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Report of the Permanent Committee on Geographical Information
System Infrastructure for Asia and the Pacific**

REPORT OF THE WORKING GROUP 1: REGIONAL GEODESY

**Submitted by the Permanent Committee on Geographical Information
System Infrastructure for Asia and the Pacific (PCGIAP)
Working Group 1: Regional Geodesy***

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Permanent Committee on GIS Infrastructure for Asia and the Pacific

Working Group 1

Regional Geodesy

Status Report

for

The 18th UNRCC-AP

Bangkok Thailand

26th-29th October 2009

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1. Introduction

WG1 roles and activities are redefined and modified following the resolutions endorsed at the 17th United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP)/12th PCGIAP meeting in Bangkok, September 2006.

The role of the Regional Geodesy Working Group of the Permanent Committee for GIS Infrastructure in the Asia and the Pacific region (PCGIAP) had been to coordinate regional cooperation in Geodesy amongst national agencies and to build a regional geodetic infrastructure.

In acknowledging the past achievements of the PCGIAP Regional Geodesy Working Group, at the 17th UNRCC-AP, discussions highlighted the need for a new phase in Regional Geodesy WG1 activities, especially a better understanding of the tectonic forces and hazard zones in the region through an improved geophysical monitoring infrastructure including the region-wide geodetic observation system established and evolving through the activities of this Working Group for the past ten years.

The resolution was endorsed as:

- 1) Enhance the regional geodetic infrastructure to contribute to monitoring, warning and post-event reconstructions through cooperative observations of crustal deformation and plate motion, and information exchange, including tide gauge networks and placement of new GPS key sites.
- 2) Encourage the transfer of GPS technology to nations in need through annual campaign observations, and the development and sharing of analysis techniques in the following geodesy workshop activities.
- 3) Promote the application of new geodetic adjustment techniques and datum change transformation parameters for regional spatial data integration and for geo-referencing cadastral and statistical information.
- 4) Interact with IAG (International Association of Geodesy) commissions 1 and 2 on the status of the regional geodetic reference frames and geoid determination using absolute gravity, satellite, airborne and terrestrial gravity.
- 5) Review the status of geodetic networks in individual countries and upgrade PCGIAP web site information.
- 6) Support the expansion of continuous GPS installations in areas of earthquake and tsunami hazards and strongly encourages nations making such data readily available on a weekly basis for shared scientific study and warning systems in relation to tectonic events.

To take the details of the resolution forward a project draft work plan was developed with identified responsibilities and milestones for the period 2006–2009 as shown in Appendix 1. This work plan was endorsed during the 13th PCGIAP meeting in Seoul, Korea in June 2007.

A summarised report against the resolutions of the 17th Conference was provided to the UNRCC-AP. Section 2 is the full report from the Regional Geodesy Working Group on activities between the 17th and 18th UNRCC-AP conferences.

2. Reports on the activities

Activities and progress on the individual item listed above of the Working Group program have varied during the period ;

1) In order to densify the ITRF in the Asia-Pacific Region an annual geodetic observation campaign (Asia Pacific Regional Geodetic Project: APRGP) has been held to provide an opportunity to connect to national geodetic networks and to determine site velocities. While these campaigns have focussed on GPS observations, coordinated through the PCGIAP, they also incorporated other geodetic techniques, including: Satellite Laser Ranging (SLR), coordinated through cooperation with

International Laser Ranging Service (ILRS) and Western Pacific Laser Tracking Network (WPLTN); and Very Long baseline Interferometry (VLBI), coordinated through the Asia-Pacific Space Geodynamics (APSG) and International VLBI Service (IVS).

Three annual GPS regional campaigns were arranged in 2006, 2007 and 2008 for the following periods:

2006 campaign period 05th Nov to 11th inclusive (GPS week 1400)

2007 campaign period 23rd Sep to 30th inclusive (GPS week 1446)

2008 campaign period 05th Oct to 12th inclusive (GPS week 1500).

6 associated geodetic VLBI campaigns arranged by IVS have been undertaken, APSG-18 (12th Sep, 2006) through APSG-23 (08th Oct, 2008).

