Government of Tonga
Ministry of Lands & Natural Resources

Positioning Strategy for the Kingdom of Tonga

Modernisation of Tonga's Geodetic Datums

References Frame in Practice Seminar
Operational Aspects of GNSS CORS
18th-20th September 2018
Holiday Inn, Suva - Fiji

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Focus of the Presentation

i. Tonga's Current Datums: Geometric & Height
ii. Various Datasets
iii. Problem with current Datum
iv. Plans for Modernisation of Datums
v. Filling the Gabs-Tonga's Strategy & PGSC
vi. Global to National

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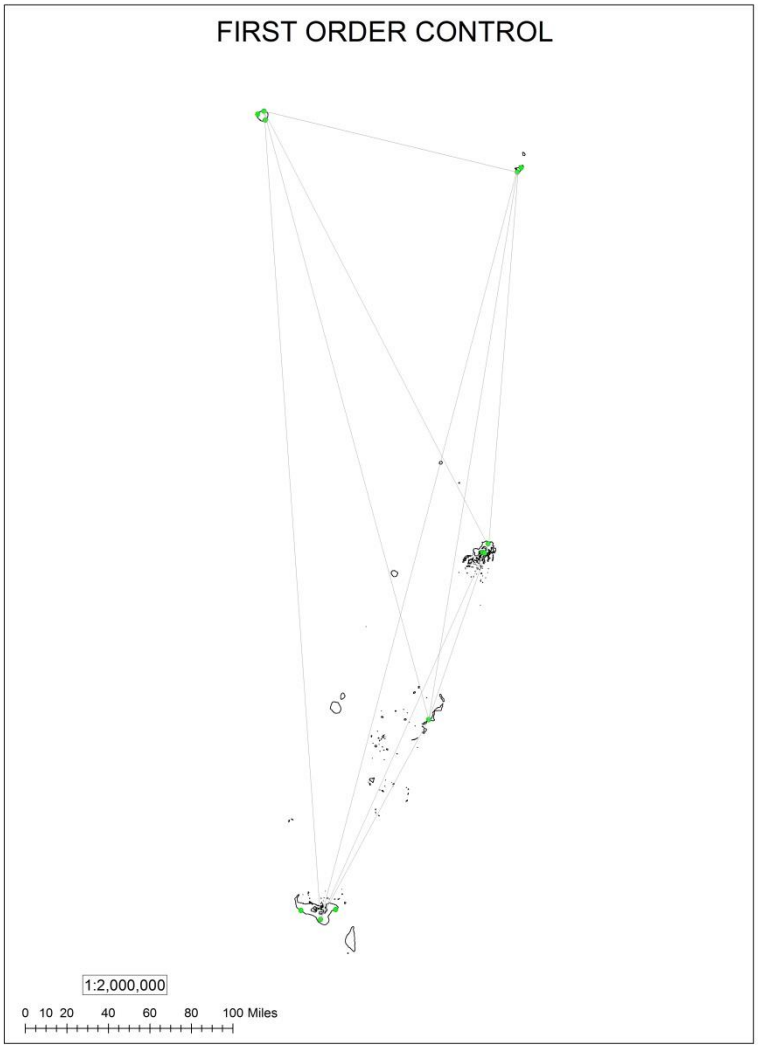
Tonga Geodetic Datum 2005

Tonga Geodetic Datum (TGD2005),

- Geocentric origin
- GRS80 ellipsoid (= WGS84)
- Static datum based on ITRF2000 as at 1 Jan 2005

Tonga Map Grid (TMG),

- Transverse Mercator
- Reference spheroid = GRS80
- Meridian of origin = 177W
- Latitude of origin = The Equator
- Central meridian scale factor = 0.9996
- False origin = 1,500,000E 5,000,000N



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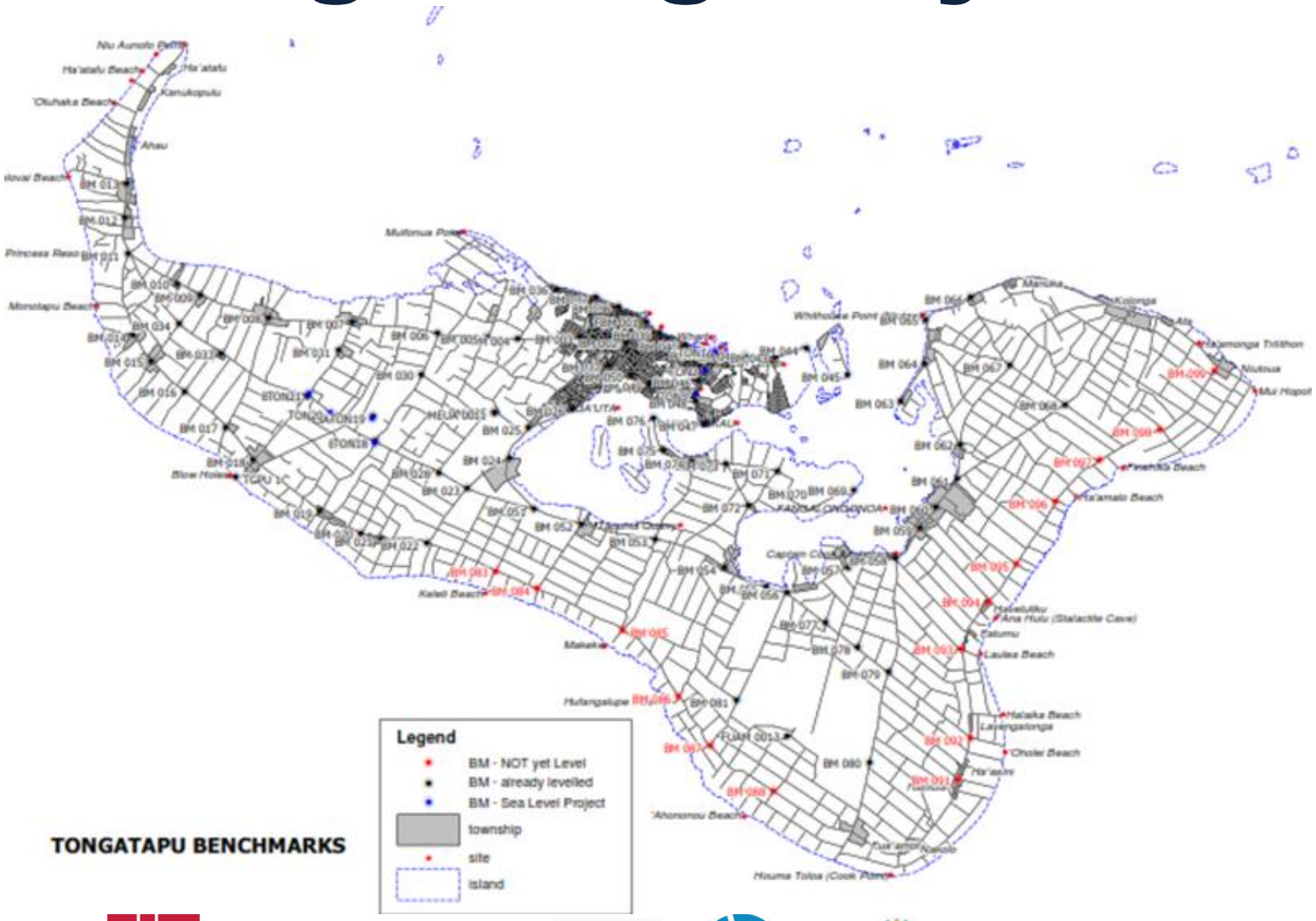
Tonga Height System



