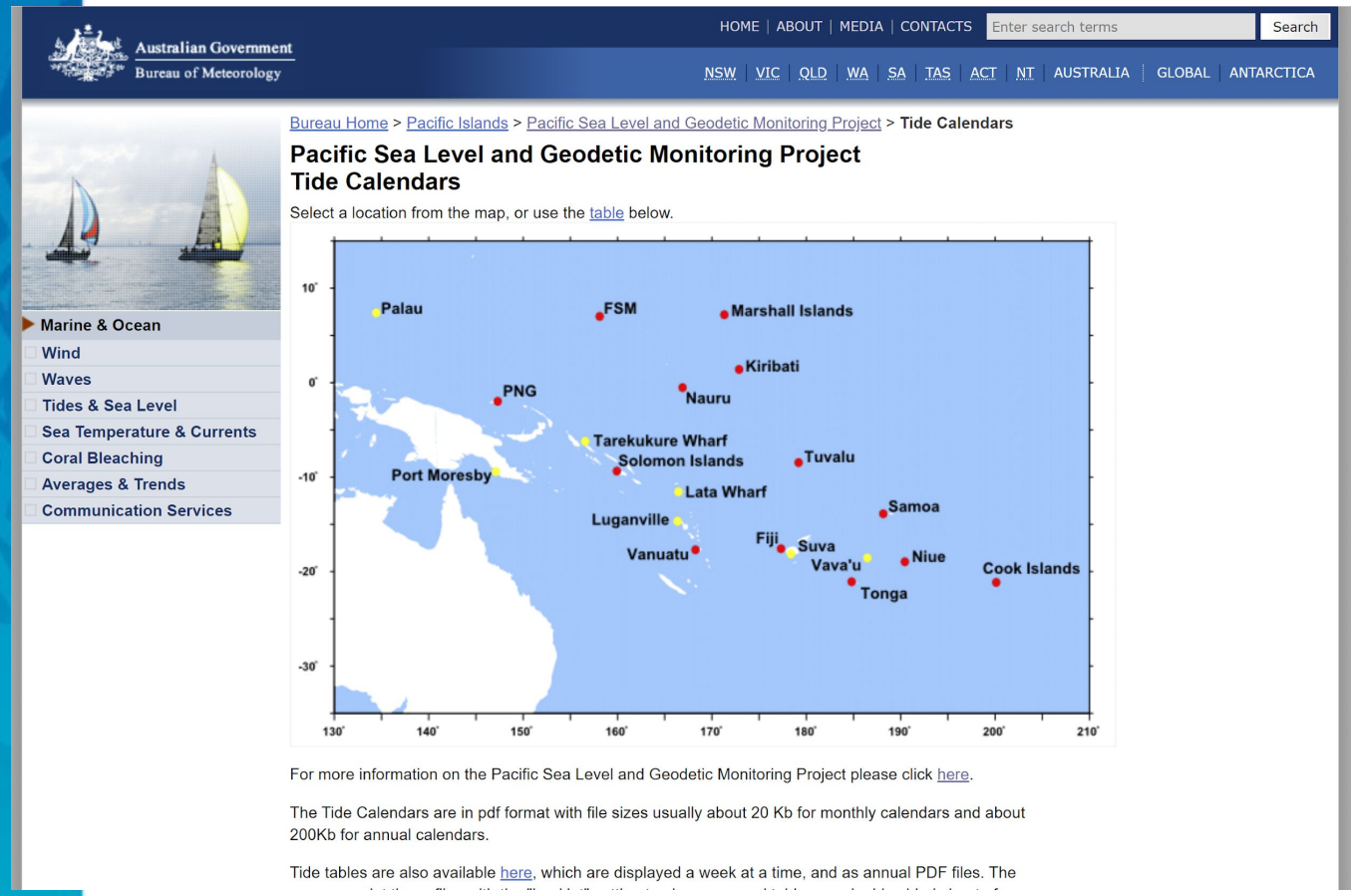
# Geodetic Monitoring Station – GNSS CORS