APRGP campaigns were coordinated by Geoscience Australia (GA) and the campaign data (1997-2008) were collated by Geoscience Australia, and subsequently made available, on request, to participating countries for analysis. GA has carried out preliminary processing of the APRGP data sets from the years 2003 to 2006 inclusive, and re-processed the 1997-2002 APRGP data sets. Work on this task is planned to recommence later this year to work towards re-processing for a final combined solution for the years 1997 to 2008 inclusive using Bernese version 5.0 in terms of ITRF2008.

The catalogue of the tide gauges in the region was completed thanks to colleagues in New Zealand.

Some fatal earthquakes occurred during 2006-2009 in the region are listed in Appendix 2 with space-geodetic results and implications.

2) As for the GPS technology transfer, Australia was discussing with SOPAC to devise strategy for seeking aid money for GPS purchases, and China has agreement with Pakistan.

3) Each country is encouraged to refer to the guideline (compiled by GA) in our web page for the new geodetic adjustment techniques and datum change transformation parameters.

4) GA will participate as a regional coordinator for the IAG - Working Group Regional Dense Velocity solution, Asia-Pacific. The PCGIAP solution will be contributing to the ITRF2008 densification activity. The data from these GPS sites are available from Geoscience Australia for local and global scientific research and local applications.

As for national geoid determination, Korea is engaged in a precise Korean geoid model development project in cooperation with NGS, USA. In 2008, National Geographic Information Institute (NGII) purchased a new FG5 absolute gravimeter and set it up above gravity origin in NGII. In 2009-2011, NGII will install 20 absolute gravity points, and plans to carry out gravity survey on 1,400 control points including BMs, triangulation points, etc. in the eastern mountainous districts. First aerial gravity survey which covers the whole territory was performed, Dec. 2008 – Jan. 2009.

5) Review of the status of each country's geodetic network is an ongoing work and the information should be up-to-date. We need to re-examine the data and ask each country for their newest revision of their geodetic network and datum.

Two topics should be mentioned;

China's national geodetic reference became geocentric in 2008, and

NGII, Korea operates 44 (as of 2008) GPS permanent observation stations equipped with latest receivers & antennas, and provides free real-time Network-based RTK service.

6) Expansion of continuous GPS (CGPS) installations has shown a steady progress in our region. China, Japan, Korea and Australia are densifying their networks, and Indonesia and Philippines are planning to build and/or densify their CGPS networks.

While these are not in the frame of PCGIAP but closely related to the activities of WG1, it could be mutually beneficial if region-wide cooperation is possible.

Some of the projects and a proposal for the future cooperation are described in section 3 and 4 below.

3. Other activities

Concerning the regional network of geodetic observation, there are several ongoing projects;

- Australia has commenced the AuScope initiative, which includes the construction and operation of 3 new VLBI observatory and 100 new IGS standard GNSS stations,
- Indonesia has a plan to expand their CGPS network (IndCORS), which will consist of 100 stations and aim at multipurpose application for geodesy, geophysics, land survey, navigation and others,
- Geographical Survey Institute (GSI), Japan has launched a new project: Asia-pacific crustal monitoring project and has upgraded its south pacific (Plume) CGPS sites,
- Korea has engaged in a construction of a new geodetic VLBI observatory, 2008-2011,
- New Zealand has constructed a new geodetic VLBI station,
- South Pacific Sea Level Monitoring Project (SPSLMP) installation phase complete, 12 CGPS stations have been collocated with tide gauges. GPS data is publicly available from Geoscience Australia.

4. Future activities

The activities of the Regional geodesy working group should be invigorated to respond to the expected roles and activities. To this end we should encourage data and information sharing among the participating countries and technology transfer to countries/regions in need.

Data to be shared will be;

CGPS data and its near real time results,

Other space geodetic data, especially interferometric SAR images for assessment of damages,

Gravity data for regional geoid determination

And, as we acknowledge there exists a substantial number of GPS/GNSS networks in this region, while existing infrastructure is inhomogeneous and their interrelationships and data sharing are poor compared to other regions like Europe and Americas, we'd like to propose a new project called the Asia-Pacific Reference Frame (APREF) project, which will address those issues in cooperation with relevant IAG components and the International Federation of Surveyors (FIG).

Following is the summary of the proposal;

The Asia-Pacific Reference Frame (APREF) Project

Objectives

APREF will address issues associated with the definition, realisation and maintenance of the Asia and the Pacific Reference Frame, focusing on both the horizontal and the vertical components, in close cooperation with the PCGIAP, the pertinent IAG components (Services, Commissions, and Inter-commission projects) and the International Federation of Surveyors (FIG). It is anticipated that the PCGIAP, through the region's national mapping agencies, will take a leading role.

