WORKING WEEK 2025 AND Locate25 THE NATIONAL GEOSPATIAL CONFERENCE
Collaboration, Innovation and Resilience: Championing a Digital Generation
Brisbane, Australia 6–10 April

PNG2020 a new semi-kinematic geodetic datum for Papua New Guinea

Richard STANAWAY
School of Surveying and Land Studies
Papua New Guinea University of Technology

Edwin NIDKOMBU and Lui GAWI
Office of the Surveyor General
Department of Lands and Physical Planning
Papua New Guinea

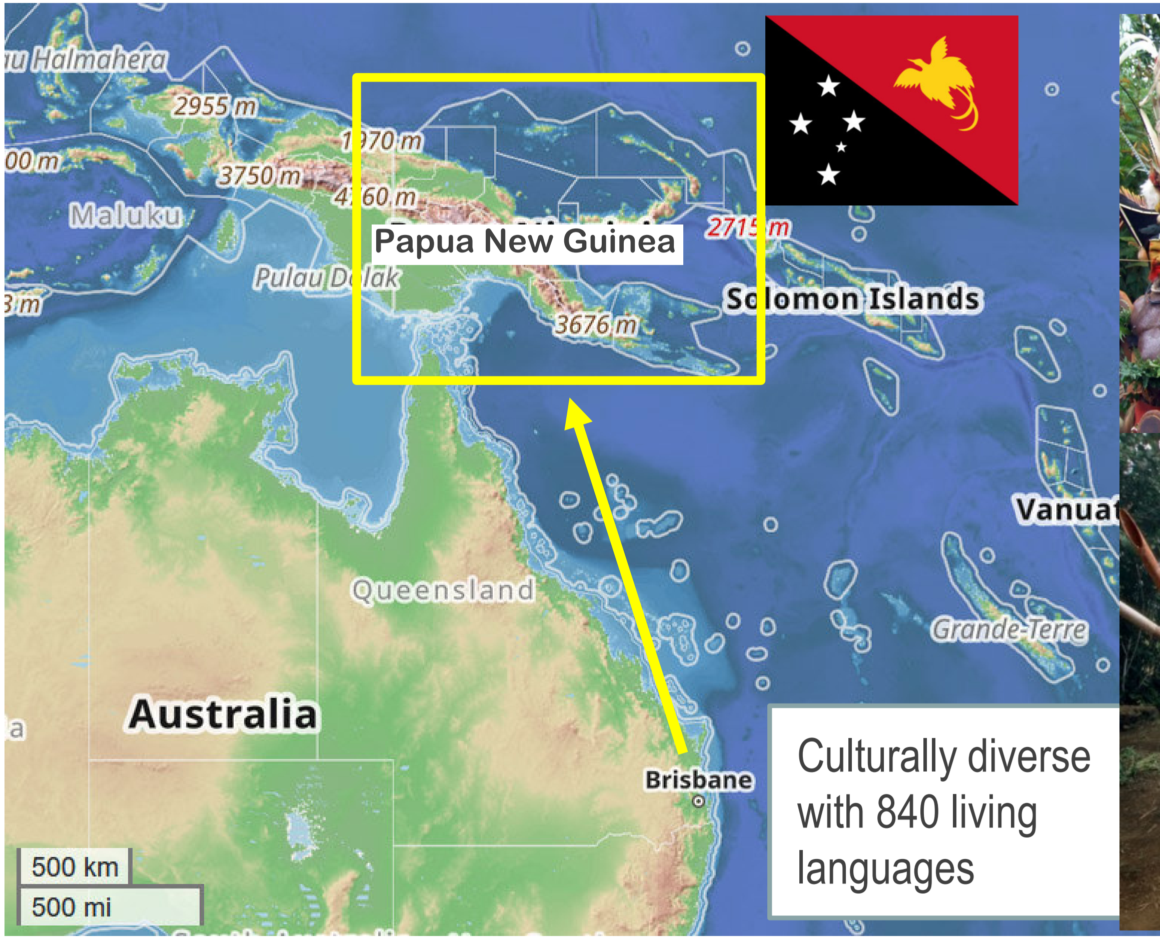
ORGANISED BY FIG Geospatial Council of Australia
PLATINUM SPONSORS Australian Government CHCNAV esri Leica Geosystems Meter Surveyors Australia

Papua New Guinea

Australia's nearest geographical neighbour

"Joined at the hip"