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MSL Heights on Outer Islands

Problems with Current Datum

- TGD2005: ITRF2000. Today ITRF2014
- All position measured today will be on 1st Jan 2005
- All GIS datasets are based on TGD2005
- No model (velocity/Plate motion/deformation model) to bring the position to today
- The farther we move from 2005-the farther we are from the true position

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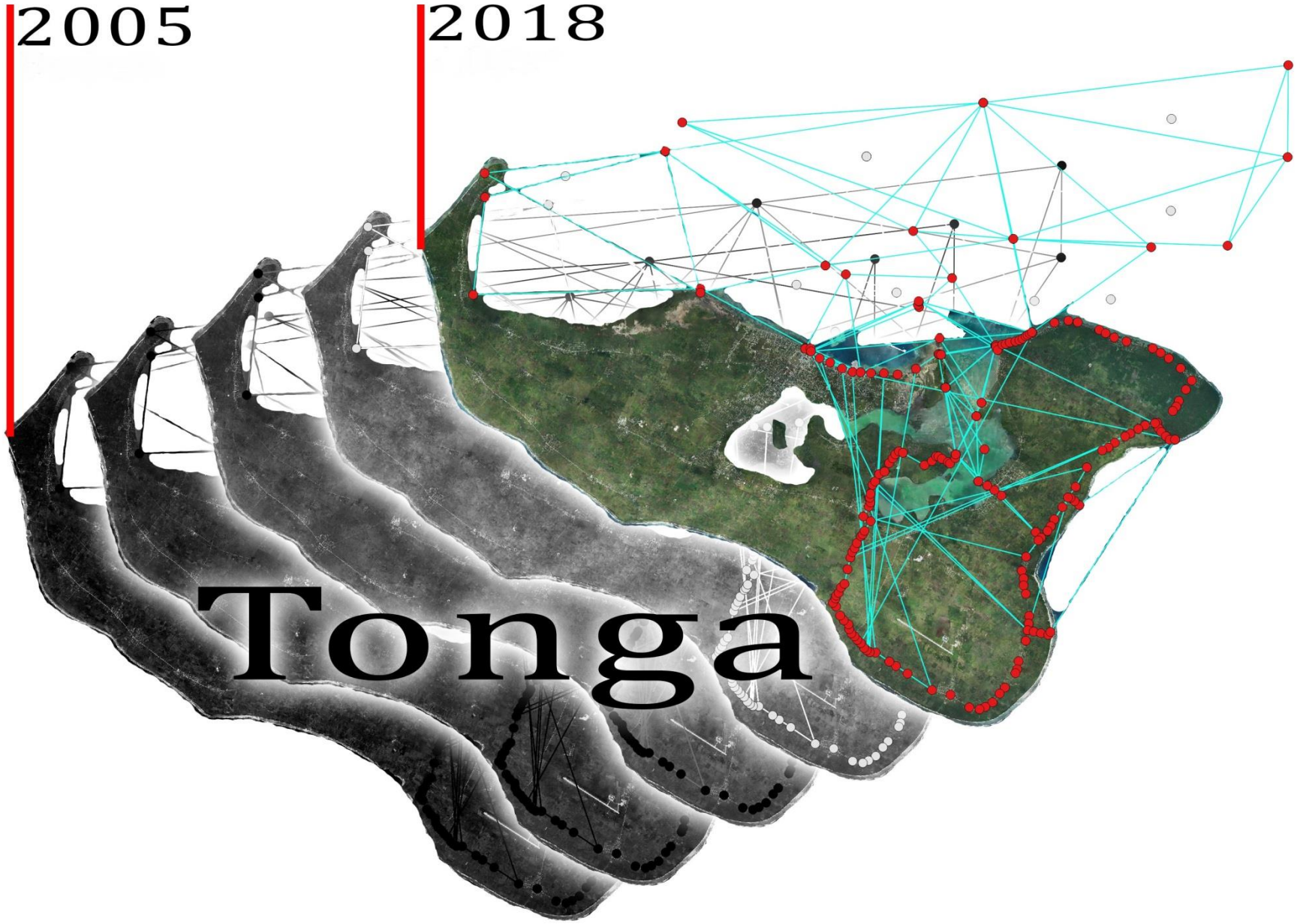