The broad objective of the Asia-Pacific Reference Frame (APREF) Project will be to create and maintain an accurate and densely realised geodetic framework, based on continuous observation and analysis of GNSS data that will support many geospatial applications across the region. APREF will be a voluntary, collegial, non-commercial endeavour, and will require wide participation from government agencies, research institutes and the private sector, although there will be no central funding source and each participating organisation will contribute their own resources.

In the short-term, the APREF will:

- Encourage the sharing of GNSS data from Continuously Operated Reference Stations (CORS) in the region; and
- Develop an authoritative source of coordinates and their respective velocities for geodetic stations in the Asia-Pacific region.

In the longer term, the APREF will:

- Develop the APREF Permanent Network, in close cooperation with IGS for the maintenance of the Asia-Pacific Reference Frame, as a contribution to the ITRF and as infrastructure to support other relevant projects;
- Establish a dense velocity field model in Asia and the Pacific for scientific applications and the long-term maintenance of the Asia-Pacific reference frame; and
- Organise regular symposia addressing activities carried out at national and regional level related with the global work and objectives of APREF.

Structure

The proposed organisational structure of the APREF is shown in Figure 1. In summary, it consists of: a steering committee; a central bureau; network operators, data centres and analysis centres.

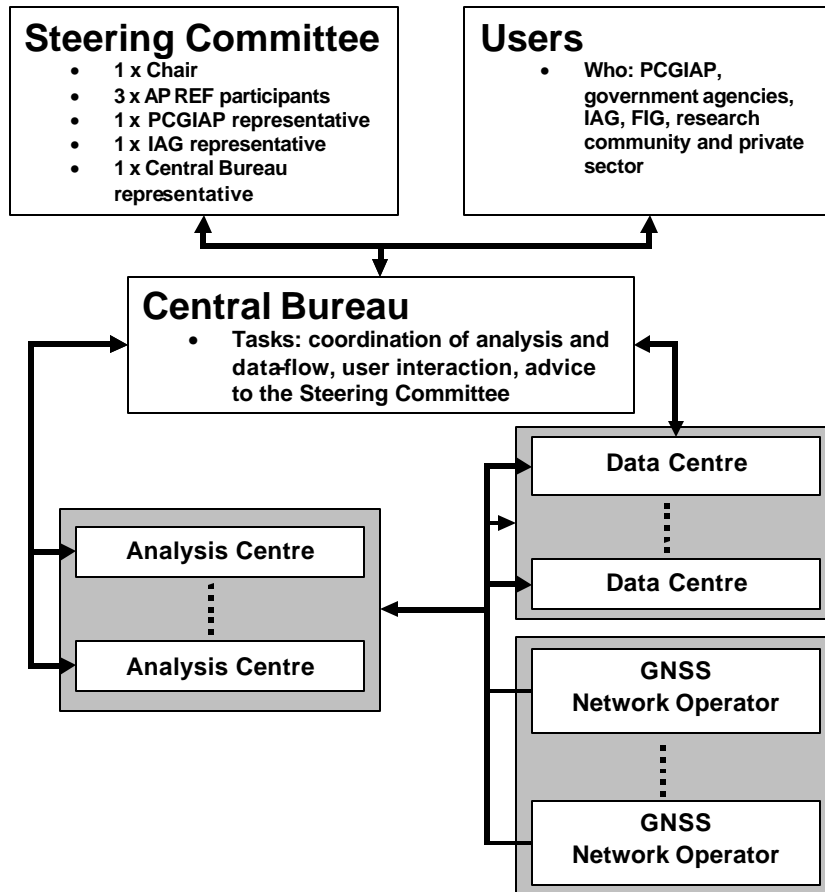


Figure 1. Proposed organisational structure of the APREF.

Membership

The members of APREF will be all those agencies and organisations contributing to its objectives.

