






Development of the Kingdom of Tonga Cyclone Emergency Recovery and Management System using Geospatial Tools

Case Studies from Small Island States
FIG Commissions 3, 7 and 8


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Kingdom of Tonga

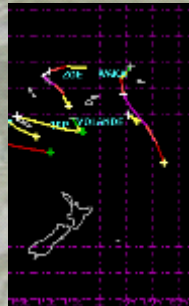
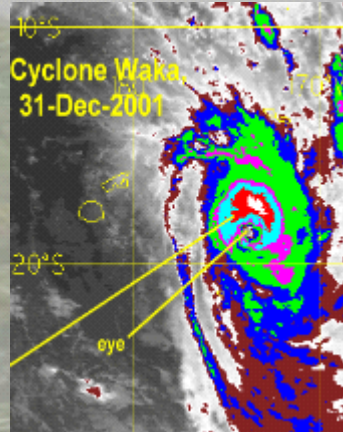


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Cyclone Waka 2001



- Dec 30 - Niuafu'ou & Niuatoputapu.
- Dec 31 - Vava'u Group.
- 26,500 people in 4,600 households affected.
- 60% Vava'u buildings damaged (20% destroyed or severely damaged).
- Losses of TOP104.4m (US\$48m).



CERMP Project 2005-2008


International Development Agency (IDA) credit to:



- A) Rehabilitate the affected social infrastructure by:
 - Providing replacement housing
 - Assisting reconstruction of community buildings
 - Retrofitting existing houses and enterprises
 - Restoring water supply and sanitation
- B) Strengthen emergency and risk management by:
 - 1. Strengthening emergency and risk management processes
 - **2. Improving land and risk information**
 - 3. Improving building standards

Component B2. Land and Risk Information


1. Apply the aerial photography, topographic mapping and GIS information to hazard assessment, risk management and land information activities.
2. Create new topographic maps for the Kingdom using a computer based Geographic Information System (GIS).
3. Acquire new aerial photography using satellite imagery throughout the Kingdom
4. Establish a Ministry Geographic Information System (GIS).
5. Assist in the procurement of new geodetic survey and computer IT equipment
6. Create a new geodetic datum and map projection.
7. Training and capacity building


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Existing Maps and Map Projection

- Existing maps are Directorate of Overseas Surveys (DOS) 1:25 000 paper based, 1970's
- Each island group has its own individual map projection origin.
- Existing maps were not in terms of the GPS system.
- In order to use the DOS map information the relationship to GPS (WGS84) had to be established. Transformation parameters.




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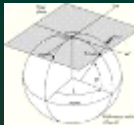



New Geodetic Datum and Map Projection

- A new, national geodetic datum has been created called the Tonga Geodetic Datum (TGD2005), based on international geodetic standards.
 - Geocentric origin
 - GRS80 ellipsoid (\cong WGS84)
 - Static datum based on ITRF2000 as at 1 Jan 2005
- A new, national map projection has been created called the Tonga Map Grid (TMG), based on international mapping standards.
 - 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
- New topographical maps and international land boundaries will be based on the Tonga Map Grid.







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Tonga Geodetic Datum 2005 (TGD2005)

- The new, national geodetic datum is based on international GPS reference stations located throughout the islands.
- Primary and Secondary geodetic stations surveyed.
- Existing DOS survey marks occupied to:
 - Update existing coordinate with Tonga map Grid coordinates
 - Calculate transformation parameters "shift" between DOS maps and Tonga Map Grid.











