A Semi-Dynamic Geodetic Datum for Papua New Guinea

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Introduction

PNG is one the most tectonically active countries in the world.

Baseline changes often exceed 120 mm/yr within the national geodetic network (PNG94). Coseismic displacements resulting from major earthquakes can be several metres in magnitude. Presently, tectonic deformation is unaccounted for where GNSS surveys span plate boundaries or deforming zones.

Since 1994 PNG94 has deformed by as much as 1.5 metres. PNG is a resource rich country where 97% of the land surface is still customary land. Such errors in the datum will impact significantly on the integrity of the cadastre and resource projects.

A semi-dynamic datum

Using a velocity model or deformation model (e.g. a strategy similar to New Zealand) can be used to model internal deformation of the network

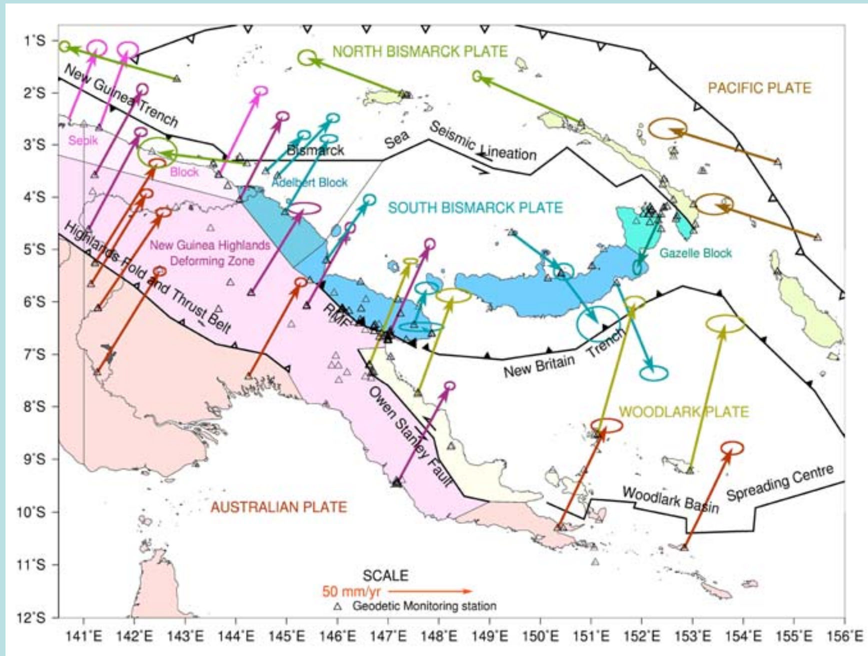

Figure 2. Plot of the velocity field and tectonic setting of PNG. The velocity fields in the Gazelle Block and the Ramu-Markham Fault Zone have been omitted for the sake of clarity. Vectors show the ITRF site velocities for selected geodetic monitoring sites.

Figure 2. Geodetic Monitoring Sites in PNG, clockwise from top; Mt. Amungwiwa Ekuti Dividing Range, Pillar on the Duke of York Islands, Angoram (Sepik River in background)

Implementing a semi-dynamic datum

Models of site velocities, coseismic and postseismic deformations can be used to transform instantaneous ITRF coordinates derived from precise point positioning systems such as AUSPOS or OmniSTAR-HP to PNG94. These deformation models can also be used to quasi-adjust baselines measured across plate boundaries to a reference epoch (i.e. 1994.0) prior to network adjustment.

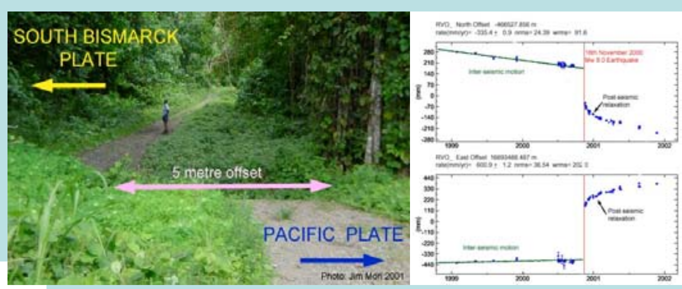

Figure 5. Co-seismic displacement and post-seismic relaxation resulting from the Mw8.0 earthquake on the Weitin Fault, Southern New Ireland, 16th November 2000. The timeseries is for RVO_ (Rabaul Volcanological Observatory) located some 40 km from the epicentre of the Mw8.0 event.

Geodetic Analysis

A significant amount of GPS observations from a 100+ station network in PNG have been collected by the Research School of Earth Sciences at the Australian National University, the PNG National Mapping Bureau, the Survey Department of the PNG University of Technology and other instutions.
Much of these data have been collected for plate tectonic studies, however the same dataset can also be used to densify the PNG geodetic datum and model the site velocity field.The PNG GPS data have been analysed using the GAMIT/GLOBK software to compute ITRF2000 site velocities (Figure 3).

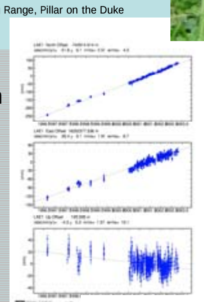

Figure 3. Geodetic time series for LAE1 IGS Site located at PNG Unitech, Lae

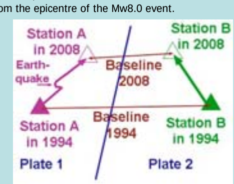

Figure 6. Cartoon showing effect of tectonic deformation on baselines and coordinates

Easting(PNGMG) = Easting(*t*) + Velocity(E) * (1994 - *t*) + Σqe
Northing(PNGMG) = Northing(*t*) + Velocity(N) * (1994 - *t*) + Σqn

Where;
t is Epoch of measurement in decimal years
Easting(*t*) is the ITRF2000 UTM Easting at the epoch of measurement (at time *t*)
Northing(*t*) is the ITRF2000 UTM Northing at the epoch of measurement (at time *t*)
Σ**qe** and Σ**qn** are the total coseismic and postseismic displacements (E & N components) between epoch *t* and 1994
Velocity(E) and **Velocity(N)** are the site velocity components in East & North, in m per year

Figure 4. Application of dynamic parameters to estimate static PNG94

Further development

Additional GPS observations are required in locations of urban or resource development. A site velocity and coordinate adjustment software package is required to enable surveyors to to tie their surveys into the PNG94 network so that consistency of the datum can be maintained in a tectonically active environment. Training and support of surveyors in PNG is also required so that these improvements can be realised.

References

Stanaway, R,, MPhil Thesis, Australian National University, 2003

Tregoning, P., Lambeck, K., Stolz, A., Morgan, P., McClusky, S., van der Beek, P., McQueen, H., Jackson, R., Little, R., Laing, A., and Murphy, B., Estimation of current plate motions in Papua New Guinea from Global Positioning System observations, *J. Geophys. Res.*, 103, 12,181-12,203, 1998.

Wallace, L., Stevens, C., Silver, E., McCaffrey, R., Loratung, W., Hasiata, S., Stanaway, R., Curley, R., Rosa, R., and Taugaloidi, J., GPS and Seismological Constraints on Active Tectonics and Arc-Continent Collision in Papua New Guinea: implications for mechanics of microplate rotations in a plate boundary zone, *J. Geophys. Res.*, *in press*, 2004

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Web-site
http://rses.anu.edu.au/geodynamics/gps/png

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