Appendix 1. Workplan for Regional Geodesy Working Group for period 2006-2009

Project	Responsibility	Milestone
<p>Enhancement of the regional geodetic infrastructure to contribute to monitoring, warning and post-event reconstructions through cooperative observations of crustal deformation and plate motion, and information exchange, including tide gauge networks and placement of new GPS key sites</p> <ul style="list-style-type: none"> • Arrange regional observation campaign in 2007, and similarly for 2008 and 2009. • Observe data and forward to Australia in RINEX format with site information. • Analyse and prepare velocity/deformation solutions for the study of geodynamics in the region. • Prepare combined regional solution for ITRF densification. <p>Interact with IAG commissions 1 and 2 on the status of the regional geodetic reference frames and geoid determination using absolute gravity, satellite, airborne and terrestrial gravity.</p> <ul style="list-style-type: none"> • Monitor the status of the regional geoid and development of new improved global gravity models developed from satellite gravity missions. • Connect gravity datums of individual countries by use of absolute gravity observations. <p>Promote the application of new geodetic adjustment techniques and datum change transformation parameters for regional spatial data integration and for geo-referencing cadastral and statistical information.</p> <p>Encourage the transfer of GPS technology to nations in need through annual campaign observations, and the development and sharing of analysis techniques in the following geodesy workshop activities.</p> <ul style="list-style-type: none"> • Identify funding sources (with Working Group 4) for access to GPS equipment resources to support participation in annual 	<p>Australia/Japan</p> <p>All countries to participate to level of resources available</p> <p>Japan, Australia</p> <p>Australia</p> <p>Australia, China, Malaysia, Japan</p> <p>Malaysia, Australia</p> <p>Japan, China</p> <p>(New Zealand)</p> <p>China/Working group</p> <p>All countries</p>	<p>APRGP 2006-2008 (completed)</p>

<p>regional geodesy workshops for presentation of geodetic campaign results and technology.</p> <ul style="list-style-type: none"> • Promote loan of GPS equipment to Pacific Island nations for regional campaigns and promote the knowledge of GPS techniques making use of available continuous GPS base stations in the region. 		
<p>Support the expansion of continuous GPS installations in areas of earthquake and tsunami hazards and strongly encourages nations making such data readily available on a weekly basis for shared scientific study and warning systems in relation to tectonic events</p> <ul style="list-style-type: none"> • endeavor to make GPS data available and shared by participating countries for hazard mitigation study • Gather information on the optimal placement of new GPS sites for crustal deformation observation. 	<p>Working Group</p> <p>All countries</p>	
<p>Review the status of geodetic networks in individual countries and upgrade PCGIAP web site information.</p> <ul style="list-style-type: none"> • Gather updated information from all countries and update the WG web site with datum and transformation details. • Develop a list server and seek contacts from each country 	<p>Japan</p> <p>Japan</p>	<p>On going annually</p>

Appendix 2. Recent earthquake activities in the region

The Asia-Pacific region is known as one of the most active zones of crustal activities in the world and we experienced several fatal earthquakes in 2006-2009 which killed people or caused significant damages to the area;

- Central Honshu, Japan, 16th Jul, 2007, M6.8
- Southern Sumatra, Indonesia, 12th Sep, 2007, M8.4
- Simueulue, Indonesia, 20th Feb, 2008, M7.4
- Eastern Sichuan, China, 12th May, 2008, M7.9
- Eastern Honshu, Japan, 13th Jun, 2008, M6.9

Here are the result of InSAR observations of 2008 China earthquake and its fault modeling (Fig.1&2), and earthquakes along the Sunda trench, Indonesia region (Fig.3) analyzed by GSI, Japan.