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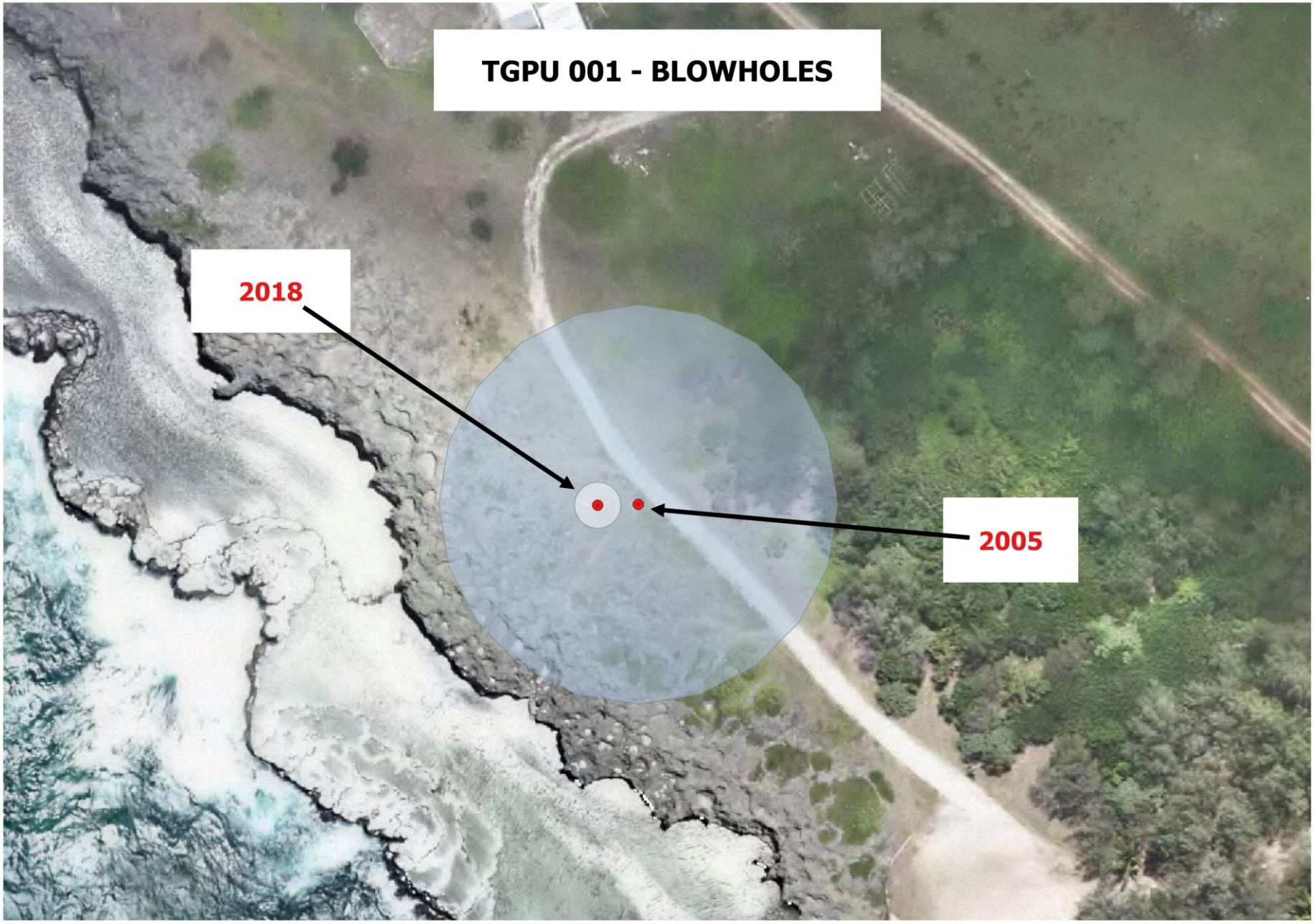