GNSS Hut

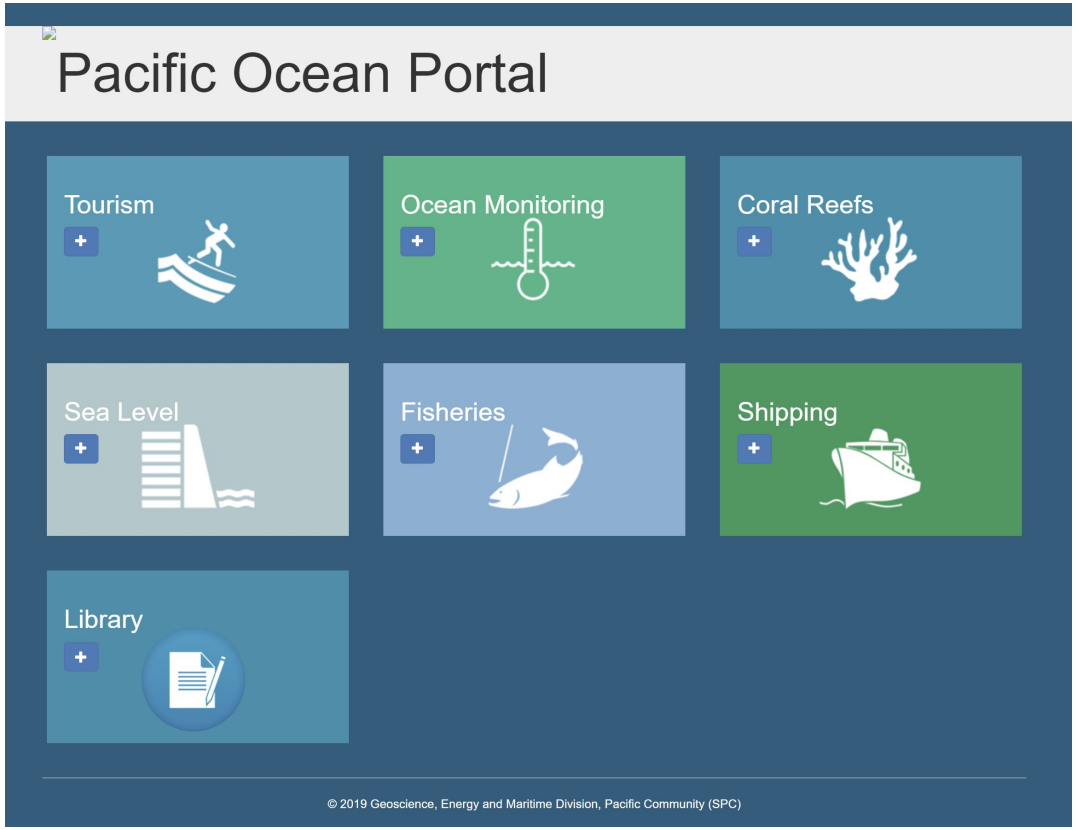
GNSS CORS Pillar

Instrument rack – GNSS Hut

# PSLGM Project Data & Information




http://www.bom.gov.au/pacific/projects/pslm/




http://oceanportal.spc.int/portal/ocean.html

# Project Data & Information – Sea Level

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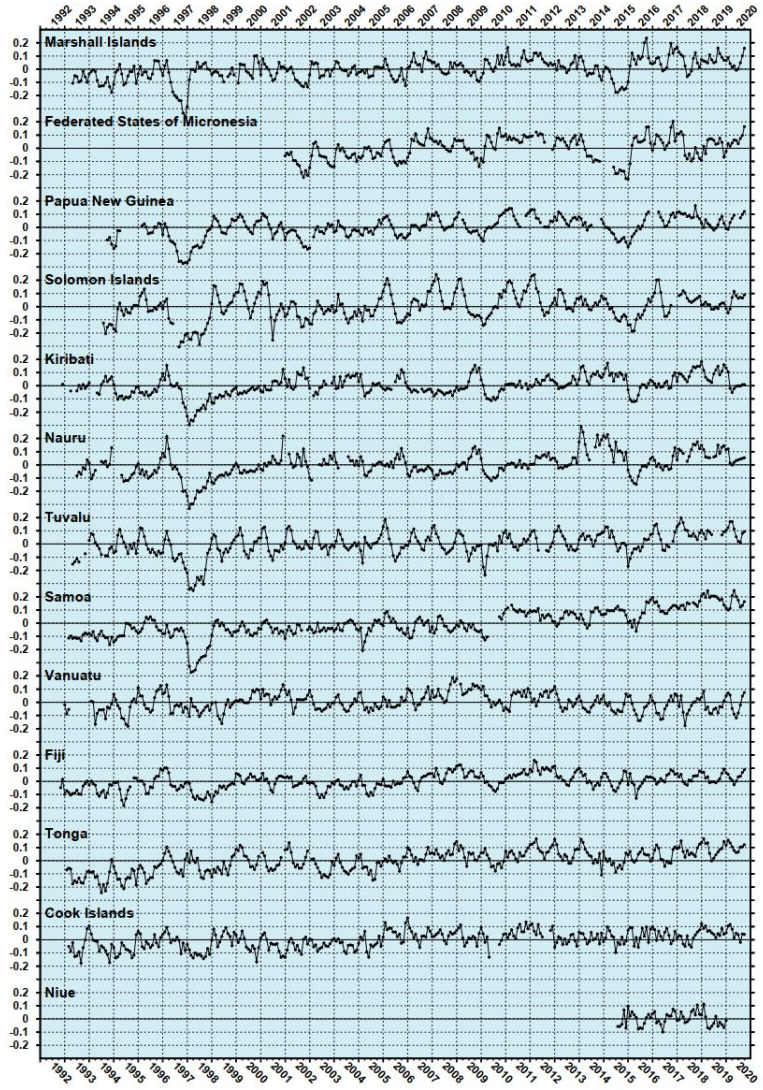
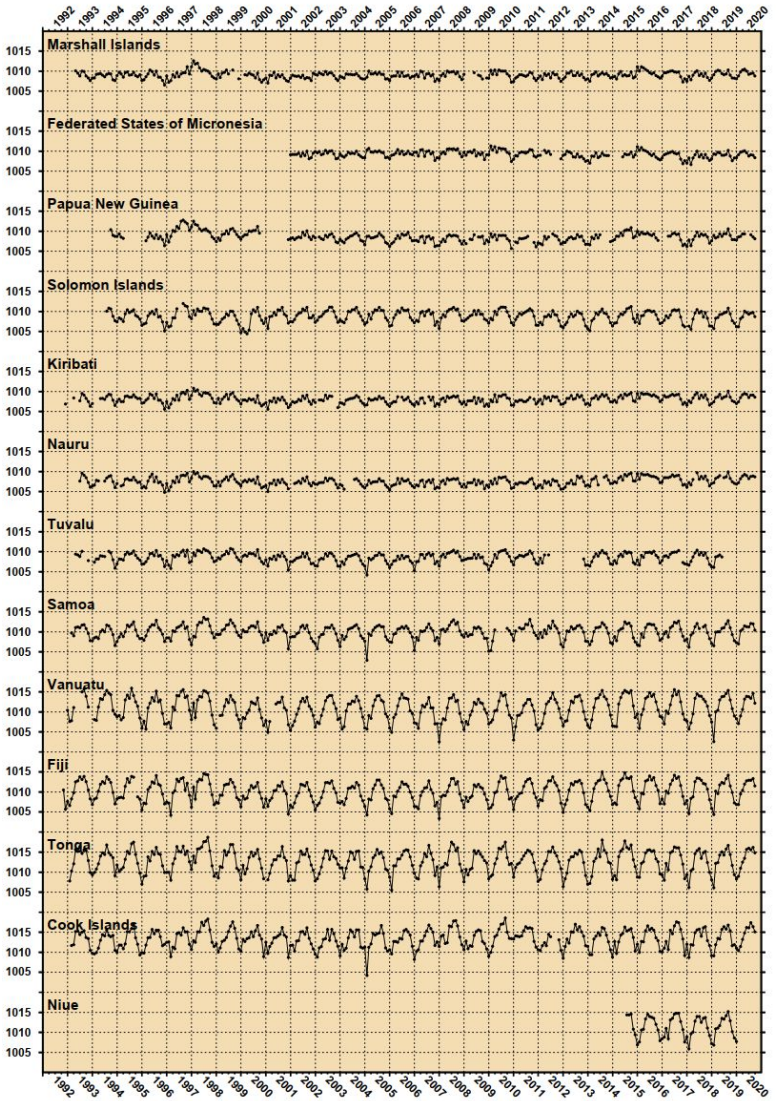
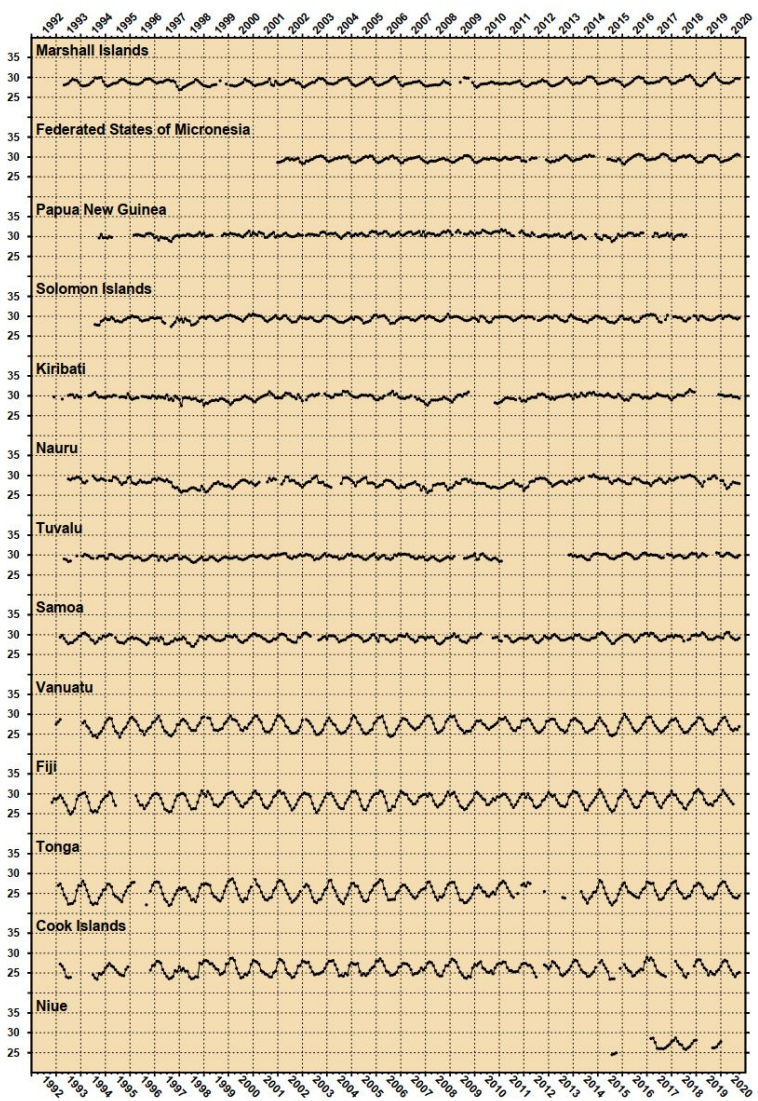
**MONTHLY MEAN SEA LEVELS THROUGH OCTOBER 2020 (m)**
**(The zero line represents mean sea level)**