50th Anniversary of Independence from Australia this year



Open Street Map

Culturally diverse with 840 living languages

Challenges of surveying in PNG

Rugged topography
up to 4509 m (Mt. Wilhelm)

dense vegetation

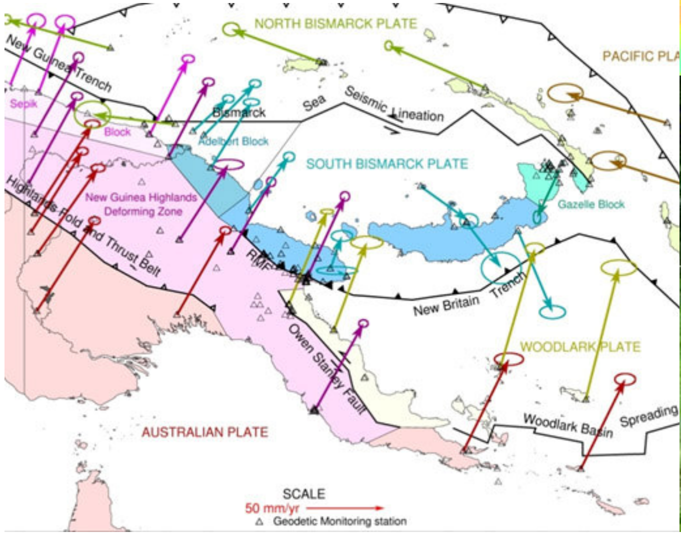
high rainfall
up to 11 m annual rainfall recorded in some locations

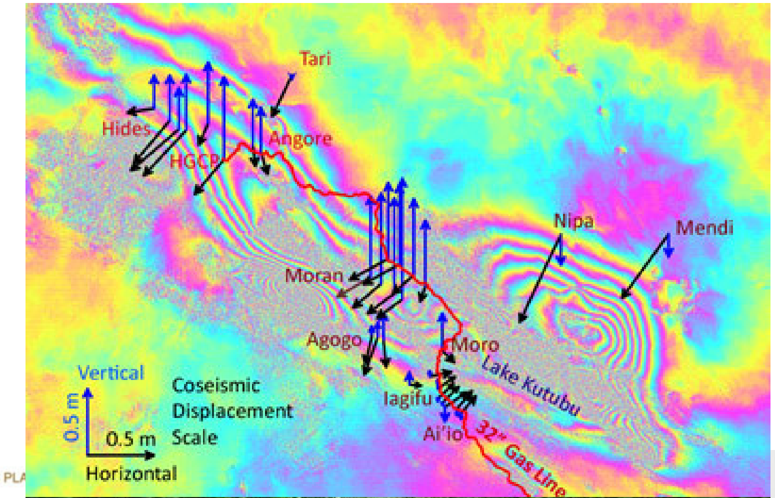
sparse infrastructure
many provinces not yet interconnected by road

limited funding & high costs

Challenges with plate tectonics and geohazards in PNG

ITRF/IGS velocities in PNG (coordinate change per year)
(from Stanaway et al. 2004)