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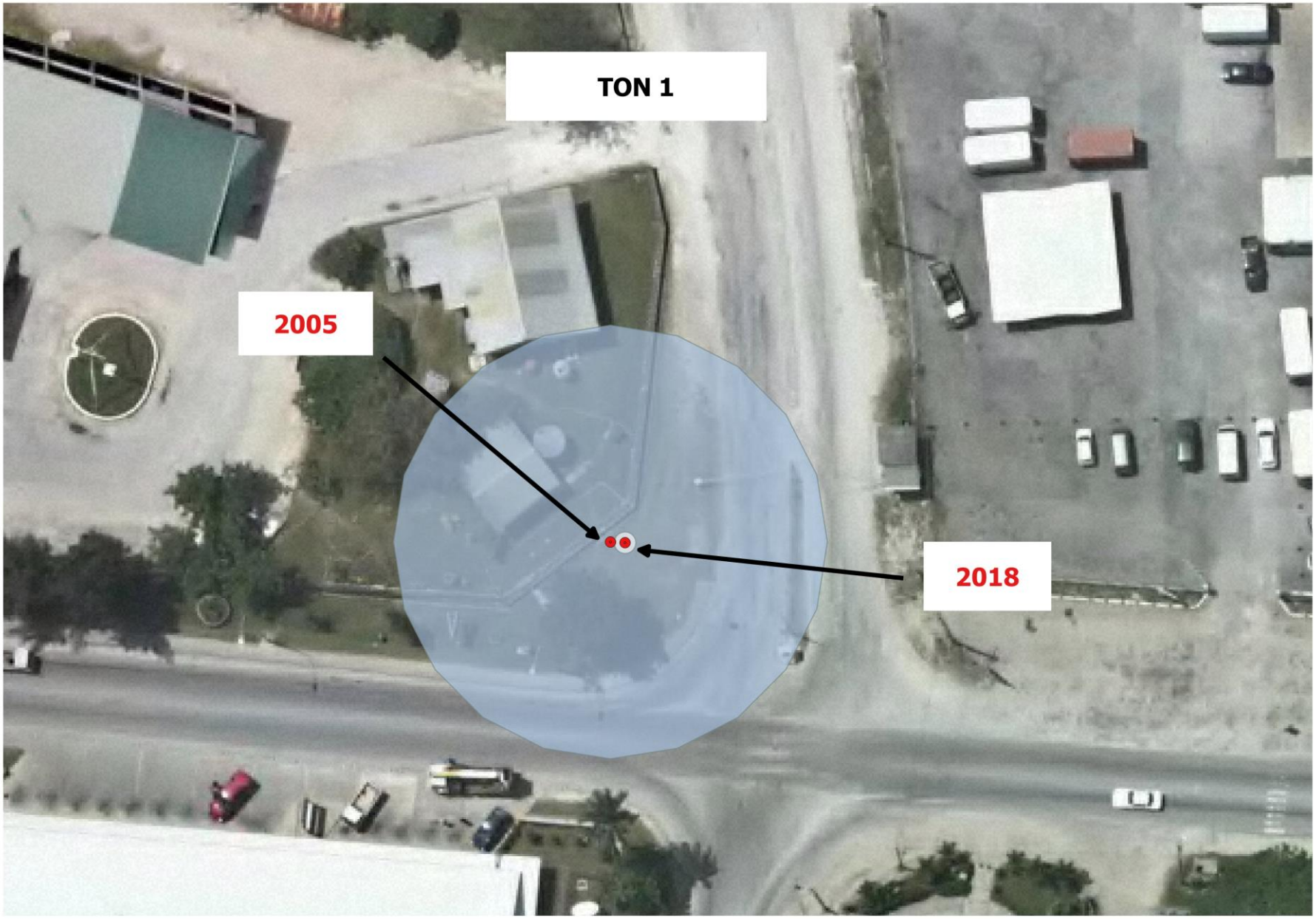

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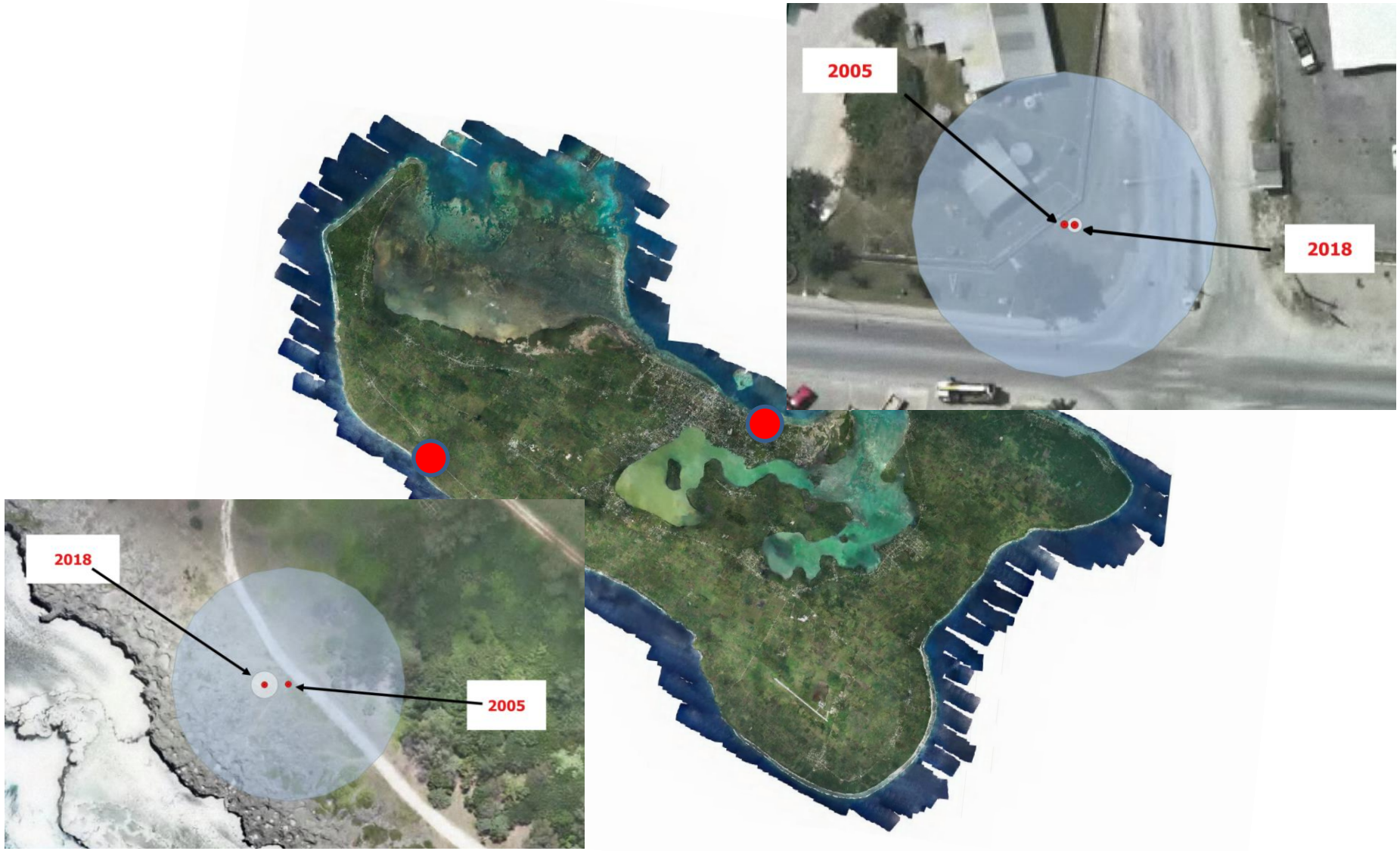

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Why a New Datum?