**MONTHLY MEAN BAROMETRIC PRESSURES THROUGH OCTOBER 2020 (hPa)**




**MONTHLY MEAN WATER TEMPERATURES THROUGH OCTOBER 2020 (°C)**



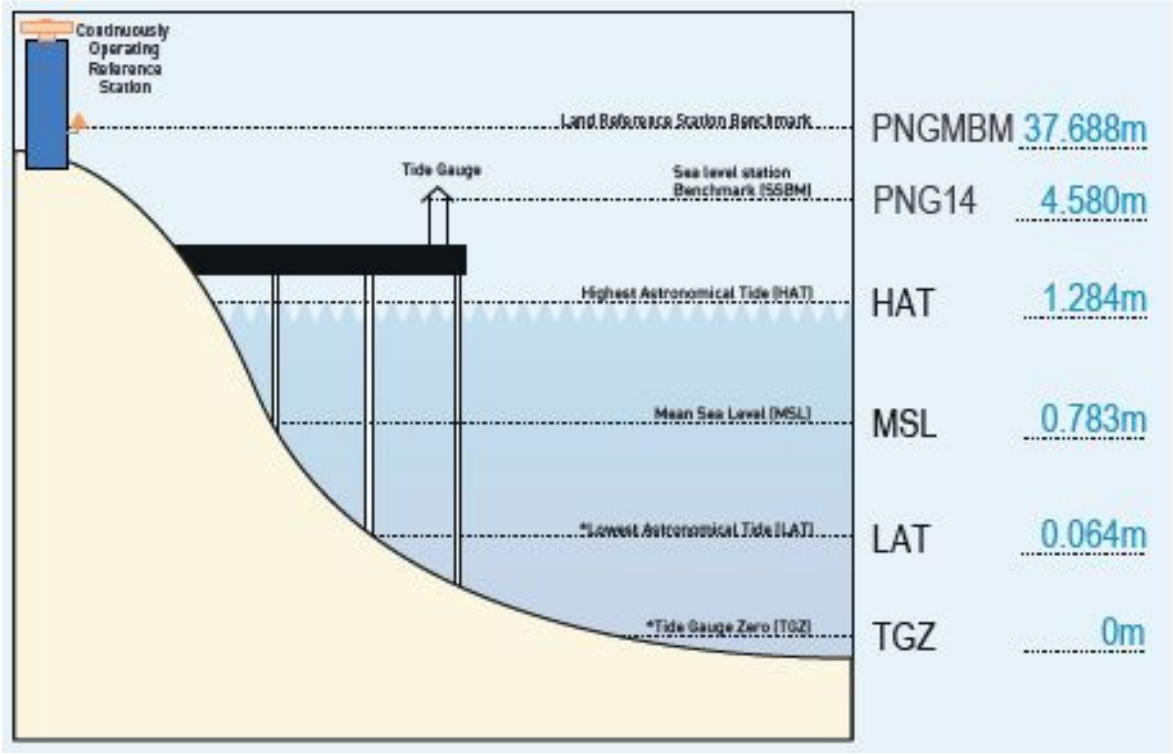
# Project related Data & Information

## METEOROLOGY (CLIMATE)

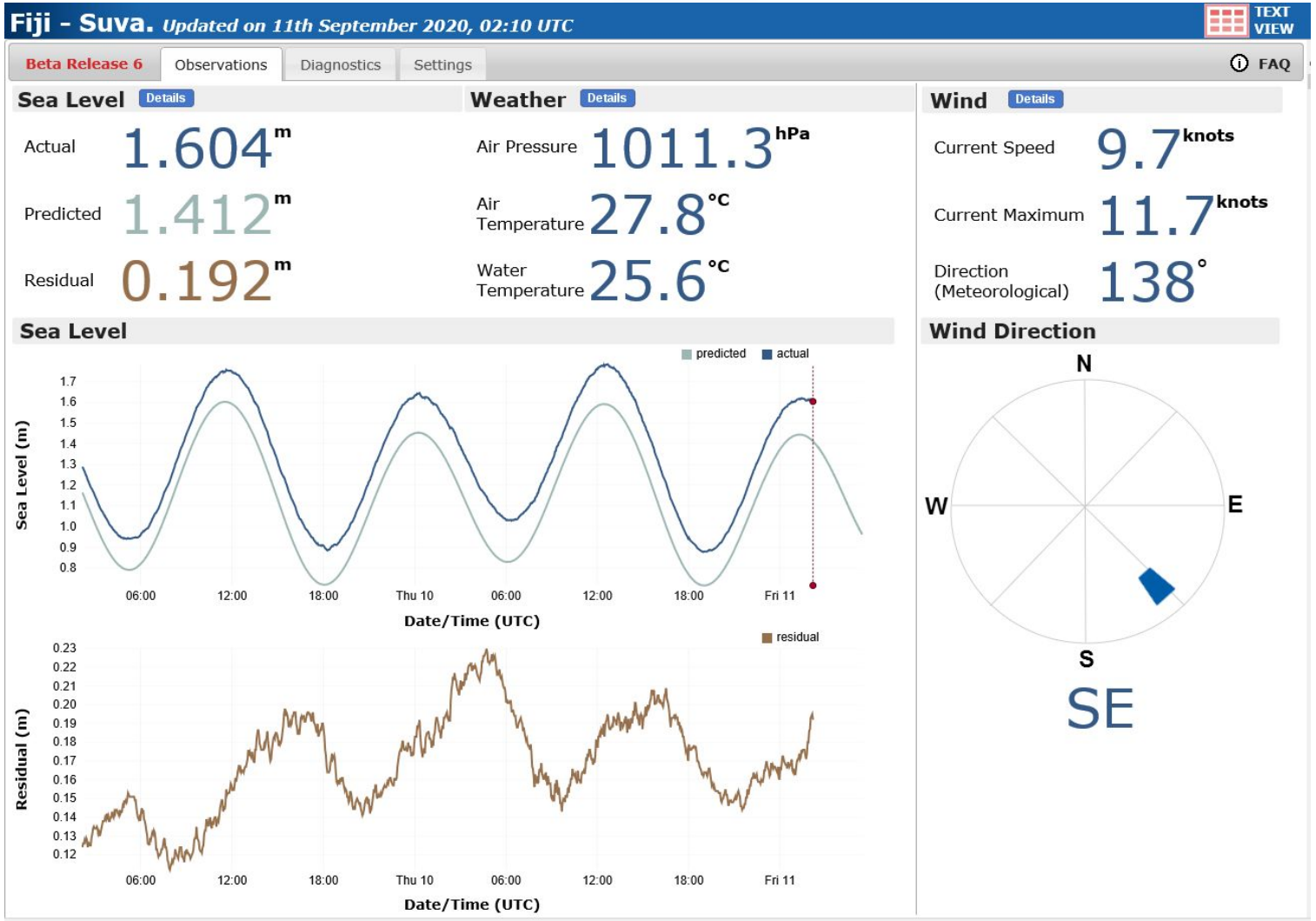
- Wind Speed & Direction
- Atmospheric Pressure
- Air & Water Temperature
- Sea Levels

*Real Time Display – Meteorological Data*

## GEODETIC (POSITIONING)



# Real Time Data Display – Sea Level



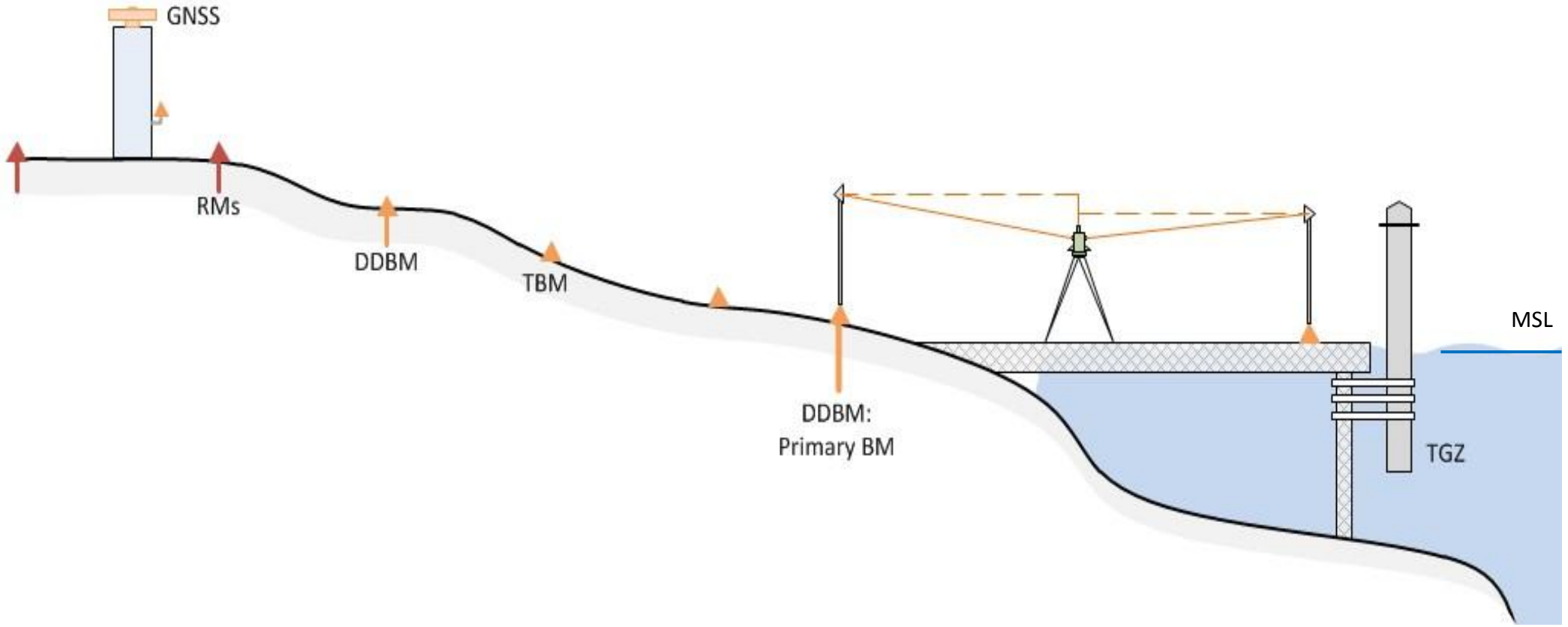

http://www.bom.gov.au/cosppac/rtdd/q1c7o0hj48yu/

# Pacific Sea Level & Geodetic Monitoring Surveys

Pacific Sea Level and Geodetic Monitoring | Geoscience Australia (ga.gov.au)