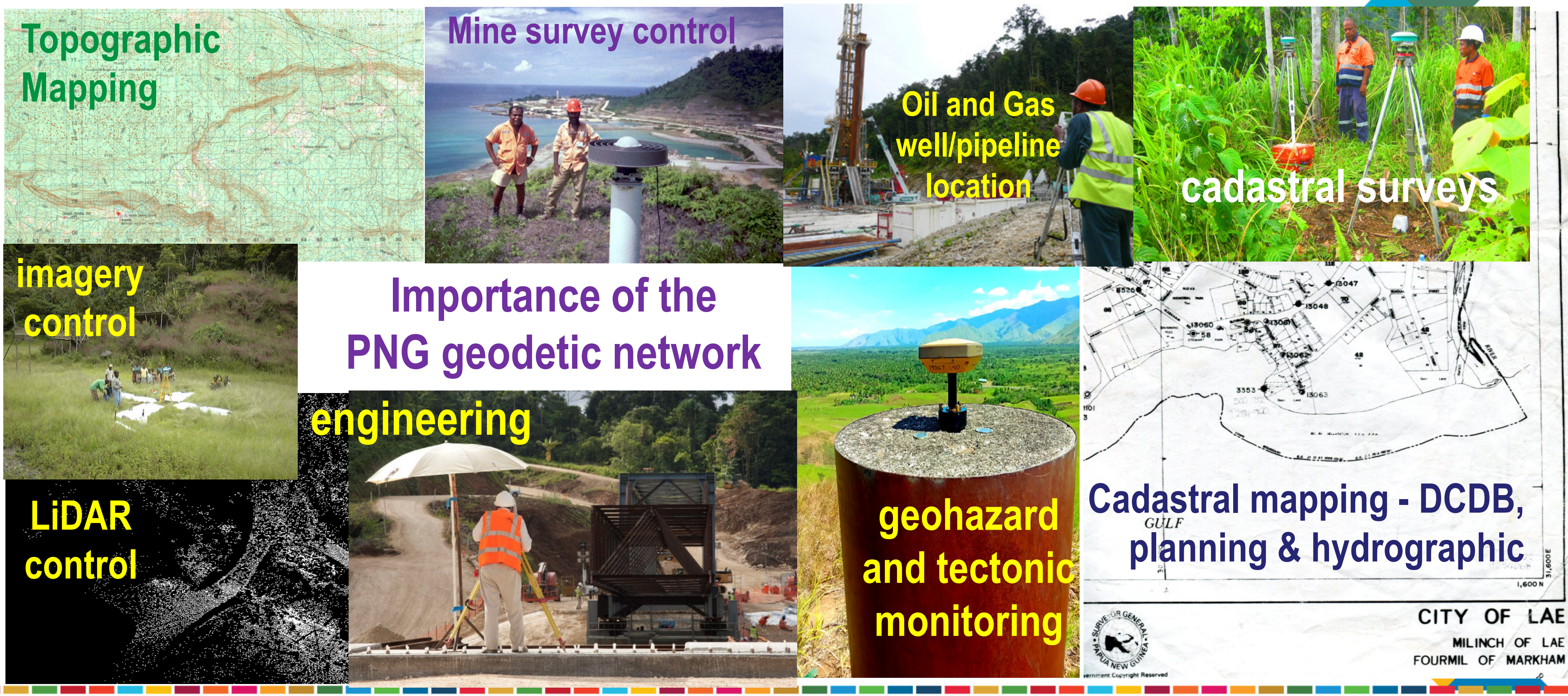




2018 PNG Highlands M_w 7.5 earthquake sequence displacement Observed by GNSS and Insar
(ALOS2 Interferogram, Jaxa, 2018 & Stanaway et al., 2022)

Twin volcanic eruptions of Vulcan (L) and Tavurvur (R), Rabaul, September 1994

Importance of the PNG geodetic network



Current geodetic datum in PNG is PNG94

Realised as ITRF92 at epoch 1994.0

Co-realised with GDA94 in Australia

Gazetted in 1996 to supersede AGD66

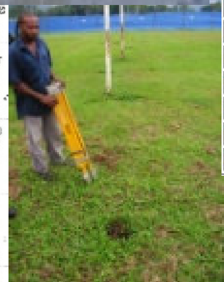
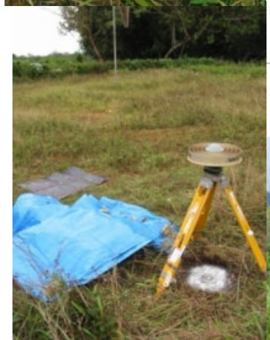
~15,000 Permanent Survey Marks (PSM)

PNG94 Fiducial (zero order) network



(3 cm 2D precision 95% CL)

Site ID	Site Name	Monument number	PNG94 Latitude	PNG94 Longitude	PNG94 Ellipsoidal Height
MORE	NMB TOWER GPS	PSM 15832	-9°26'02.76968"	147°11'12.20017"	116.610
AIAM	AIAMBAK	PSM 9550	-7°20'51.81934"	141°16'01.44646"	95.465
MIS1	BWAGAOIA AIR	PSM 9195	-10°41'19.90490"	152°49'58.93878"	87.456
GOKA	GOROKA	PSM 9833	-6°04'53.07151"	145°23'30.44618"	1664.580
ALT2	GURNEY	PSM 9538	-10°18'37.50877"	150°20'18.09080"	94.871
KAVI	KAVIENG AIR	PSM 9513	-2°34'53.06528"	150°48'22.53578"	78.828
KIKO	KIKORI AIRPORT	PSM 5583	-7°25'24.65305"	144°14'55.76611"	88.965
MAD1	MADANG	GS 15495	-5°12'41.28824"	145°46'56.19305"	73.293
MANU	MANUS SECOR	PSM 9522	-2°03'02.29337"	147°21'37.63577"	129.751
MEND	MENDI	PSM 3507	-6°08'36.73422"	143°39'22.16540"	1815.154
9799	UNITECH SPORTS	PSM 9799	-6°40'16.96985"	146°59'52.37457"	130.389
VANI	VANIMO DOPPLER	PM 63/1	-2°41'05.28039"	141°18'15.65564"	80.516
NM34	WANKKUN	PSM 15029	-6°08'52.07208"	146°04'52.44226"	510.015
WUVU	WUVULU ISLAND	PSM 15456	-1°44'07.59465"	142°50'10.07846"	79.056