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Survey Equipment Procurement




- Geodetic Survey Equipment comprising:
 - Three Trimble geodetic GPS units (RTK and DGPS capable) and software
 - Three handheld eTrex GPS receivers.
 - Two Nikon total stations (electronic theodolites).
 - Accessory survey equipment (metal detectors, survey tripods, etc)
 - Supplier: Geosystems, Christchurch, NZ




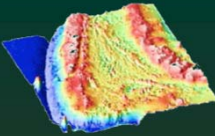
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Land Imagery











Hazards & Risk

- Cyclonic wind
- Storm surge
 - Coastal erosion
 - Contamination of groundwater
- Climate fluctuation
 - La Nina
 - Flooding
 - Insect population explosions
 - El Nino
 - Drought
 - Groundwater shortages
- Sea level rise
 - Inundation
- Earthquake ground shaking
- Tsunami
 - Near source from earthquake, landslide, or volcano)
 - Distal (Pan Pacific)
- Volcano
 - Ashfall



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GIS/Land Information Unit

Project objectives:

- To establish updated high-resolution Land and Geographic Information Systems to support land, risk and hazard management.

GIS Unit objectives:

- Kingdom's authoritative source of land information
- Record land information in a digital spatial environment
- Provide land information for effective land management and land title purposes






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Topographical Maps

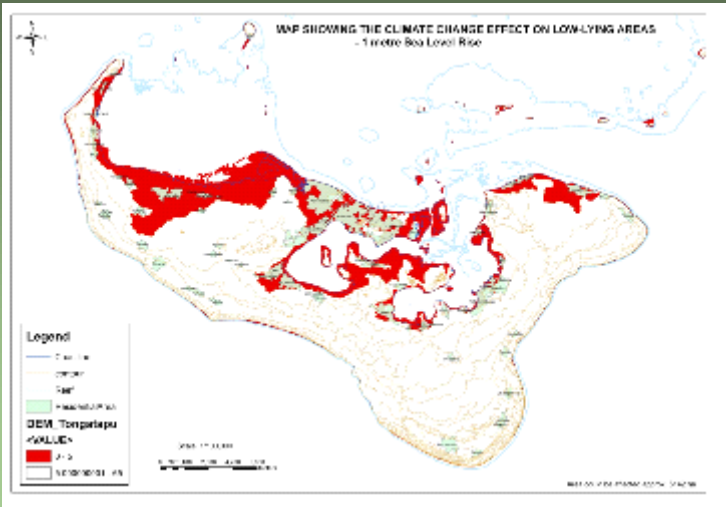


The slide features a vertical image on the left showing a stone sculpture of a figure on a pedestal. The main content is a topographical map of a coastal region, overlaid with a grid. A 3D elevation model inset in the top right corner shows the terrain's relief in various colors. The map includes labels for 'Kuala Lumpur' and 'Kuala Selangor'.

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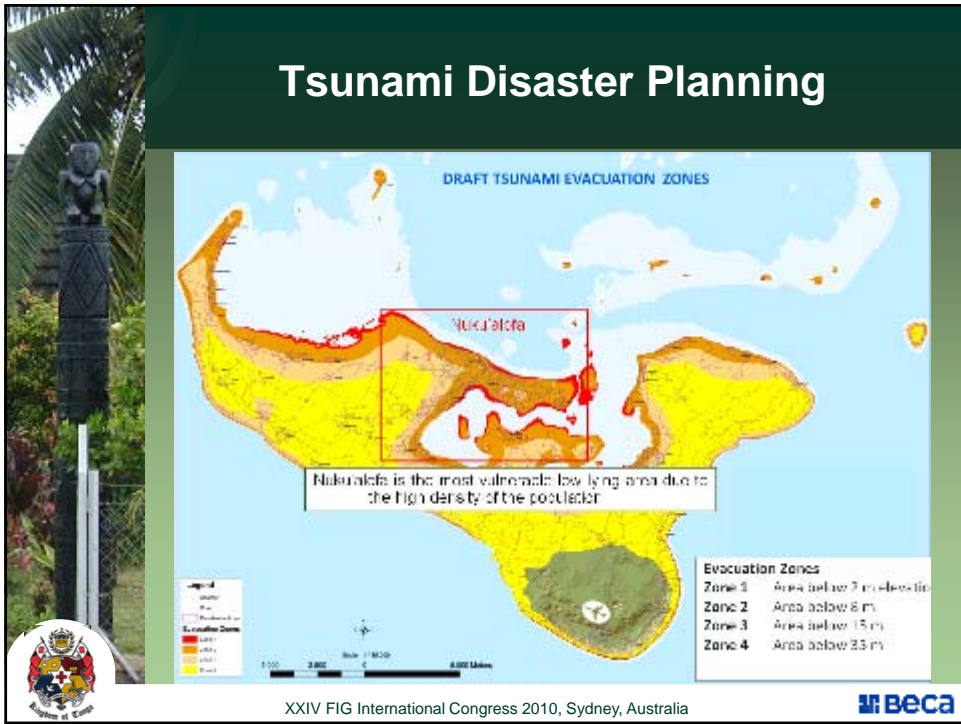
Hazard and Climate Change Mapping