High precision survey equipment and Total Station Differential Levelling technique

# Pacific Sea Level & Geodetic Monitoring Stations




Vertical motion of Pacific Island tide gauges: combined analysis from GNSS and levelling (GA Record 2020/03) (d28rz98at9flks.cloudfront.net)

# Pacific Sea Level & Geodetic Monitoring Surveys

https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/146976

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## Pacific Sea Level and Geodetic Monitoring Project: Levelling & GNSS Monitoring Survey Report

Tarawa, Kiribati, December 2019

GEOSCIENCE AUSTRALIA
RECORD 2022/24

A.Lal[1], V.Rattan[1], M.Kalouniviti[1], Z. Begg[1], N.J. Brown[2], B.R.Thomas[2]

Australian Government
Geoscience Australia

1. Pacific Community (SPC), Suva, Fiji
2. Geoscience Australia, Canberra, Australia

### 3.1.1 PSLGMP Vertical Reference Frame Wiring Diagram

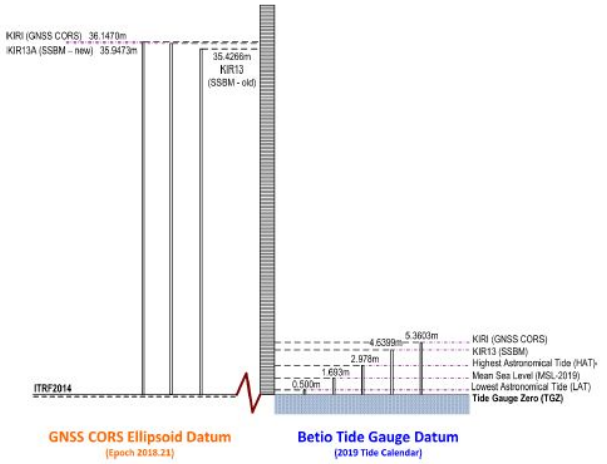



*Figure 3.1 Wiring diagram depicting the offsets between surveyed marks. The left-hand side shows the height of the GNSS CORS pillar (KIRI), SEAFRAME sensor reference benchmark (old height; KIR13), SEAFRAME sensor reference benchmark (new height; KIR13A) with respect to the International Terrestrial Reference Frame 2014 at epoch 2018.21. The right-hand side shows the height of KIRI, KIRI13, and tidal datums with respect to tide gauge zero. For more information on tidal datums, please refer to Pacific Sea Level and Geodetic Monitoring Project File information and Instructions (bom.gov.au)*



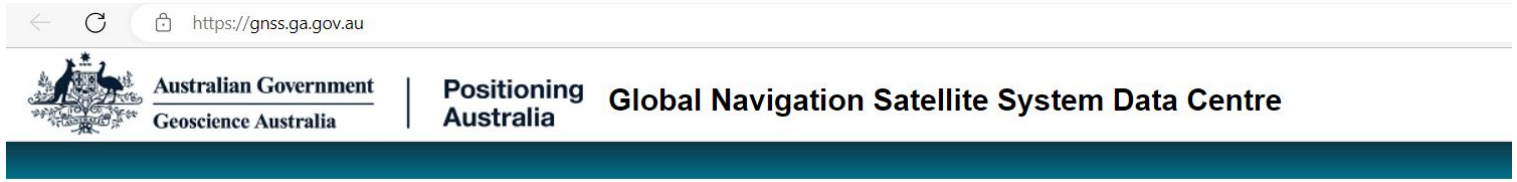
*Table 6.1 Comparison of results with 2018 results.*

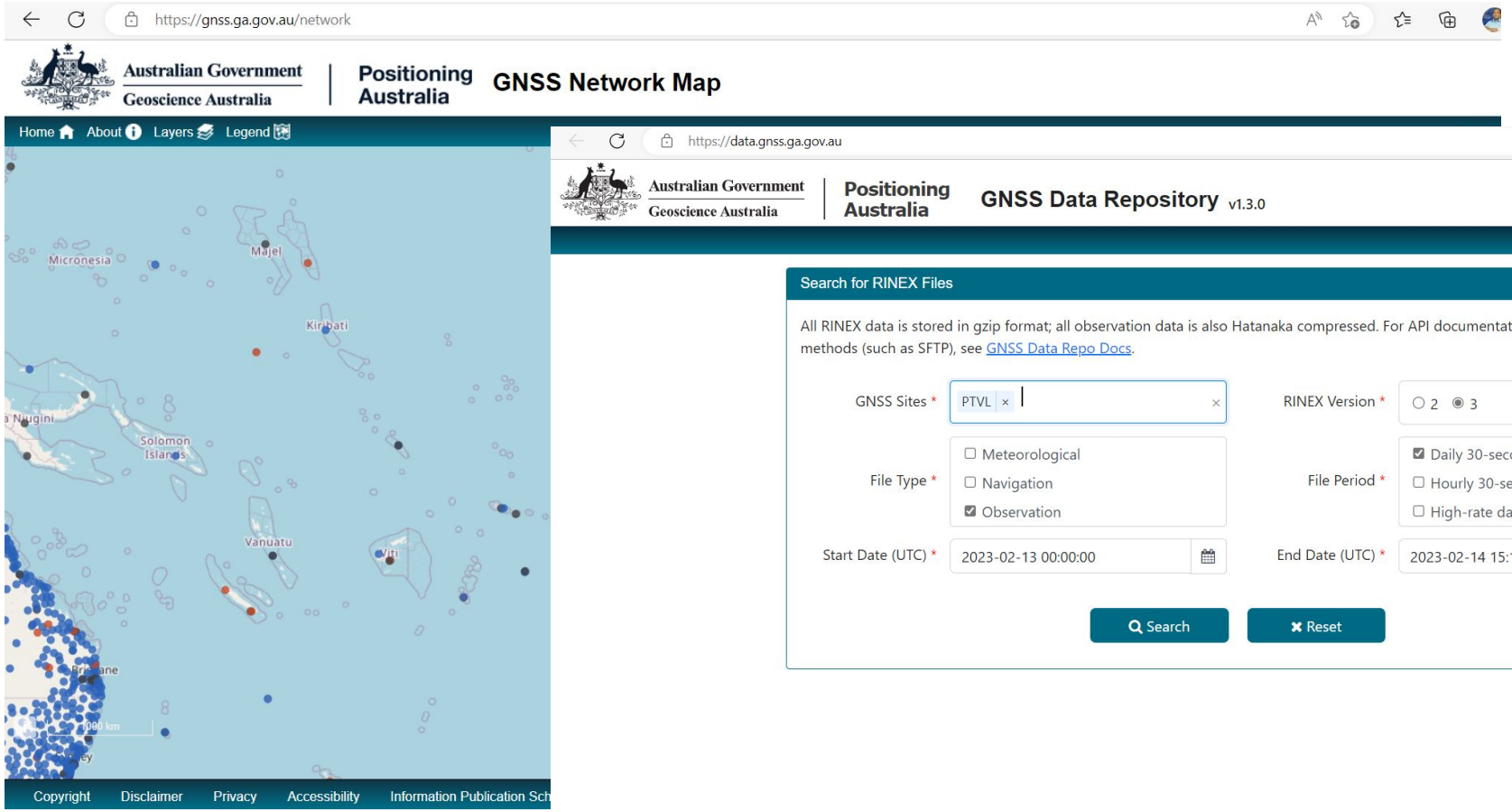
| PT ID | Reference ^H (m) | 2019.94 Value (m) | Difference |
|---|---|---|---|
| KIRIBM - KIR1 | -0.8802 | -0.8840 | 0.0038 |
| KIR1 - TG Plaque BM (KIR12) | 0.6871 | 0.6911 | 0.0040 |
| KIR1 - TG ref pin (KIR13) | 1.0999 | 1.1065 | 0.0066 |
| KIR12 - KIR13 | 0.4128 | 0.4154 | 0.0026 |
| | | | |
| KIRI - TG Plaque | -1.1360 | -1.1359 | -0.0002 |
| KIRI - TG BM | -0.7232 | -0.7204 | -0.0028 |
| KIRI - TGZ | -5.3533 | -5.3505 | -0.0028 |