GNSS CORS in PNG

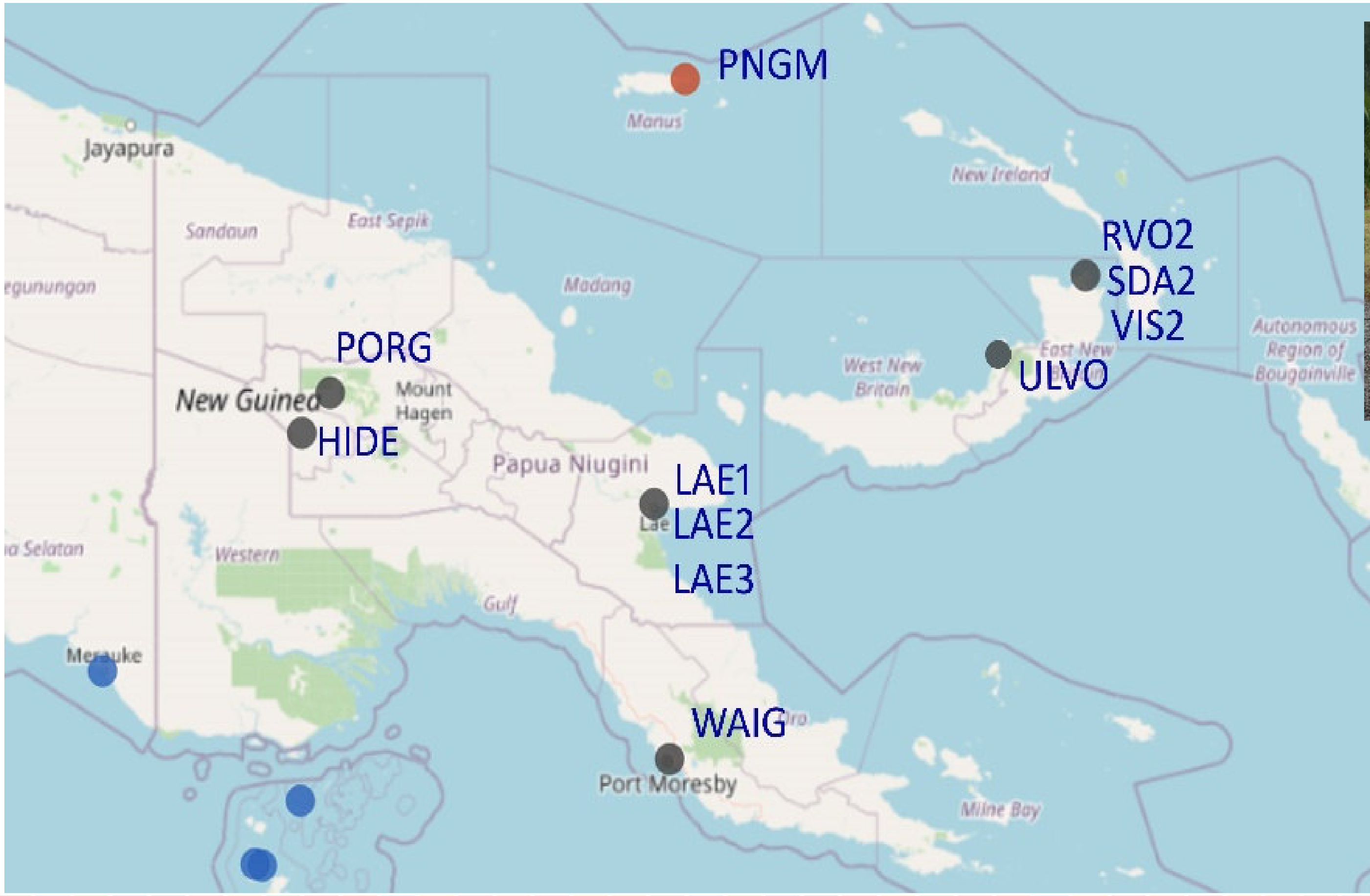
2 IGS stations
LAE1 and PNGM

4 APREF stations
RVO2, WAIG, PORG & HIDE

4 National CORS
LAE2, ULVO, SDA2, VIS2

1 Commercial CORS
LAE3 AllDayRTK/Theodist

Private CORS networks (e.g. Mines, Oil Palm)



PNG94 is well past its retirement age (for a modern datum)!