- Accurate Topography Maps
- Improved Floodplain and Inundation Maps
- Uses of Real-Time Geodetic Positions
- Global Positioning System Monitoring and Improvement
- Improved Early Warning for Natural Hazards
- Autonomous Navigation
- Precision Agriculture
- Coastal Wetland Monitoring

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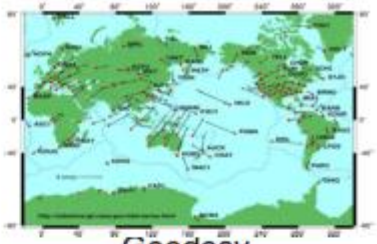
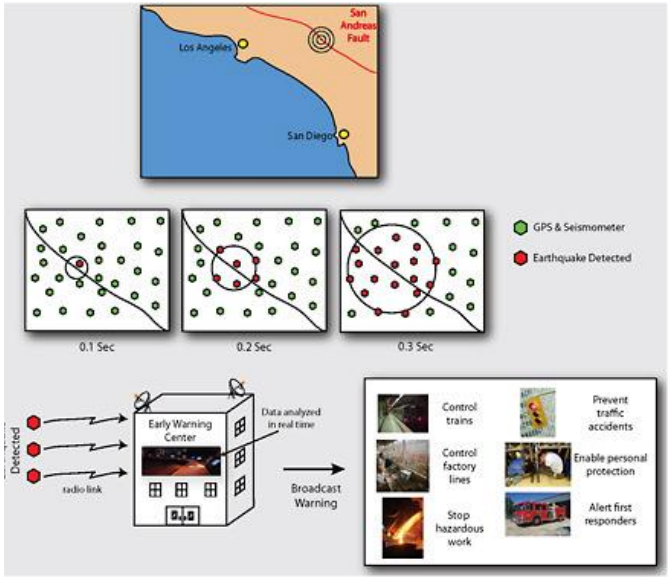
Why a New Datum?