*Table 6.2 List of height differences from KIRIBM to primary benchmarks, and conversion to TGZ & ITRF2014.*

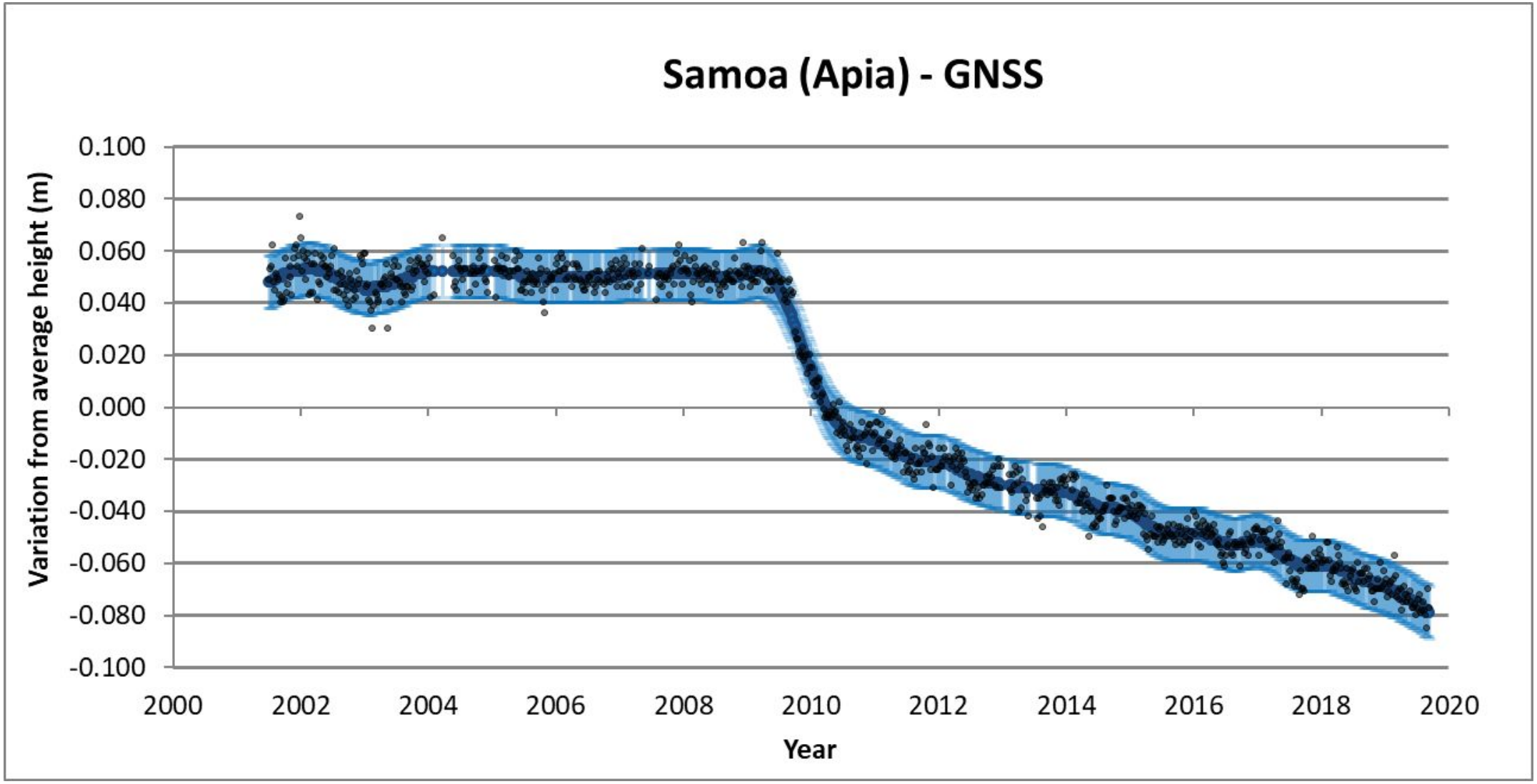
| PT ID | Reference RL (m) | 2019.94 Value (m) | Difference | TGZ | ITRF2014 |
|---|---|---|---|---|---|
| KIRIBM | 0.0000 | 0.0000 | 0.0000 | 4.4174 | 35.2041 |
| KIR3 | -0.8477 | -0.8482 | -0.0006 | 3.5692 | 34.3559 |
| KIR47 | -1.1176 | -1.1172 | 0.0004 | 3.3002 | 34.0869 |
| KIR2 | -1.2299 | -1.2319 | -0.0020 | 3.1856 | 33.9722 |
| KIR46 | -1.0333 | -1.0344 | -0.0011 | 3.3831 | 34.1697 |
| KIR1 | -0.8802 | -0.8840 | -0.0038 | 3.5334 | 34.3201 |
| KIR49 | -0.3900 | -0.3924 | -0.0024 | 4.0250 | 34.8117 |
| KIR12 | -0.1931 | -0.1930 | 0.0002 | 4.2245 | 35.0112 |
| KIR13 | 0.2197 | 0.2225 | 0.0028 | 4.6399 | 35.4266 |
| RM1 | -0.8756 | -0.8757 | -0.0001 | 3.5417 | 34.3284 |
| RM2 | -0.9129 | -0.9129 | 0.0000 | 3.5045 | 34.2912 |
| RM3 | -0.8978 | -0.8978 | 0.0000 | 3.5197 | 34.3063 |
| KIRI | 0.9429 | 0.9429 | 0.0000 | 5.3603 | 36.1470 |
| KIR13A | | 0.7432 | | 5.1606 | 35.9473 |
| TGZ | -4.4104 | -4.4076 | 0.0028 | 0.0098 | 30.7965 |