PNG94 is now over 31 years old (reference epoch)

Users of precise GNSS positioning (and increasingly also handheld GNSS/GPS) see differences between GNSS coordinates (WGS 84 or ITRF2020) and PNG94.

This difference is due to ~ 2 metres of tectonic displacement in PNG since 1994 (secular interseismic displacement between 1994 and 2025) and

3458 ~~3457~~ M_w 5.0 and larger earthquakes since 1994 (< 30 cm displacement)

113 ~~112~~ M_w 6.5 and larger earthquakes since 1994 (< 1m level displacement)

14 M_w 7.5 and larger earthquakes since 1994 (1-5 metre displacement for each event)

Significant distortions now in the PNG94 network that exceed many surveying and positioning tolerances. It is increasingly difficult to use a site velocity model to estimate PNG94 coordinates from current ITRF coordinates using precise point positioning GNSS/GPS and AusPOS or similar.

PNG2020
a new semi-kinematic datum for PNG

The PNG Government commenced development of PNG2020 in May 2024 to supersede PNG94

Static component: ITRF2020 at epoch 2020.0 (1st January 2020 reference epoch) – closely aligned with GDA2020 in Torres Strait

Kinematic component:
ITRF2020 at epoch *yyyy.yyy*

Velocity model (grid) to transform between ITRF2020 and PNG2020

Support from other sectors and agencies is essential!

Government

Academic

Private Sector Surveyors

Resource Sector

Lae seismic zone GNSS survey

Geoscience Australia through DFAT provided financial support for a major geodetic survey of the Lae seismic zone and region between 2022 and 2024.

Four geodetic capacity building workshops were conducted in Lae and Port Moresby in late 2022 funded by GA/DFAT.



Australian Government
Geoscience Australia
PNGAus Partnership
PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

PNG2020 densification and observation priorities

Geodynamic monitoring stations (to develop velocity model)
Urban survey control (cadastral, construction, services)
International border monuments (Indonesia/PNG border)
Critical infrastructure (airports, ports, highways, utilities)
Mining operations (SML, mine & exploration grids)
Oil and gas operations (well locations, pipelines, facilities)
Agriculture and Forestry (plantations, forestry mapping)
Geohazard monitoring (volcanoes, active faults, landslides)
Sea level monitoring (vertical movement of tide gauges)
Rural cadastral control (customary land surveys)
Existing geodetic stations (for transformation parameter estimation from legacy datums and cadastral grids)

PNG2020 geodetic data analysis

Data recovery and analysis of 33 years of GNSS/GPS static observation data archive (Rinex/binary obs.) processed in a consistent ITRF2020 geodetic reference frame.

Aim 1 : Station velocities estimated to 1 $mmyr^{-1}$ at 95% CL
Aim 2: Positions estimated at 1 cm precision (95% CL) - ITRF2020 at epoch 2020.0 (1st January 2020)

Surveyor General Papua New Guinea 1990-2025

UNSW Sydney – Simon McClusky 1990-1994

Rensselaer Polytechnic Institute – Colleen Stevens 1993-1997

Papua New Guinea University of Technology 1993-2025

Australian National University – Paul Tregoning 1996-2008, Richard Stanaway 2000-2004