Building Construction



Geodesy



Monitoring

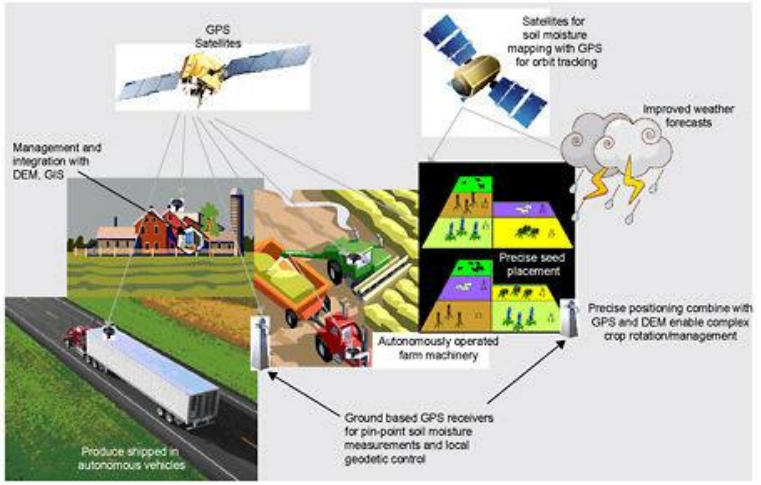
Rapid Mobile Mapping

Port Operations

Land Surveying

Machine Guidance

Precision Agriculture



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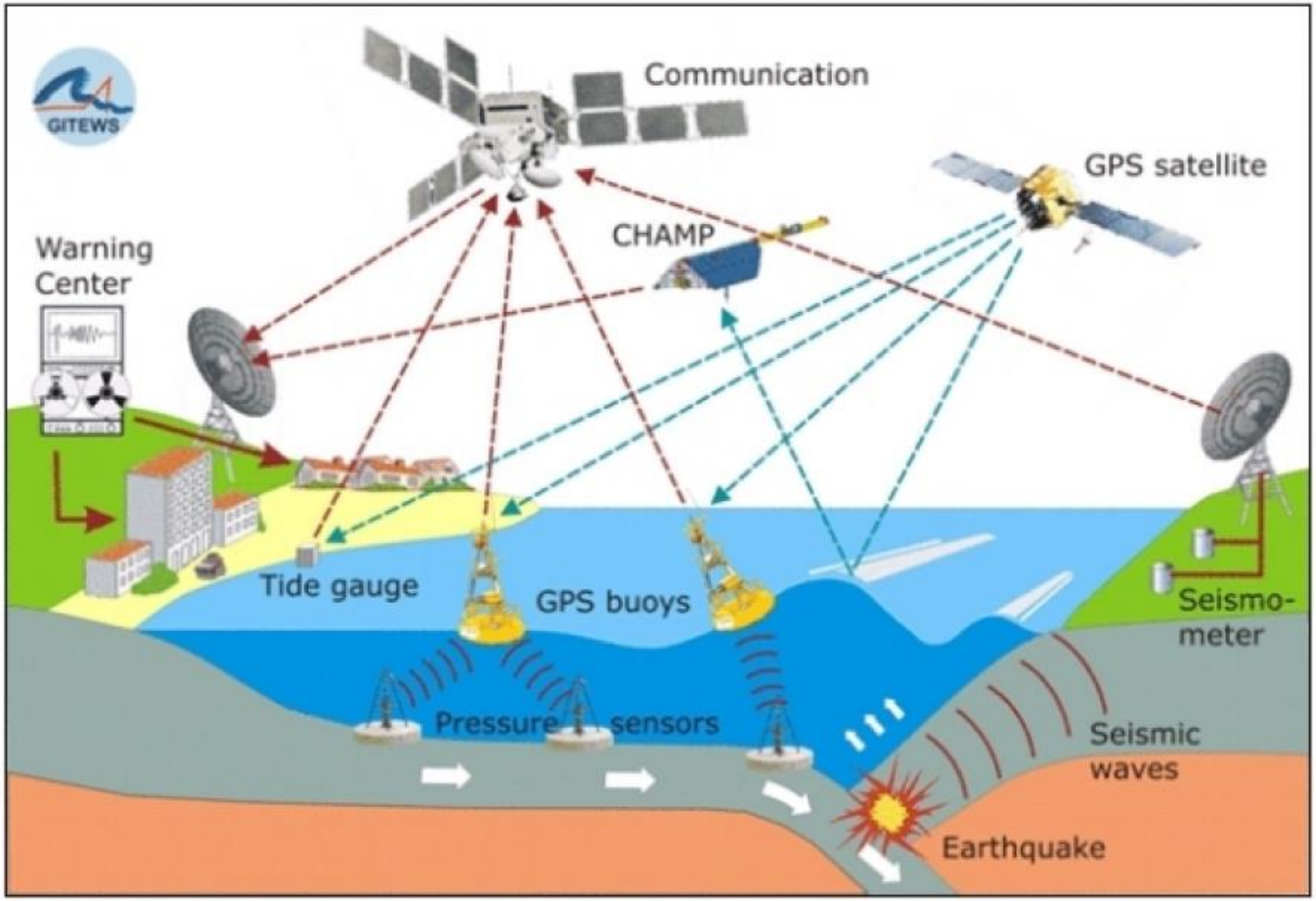

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Why a Modern Height Reference Frame?

- Sea level rise + low-lying islands
- Community safety
- Support development
- Land use planning
- A more accurate & reliable modelling of sea level, tsunami, inundation throughout Tonga

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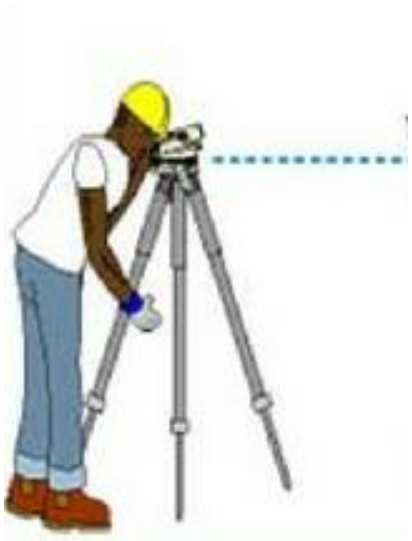
Why a Modern Height Reference Frame?



- Building Legislation or Building Codes:

  Mitigate risk from storm surge or flooding events and ensure that houses and buildings are set above levels which could be impacted by flood waters

Challenges Faced: Datum Modernisation

- Lack of expertise
- Lack of Funding
- Land of equipment & resources
- Not enough staff
- Lack of political will
- Lack of recognition by decision makers/stakeholders/potential users

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Tonga's Plan for Datum Modernisation

Strategic Plan-Action Plan-Implementation Plan

Vision:

Improved decision making, prosperity and safety enabled by world-class reference systems, geospatial information and services.

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Tonga's Plan for Datum Modernisation

- **Strategic Priorities:**
  i. Modern geodetic reference frame aligned to the Global Geodetic Reference Frame;
  ii. Modern height reference frame for the whole of Tonga; and
  iii. Legal framework to empower geodetic datum modernization-Survey Act

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Strategic Priorities

I. **Modern geodetic reference frame aligned to the Global Geodetic Reference Frame:**

a. **Tonga Geodetic Datum 2023 (TGD2023) with new plate motion model**

- **0 Order:** Existing 2 CORS
- **1st Order:** High Stability Marks, 1 week long observation
- **2nd Order:** Existing survey marks, cadastral control- 6 hours observation. Form the basis for 3rd order controls
- **3rd Order:** bearing and distance data available from historical surveys in the adjustment to propagate TGD coordinates onto all remaining marks.

  Purpose of this data is to enable **access to the datum down to the street corner**.