# Geodetic Monitoring Stations – Data Centre

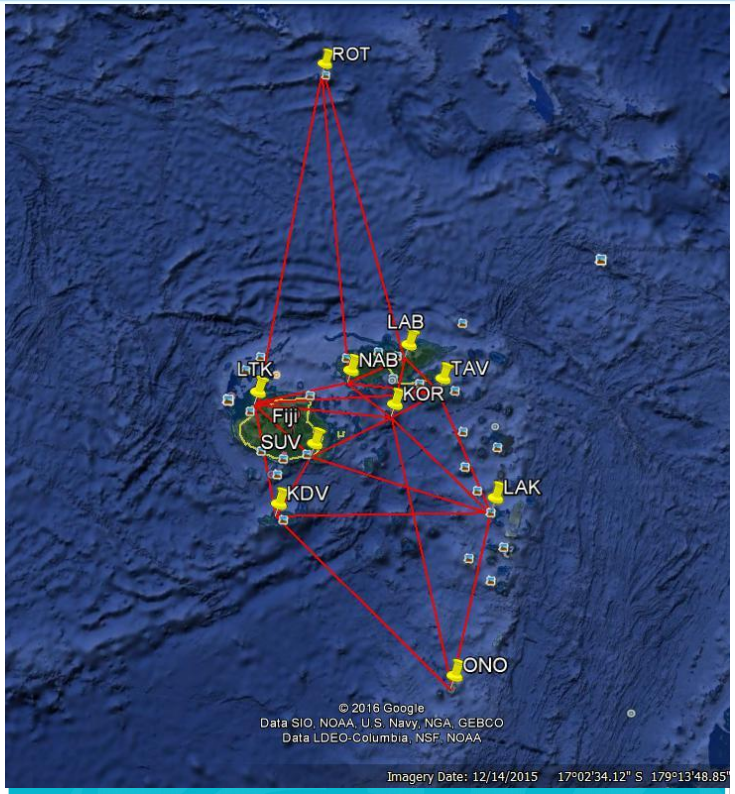


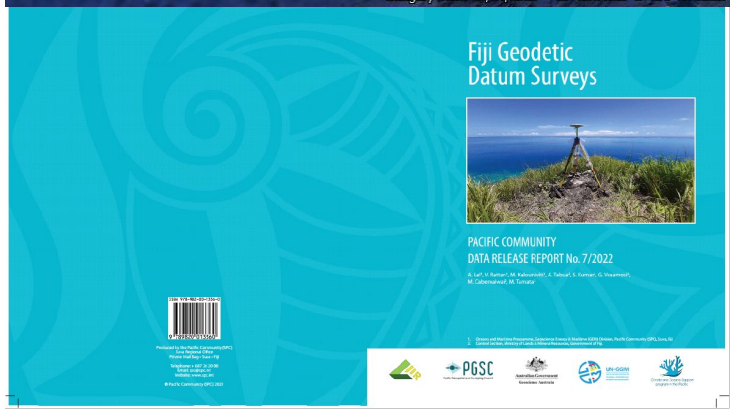



# GNSS COR Station Data – Land Velocity



# Geodetic Reference Frame – Pacific

# PSLGM Stations supports Oceanography

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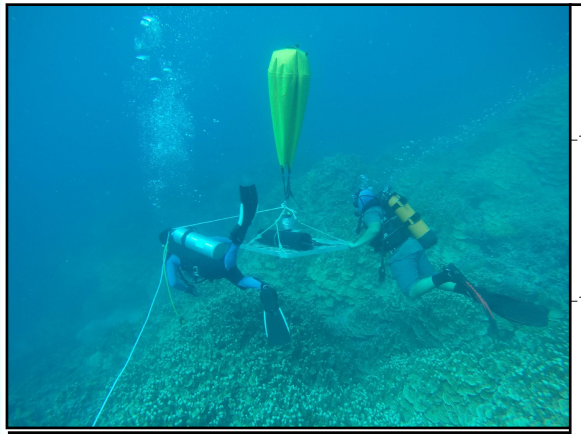
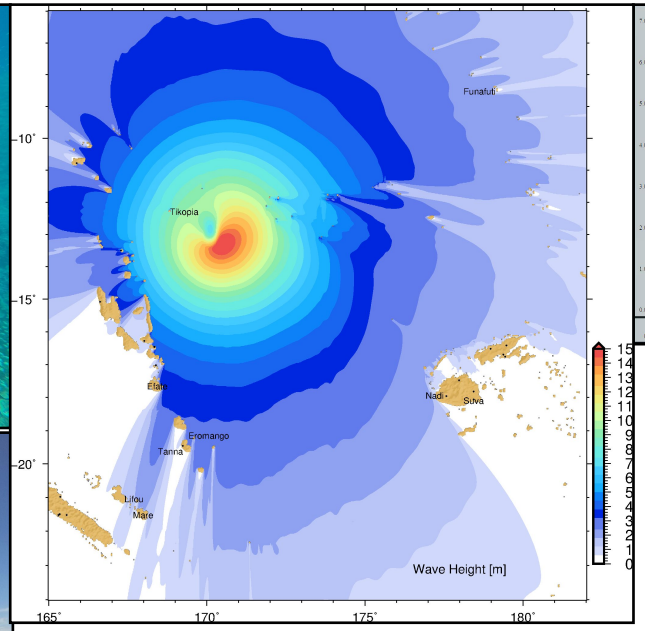
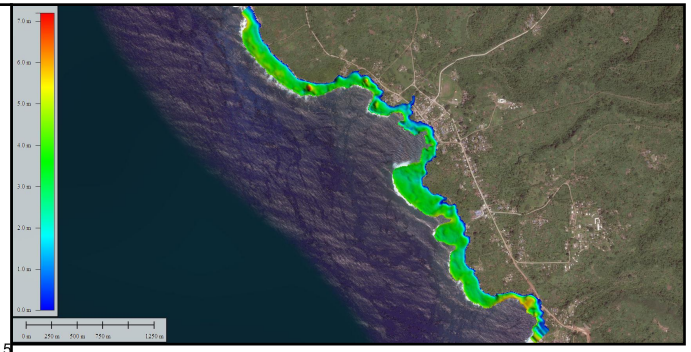
## Coastal monitoring