UC Santa Cruz – Laura Wallace 1997-2002

Haus Guria Rabaul Volcanological Observatory – Steve Saunders 1998-2025

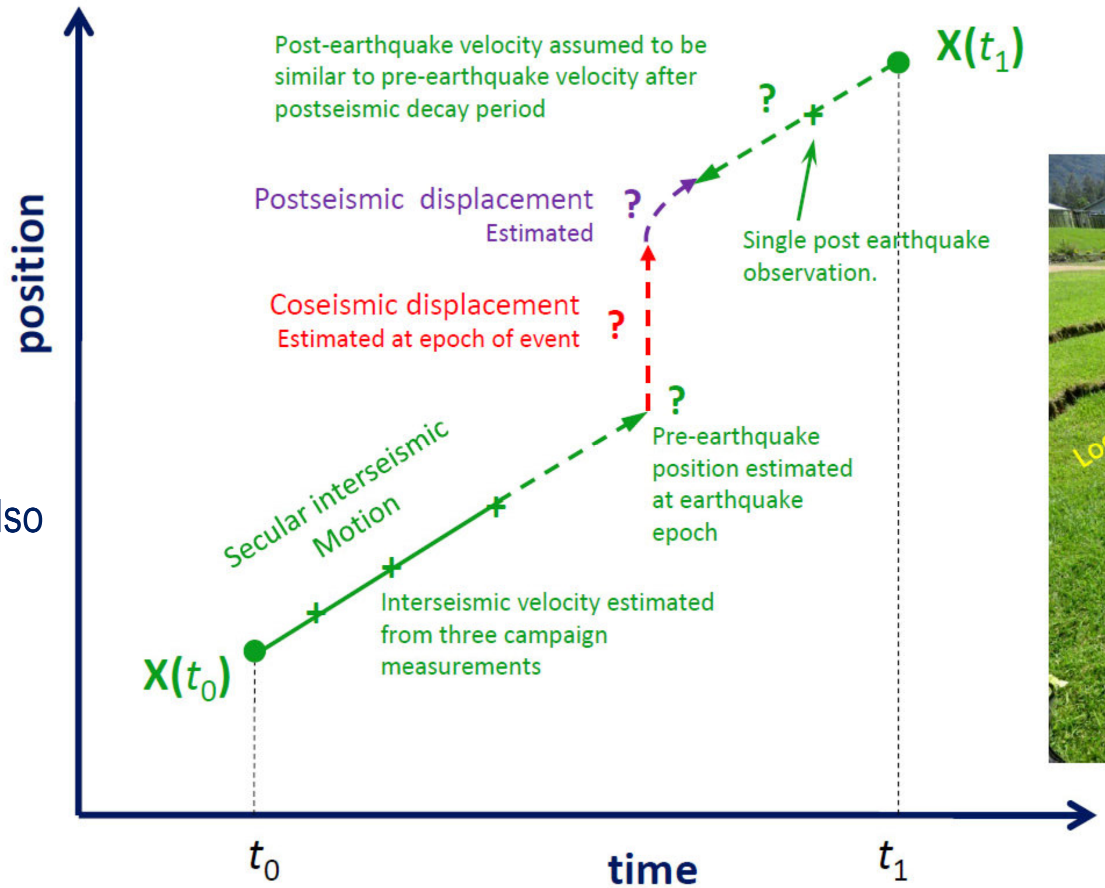
QUICKCLOSE – Richard Stanaway 2005-2023

GNS Science Te Pū Ao – Laura Wallace 2003-2013

Australian Government Geoscience Australia

Effect of seismic displacements on site velocity estimation

A major issue is the lack of CORS and campaign static data in seismically affected locations. Many stations are also affected by localised deformation. This impacts on the precision of site velocities and derived plate/microplate rotation parameters (Euler poles). Sparse seismic network in PNG to constrain earthquake source locations.