b. **CORS network for Tonga-Building o**

- 1 on each main Islands

c. **National adjustments**

- SNAP
- Old data plus new observation

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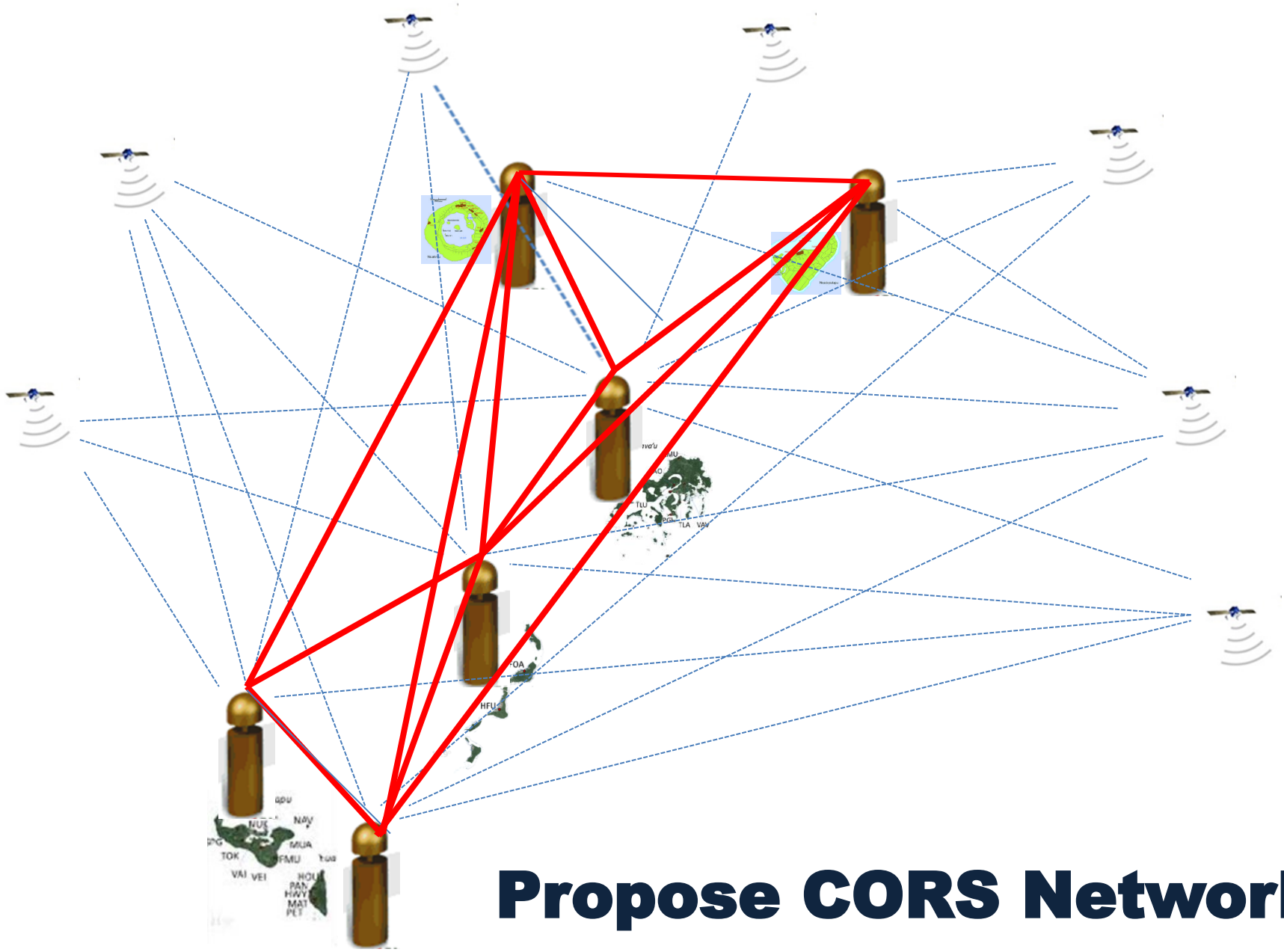

Propose CORS Network

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CORS Hierarchy

- **Tier 1 CORS**

Require high stability monuments to support geo-scientific research and global reference frame definition. These sites are established to support the International GNSS Service (IGS).

- **Tier 2 CORS**

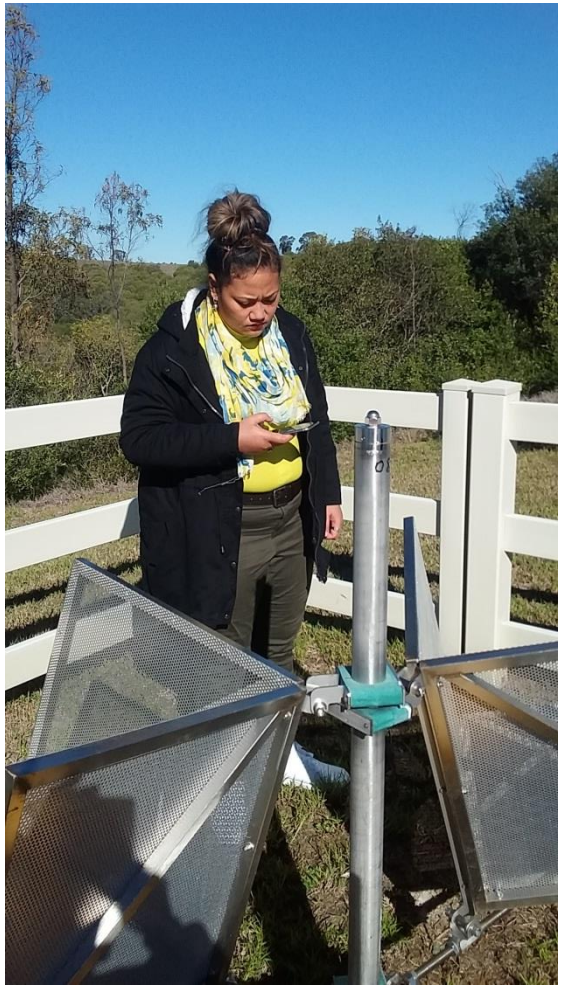
Require high stability monuments, usually established by national geodetic agencies for the purpose of defining and maintaining national geodetic reference frames

- **Tier 2 CORS**

Require stable monuments and are established by national, state, territory governments and/or commercial agencies for the purpose of densification of the national CORS network, often supporting real-time positioning applications.

These stations generally operate in, and provide access to, the datum rather than define it.