The slide features the same vertical image on the left. The main content is a map titled 'MAP SHOWING THE CLIMATE CHANGE EFFECT ON LOW-LYING AREAS - 1 metre Sea Level Rise'. The map shows the same coastal region as the topographical map, but with red shaded areas indicating low-lying zones. A legend in the bottom left corner defines symbols for 'Coastline', 'Canal', 'Road', 'Waterbody (Blue)', 'DEM Topographic VALUE', '1m SLR', and 'NEIGHBOURHOOD'. A scale bar and north arrow are also present.

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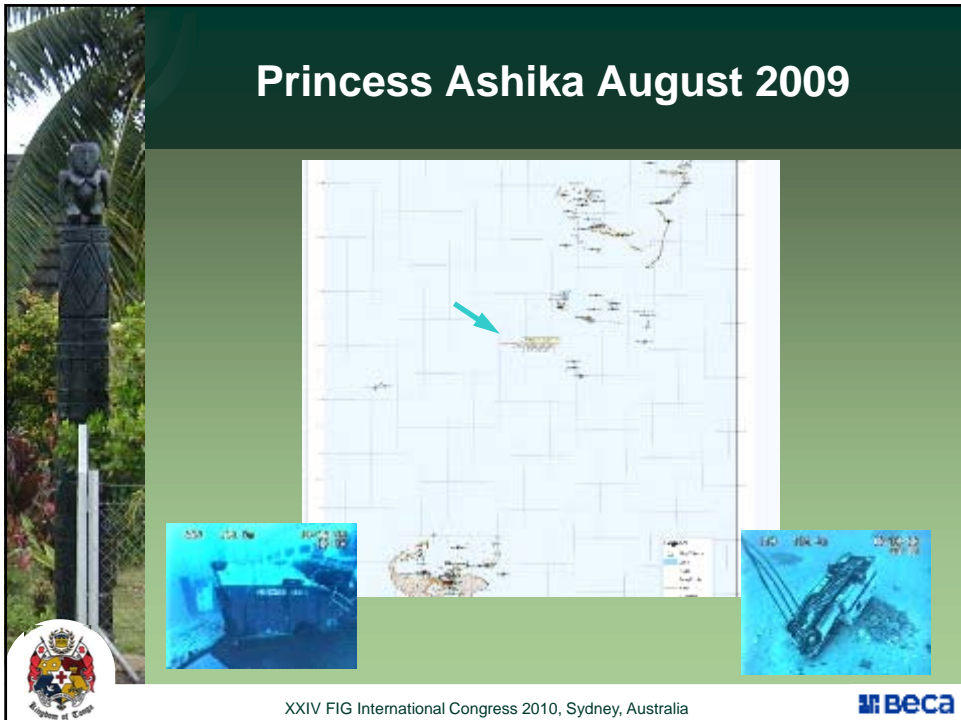


Cadastral Boundaries





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Volcanic Activity March 2009