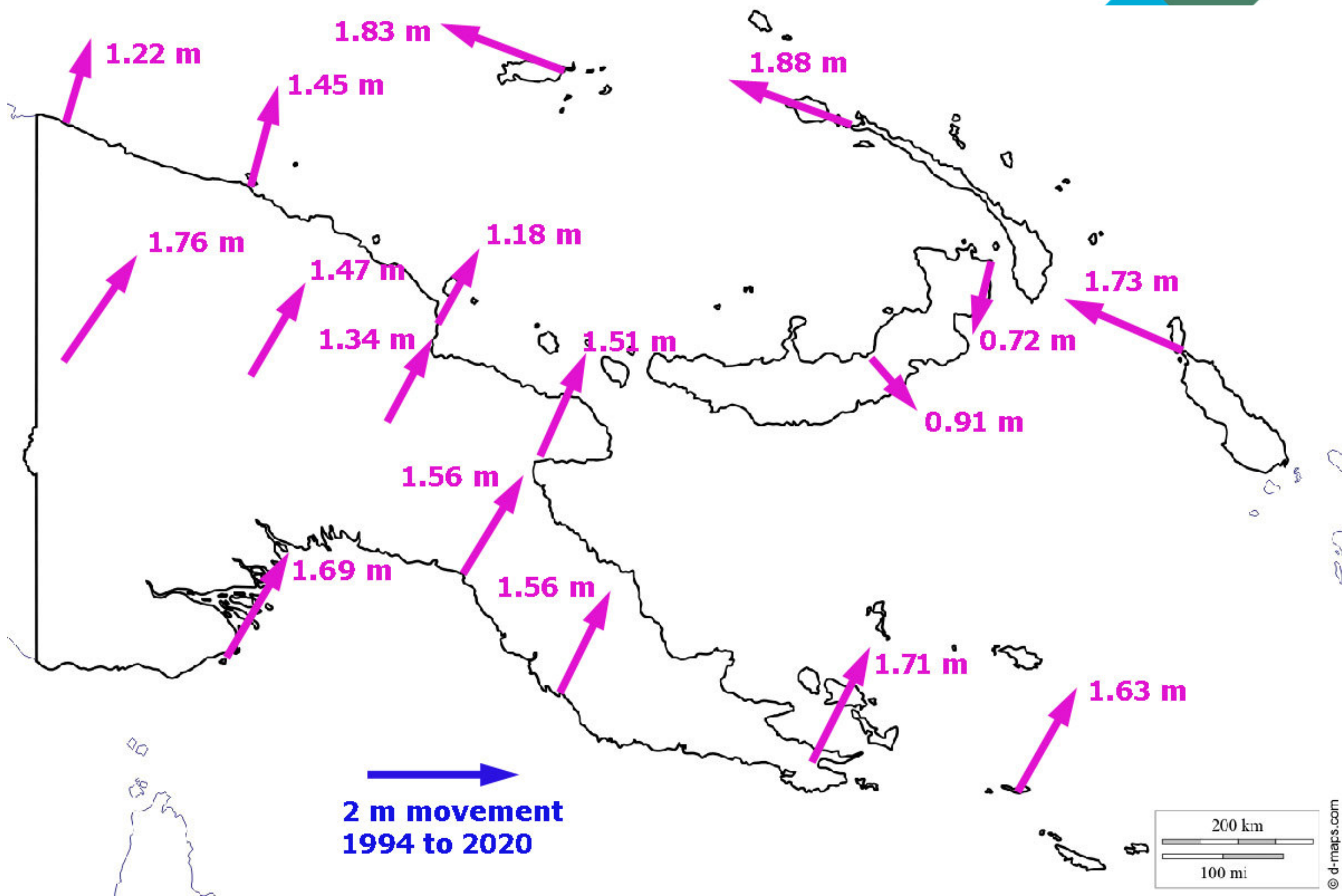


Good to have redundant local site ties / RMs!

Spatial difference between PNG94 and PNG2020

The highly complex tectonic setting in PNG precludes the use of a conformal transformation (e.g. 7 parameter).

Grid transformation approach is essential (NTv2, GGXF/NetCDF, or GeoTIFF)



PNG08 Geoid – “geoid on steroids”

Currently EGM2008 corrected to fit observed MSL at several TG around PNG.