Monumentation



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Strategic Priorities

II. Modern height reference frame for the whole of Tonga:

a. Be a gravity based geoid model combined with levelling data is used to establish a new height datum.

b. Create a Geoid Model for Tonga Combine the global gravity model and land based gravity data (this is a model of the ellipsoid to geoid separation values)

c. Gravity measurements

d. Global Models EGM2008 DTU15 MSS

Strategic Priorities

III. Legal framework to empower geodetic datum modernization-Proposed Survey Act:

9. Functions and duties of Surveyor General –

The functions and duties of the Surveyor – General, as head of the Department, shall be:

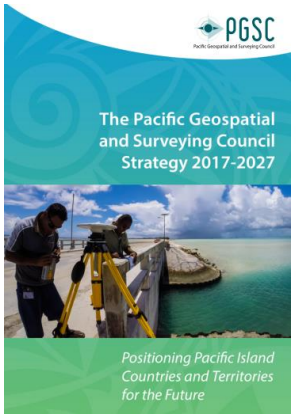
1) *To administer, coordinate, maintain and extend geodetic control networks and traverses, precise levelling or other precision measurements forming the National Geodetic Control Network, and to maintain permanent reference marks governing or providing subsidiary controls for any surveys of land:*

29. Geodetic Reference Frame and Map Grid

1) *All Survey and mapping in Tonga shall be based on-*

   a) *The national geodetic reference frame or geodetic datum and*

   b) *the Tonga Map Grid (TMG)*



Vision

Sustainable development in the Pacific Islands region enabled by world-class geospatial information and surveying services.

Mission

Pacific Island survey and geospatial services, including hazard mapping, urban planning, cadastre mapping, hydrography and other geospatial requirements for sustainable development, are sufficiently resourced to respond to member country priorities.

GOAL 2: Countries across the region adopt a modern Geodetic Reference Frame (GRF) and improved technology underpinning geospatial systems and applications.

Positioning Strategy for the Kingdom of Tonga

- *Modern geodetic reference frame aligned to the Global Geodetic Reference Frame*
- *Modern height reference frame for the whole of Tonga*
- *Legal framework to empower geodetic datum modernization*

Implementation Plan

Action Plan

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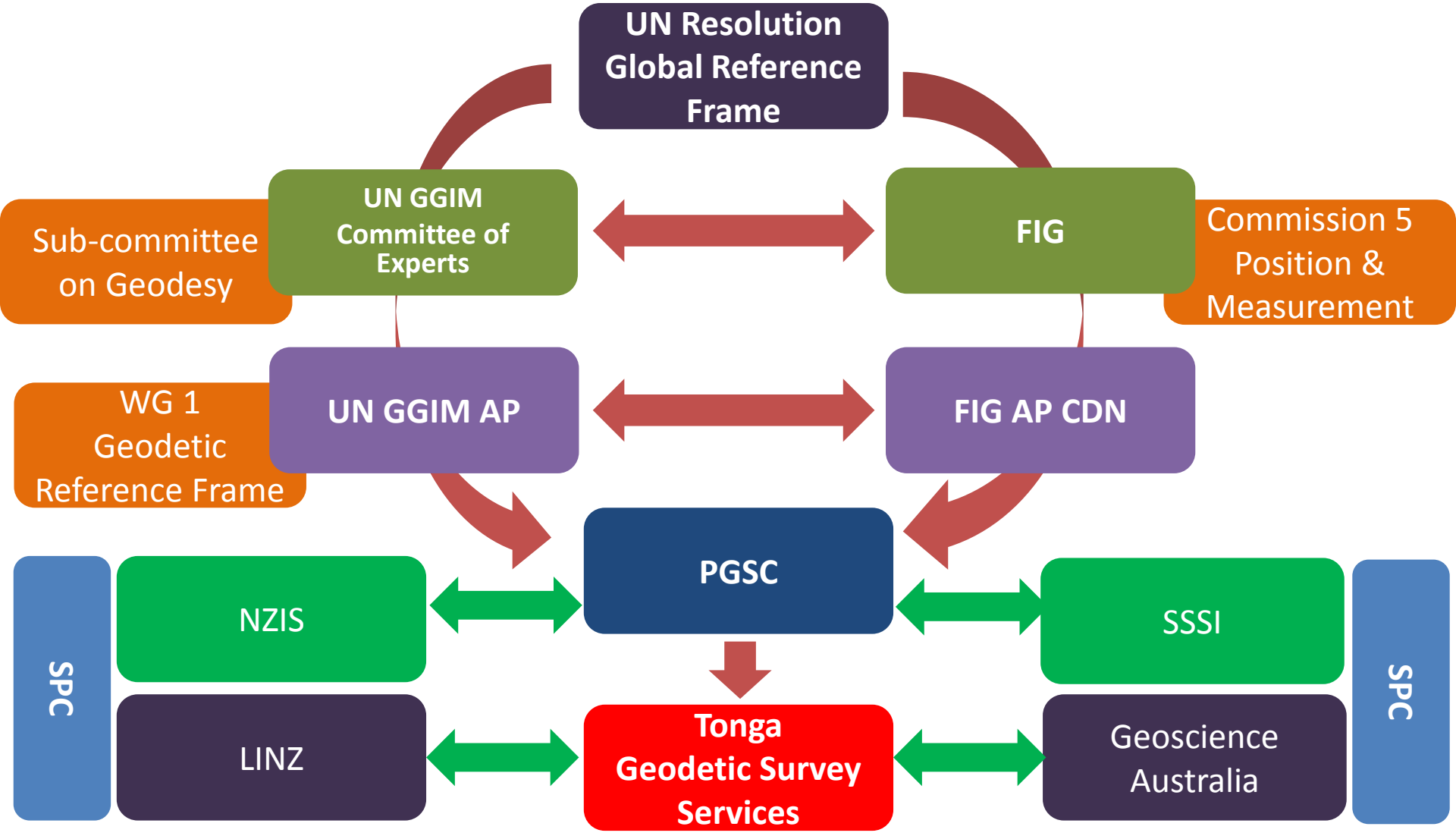
Global/Regional/Sub-regional/National



Malo ‘Aupito

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