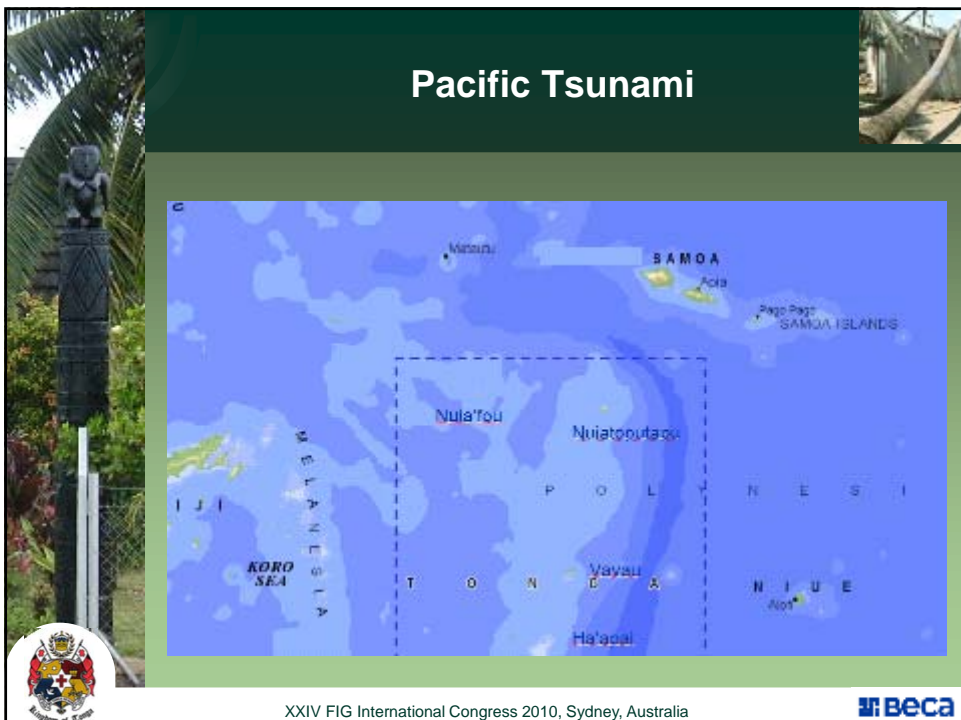

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Princess Ashika August 2009




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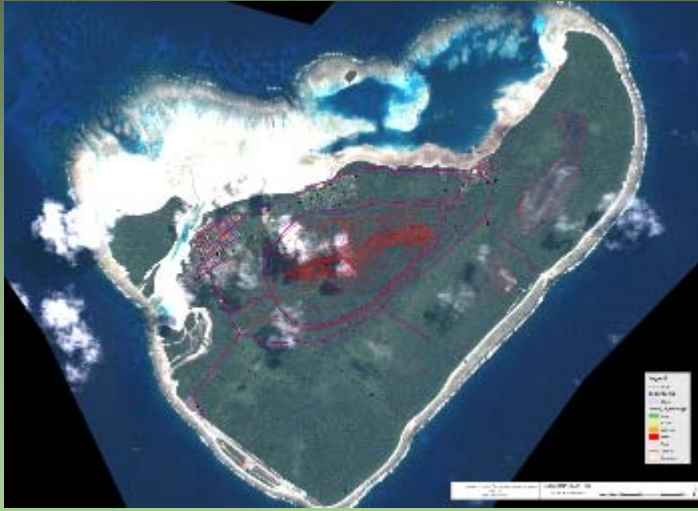
Pacific Tsunami