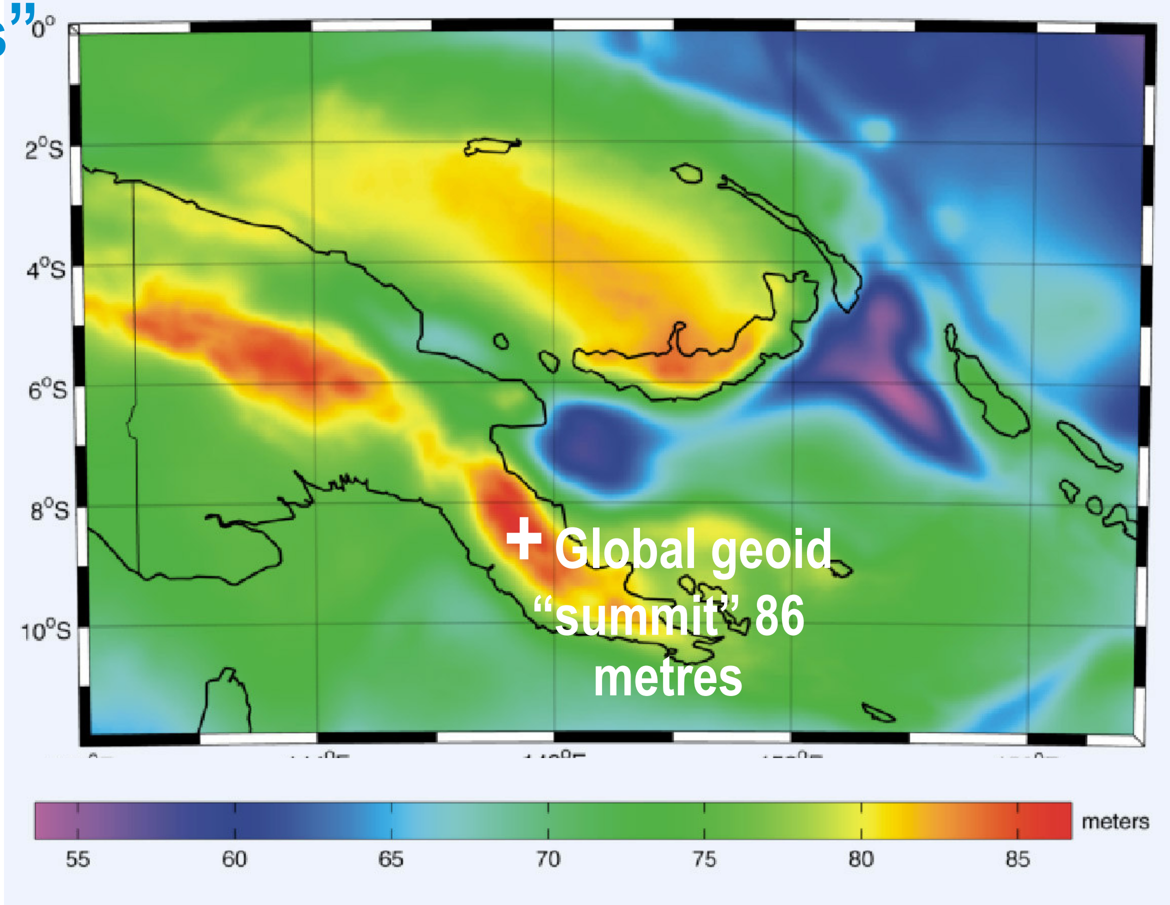
Precision 0.2 m at 1 σ.

Mean Dynamic Topography (MDT) of the sea surface is significant (between 0.8 and 1.4 m above EGM2008 geoid in PNG)

National airborne gravity survey and NMSA TG analysis required to improve PNG geoid

Dual gravimetric and MSL aligned geoid is required for practical surveying applications

with HAT/LAT offset models for hydrographic surveys.



PNG2020 Datum components

Physical Monuments PSMs, CORS antenna mounts

Legal & registry PNG Government Gazette, Geodetic Registry (EPSG and ISO TC

Information geodetic database (coordinates, elevations, metadata), PSM sketc
kml files etc. – Free access to data (UN-GGIM FAIR principle)

Access CORS RINEX data portal, RTCM3/NTRIP, online access to geodetic database
(Potential AusPOS update to support PNG2020/PNG94 and MSL PNG08)

Models/tools velocity grids, transformation tools & geoid models - GUI
projected CRS (UTM based PNGMG2020 grid and local TM town/project grids)

Knowledge stakeholder involvement and training, user-guidelines, workflows
(DLPP, MRA, DPE, NAC, Urban Authorities, utilities)

adopt ICSM (Australia & NZ) and LINZ (NZ) formats and guidelines

PNG2020 – Geodetic Registry

EPSG geodetic registry (and ISO TC 211 registry)
Industry and international standard for GIS/Mapping and positioning software

EPSG codes for the PNG2020 datum, projected map grids (PNGMG2020 Zone 54 to Zone 58 and LTM based town grids)

Kinematic tectonic model (velocity grid) – to transform between ITRF2020 (dynamic coordinates) and PNG2020 (NTv2 & GGXF format)

PNG94(2025) to PNG2020 transformation grid (NTv2 & GGXF)
AGD66 to PNG2020 transformation grid (NTv2 & GGXF)

Coseismic displacement grids (as required – NTv2 & GGXF)

PNG2020 development progress and immediate plans

OSG Geodetic Section will progressively complete remaining observations around key geodetic stations in PNG over the next 4 months

Currently 70% of zero, first and second order geodetic stations have been reobserved to date to define PNG2020 fiducial network for government gazettal

Gazettal of PNG2020 by 50th Anniversary of Independence (16 September 2025)

PAPUA NEW GUINEA 1975 - 2025

CELEBRATE OUR HISTORY INSPIRE OUR FUTURE

Tenkyu tru!

Yu gat sampela askim o toktok?