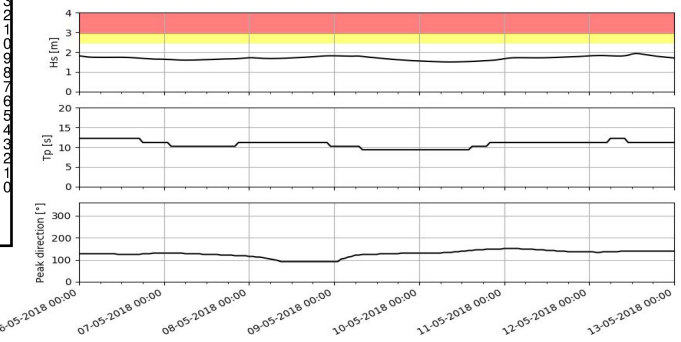


## Development of numerical models

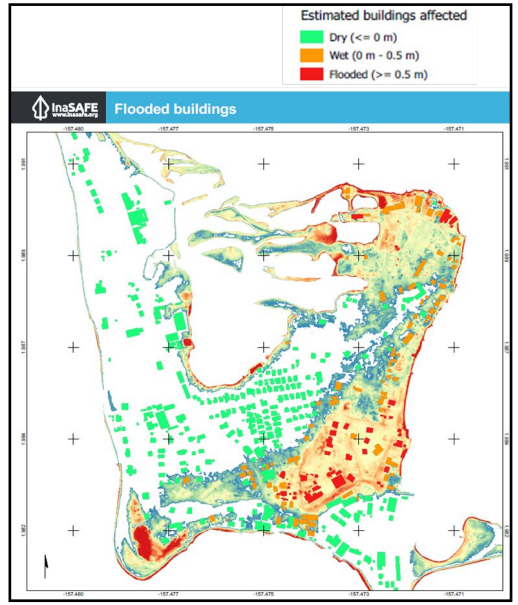



## Coastal hazard assessments and early warning systems



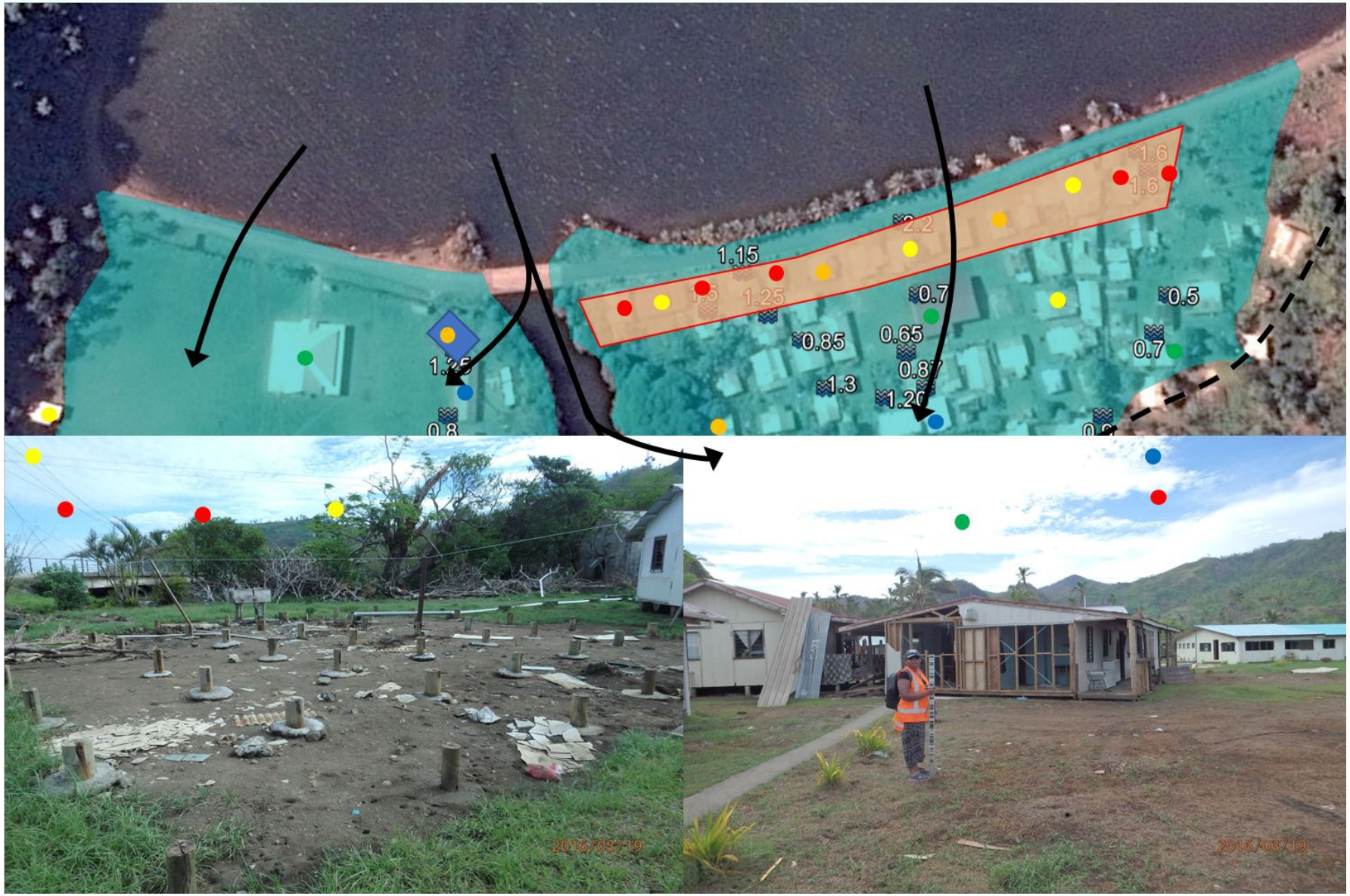



## Risk assessments



# Inundation Map In Tokou, Ovalau

Damages: None ; Minor ; Moderate ; Severe ; Destroyed ;



# Development of Innovative and Tailored Inundation Forecast Systems

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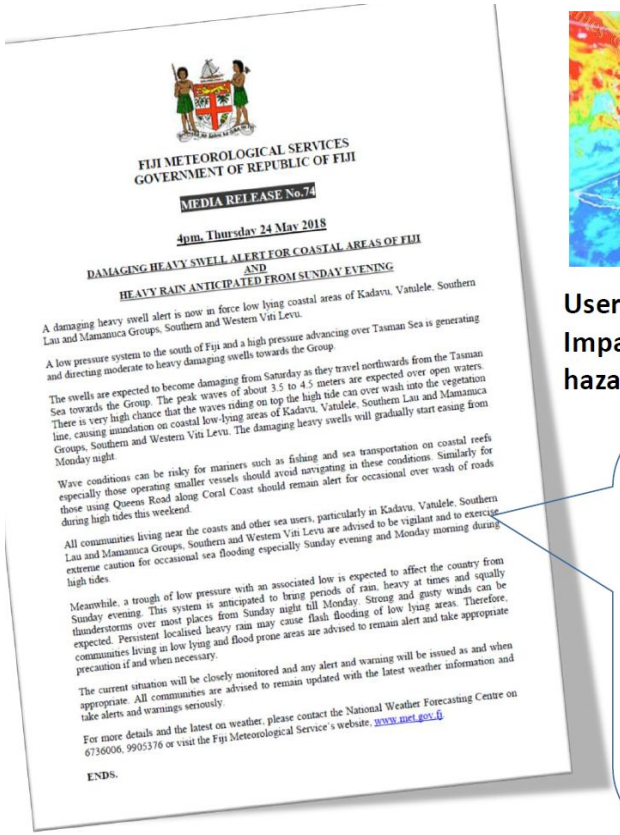
## Fiji Met Service now issues impact-based forecasts



FIJI METEOROLOGICAL SERVICES
GOVERNMENT OF REPUBLIC OF FIJI

**MEDIA RELEASE No.74**

**4pm, Thursday 24 May 2018**

**DAMAGING HEAVY SWELL ALERT FOR COASTAL AREAS OF FIJI AND HEAVY RAIN ANTICIPATED FROM SUNDAY EVENING**

A damaging heavy swell alert is now in force low lying coastal areas of Kadavu, Vatulele, Southern Lau and Mamanuca Groups, Southern and Western Viti Levu.

A low pressure system to the south of Fiji and a high pressure advancing over Tasman Sea is generating and directing moderate to heavy damaging swells towards the Group.

The swells are expected to become damaging from Saturday as they travel northwards from the Tasman Sea towards the Group. The peak waves of about 3.5 to 4.5 meters are expected over open waters. There is very high chance that the waves riding on top the high tide can over wash into the vegetation line, causing inundation on coastal low-lying areas of Kadavu, Vatulele, Southern Lau and Mamanuca Groups, Southern and Western Viti Levu. The damaging heavy swells will gradually start easing from Monday night.

Wave conditions can be risky for mariners such as fishing and sea transportation on coastal reefs especially those operating smaller vessels should avoid navigating in these conditions. Similarly for those using Queens Road along Coral Coast should remain alert for occasional over wash of roads during high tides this weekend.

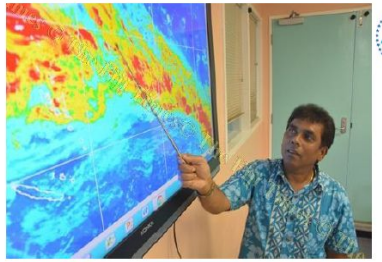
All communities living near the coasts and other sea users, particularly in Kadavu, Vatulele, Southern Lau and Mamanuca Groups, Southern and Western Viti Levu are advised to be vigilant and to exercise extreme caution for occasional sea flooding especially Sunday evening and Monday morning during high tides.

Meanwhile, a trough of low pressure with an associated low is expected to affect the country from Sunday evening. This system is anticipated to bring periods of rain, heavy at times and squally thunderstorms over most places from Sunday night till Monday. Strong and gusty winds can be expected. Persistent localised heavy rain may cause flash flooding of low lying areas. Therefore, communities living in low lying and flood prone areas are advised to remain alert and take appropriate precaution if and when necessary.

The current situation will be closely monitored and any alert and warning will be issued as and when appropriate. All communities are advised to remain updated with the latest weather information and take alerts and warnings seriously.

For more details and the latest on weather, please contact the National Weather Forecasting Centre on 6736006, 9905376 or visit the Fiji Meteorological Service's website, www.met.gov.fj.

ENDS.



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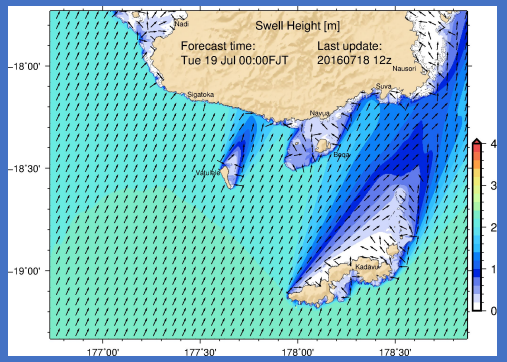
**User-focused communication, 24 May: Impact-based forecasting, that includes hazard and vulnerability information**

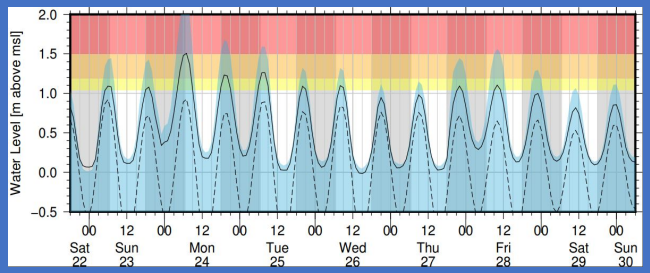
*"There is very high chance that the waves riding on top the high tide can **over wash into the vegetation line**, causing **inundation on coastal low-lying areas**"*

*"Similarly for those using Queens Road along Coral Coast should remain alert for occasional **over wash of roads during high tides this weekend**."*

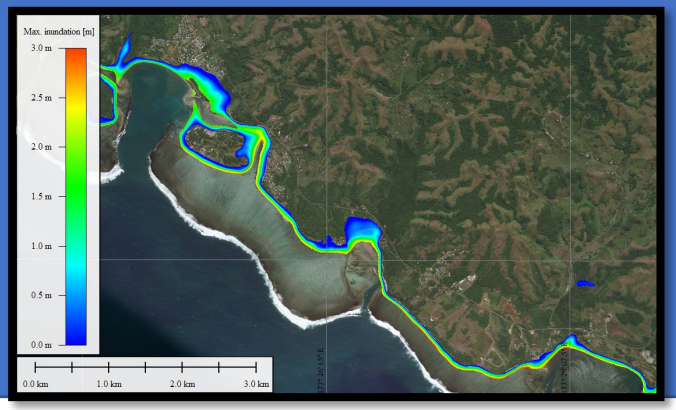
**Timely, Accurate** and **Actionable** information