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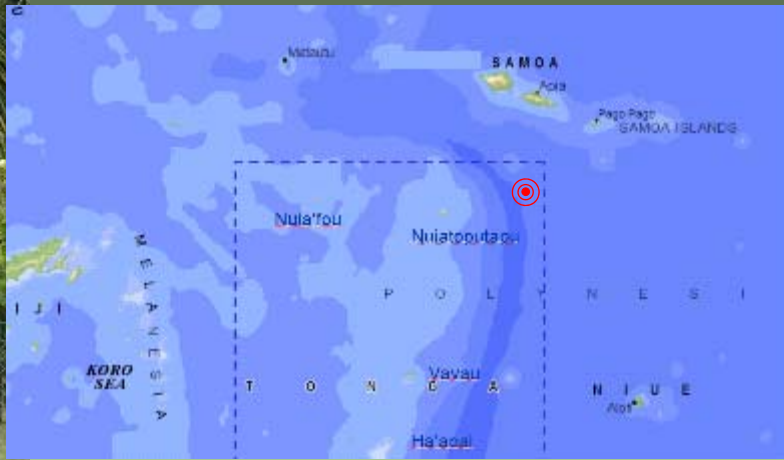
Nuiatoputapu Island




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Pacific Tsunami



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Pacific Tsunami



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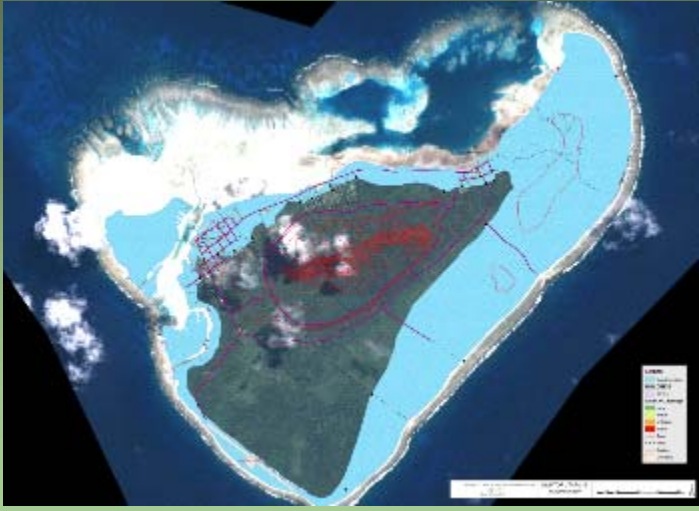
Pacific Tsunami




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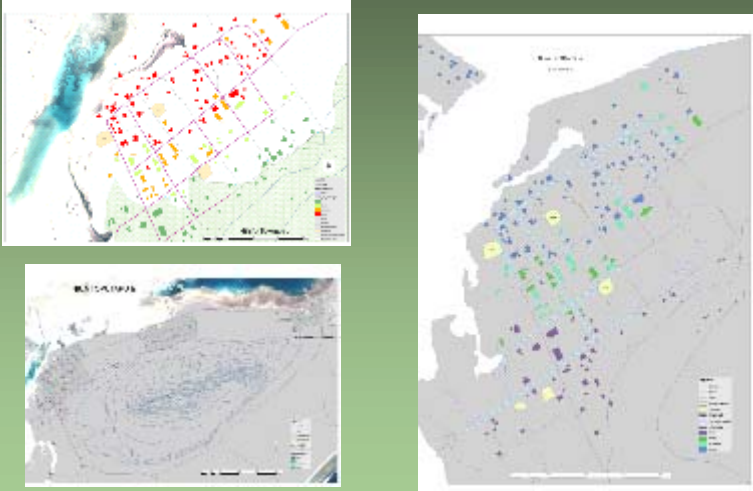
Pacific Tsunami




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Post Tsunami Mapping




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Conclusions

- Ministry of Lands Survey and Natural Resources achieved all objectives of the CERMP project.
- Achieved through funding by the World Bank.
- Established a modern international compliant datum and map projection.
- Modern topographical maps produced including capacity building
- Geospatial tools are being used for disaster mapping and recovery.
- GIS mapping has now formed the basis of the national land information system.
- Activities of the past 6 years have achieved a sustainable outcome.
- A Small Island State capacity building and geospatial success.



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