Offshore wave forecast

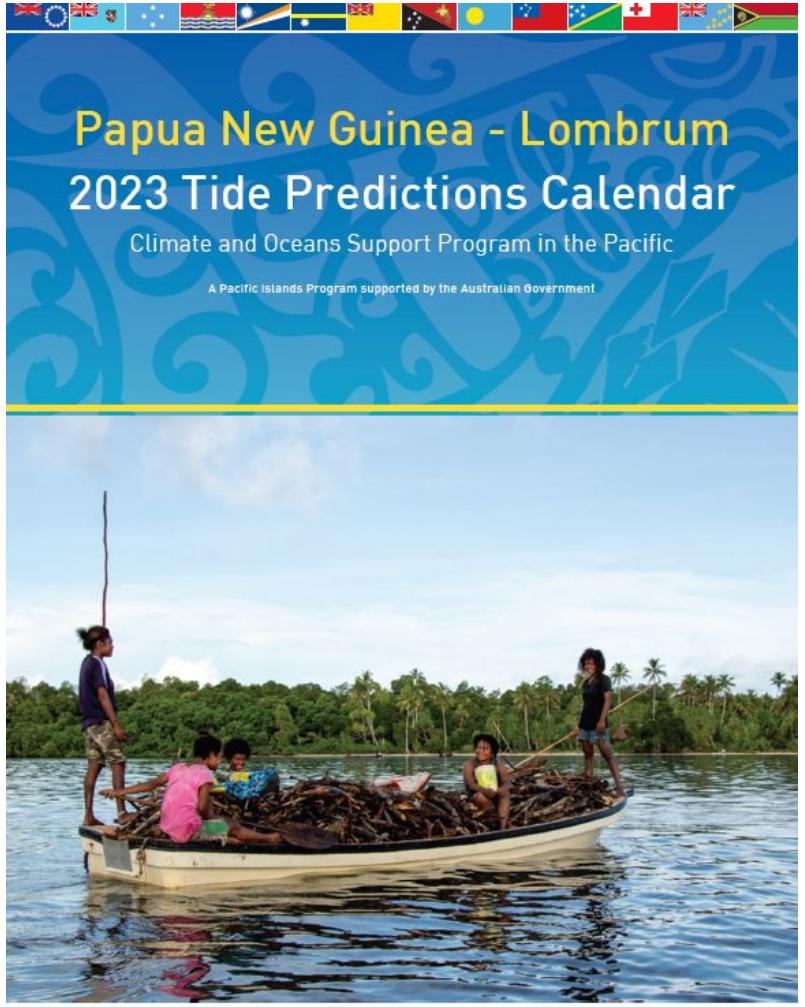


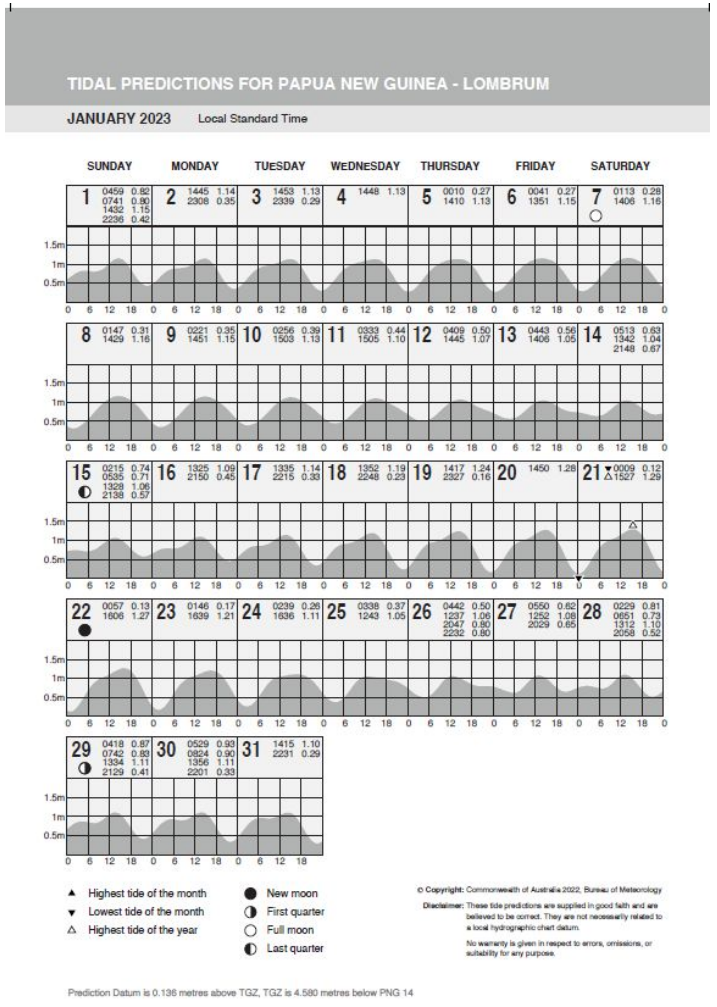

Water Level forecast at the shore

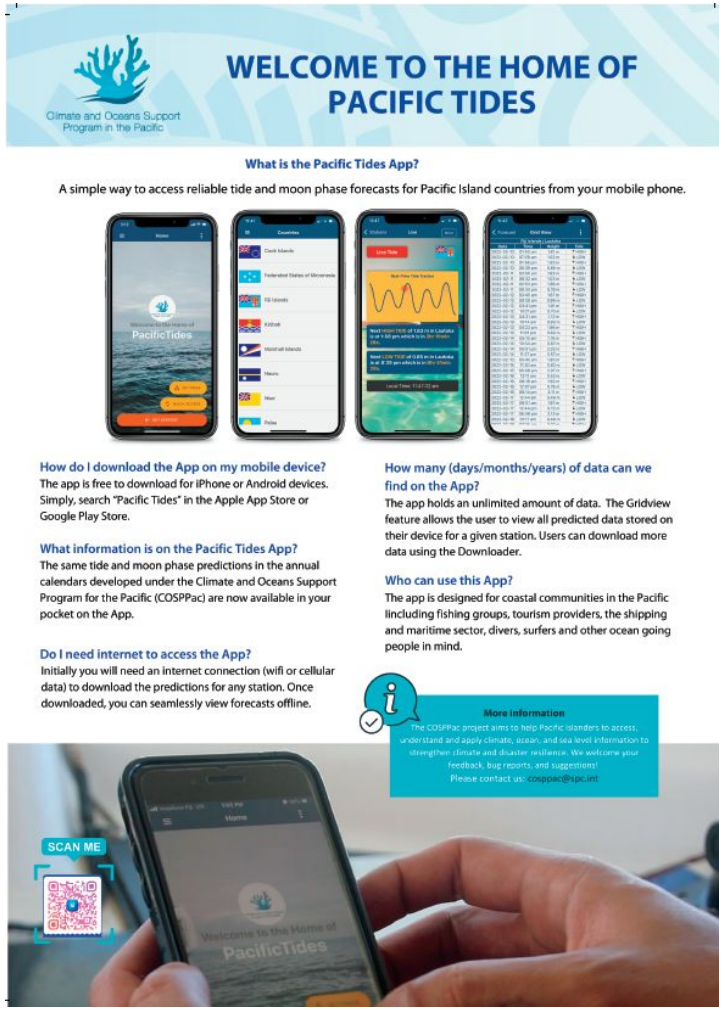



Inundation Forecast

# PSLGM Project Products – Tide Calendar




http://oceanportal.spc.int/portal/library/assets/

# Thank You

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SPREP
PROE

NIWA
Taihoro Nukurangi
Climate, Freshwater & Ocean Science

WMO

UNDP

NOAA

INTERNATIONAL FEDERATION

NEW ZEALAND
FOREIGN AFFAIRS & TRADE
Aid Programme

Australian Government
Department of Foreign Affairs and Trade

Australian Government
Geoscience Australia

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Bureau of Meteorology

Climate and Oceans Support Program in the Pacific