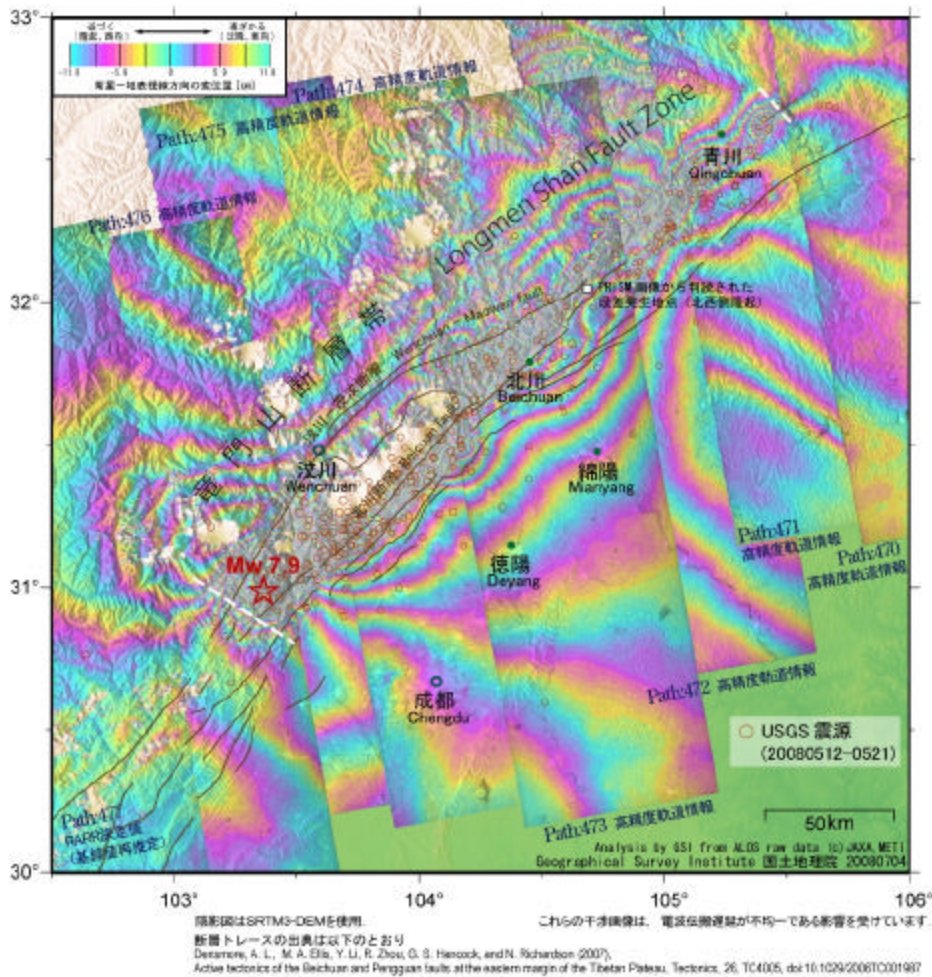


Figure 1. Crustal deformation and source fault of the Sichuan (Wenchuan) Earthquake, China, 12th May, 2008, M7.9. The image disclosed the length and position of the source fault, the length was estimated as 285±5km.

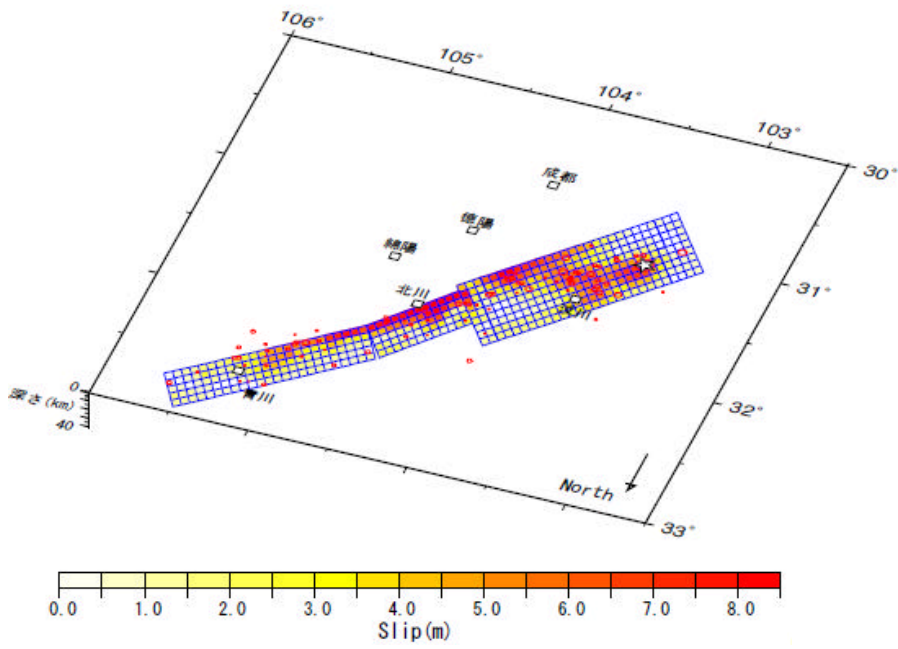


Figure 2. Fault model. The fault was reverse type with right lateral component. Max. slip was about 11m near Beichuan (??).

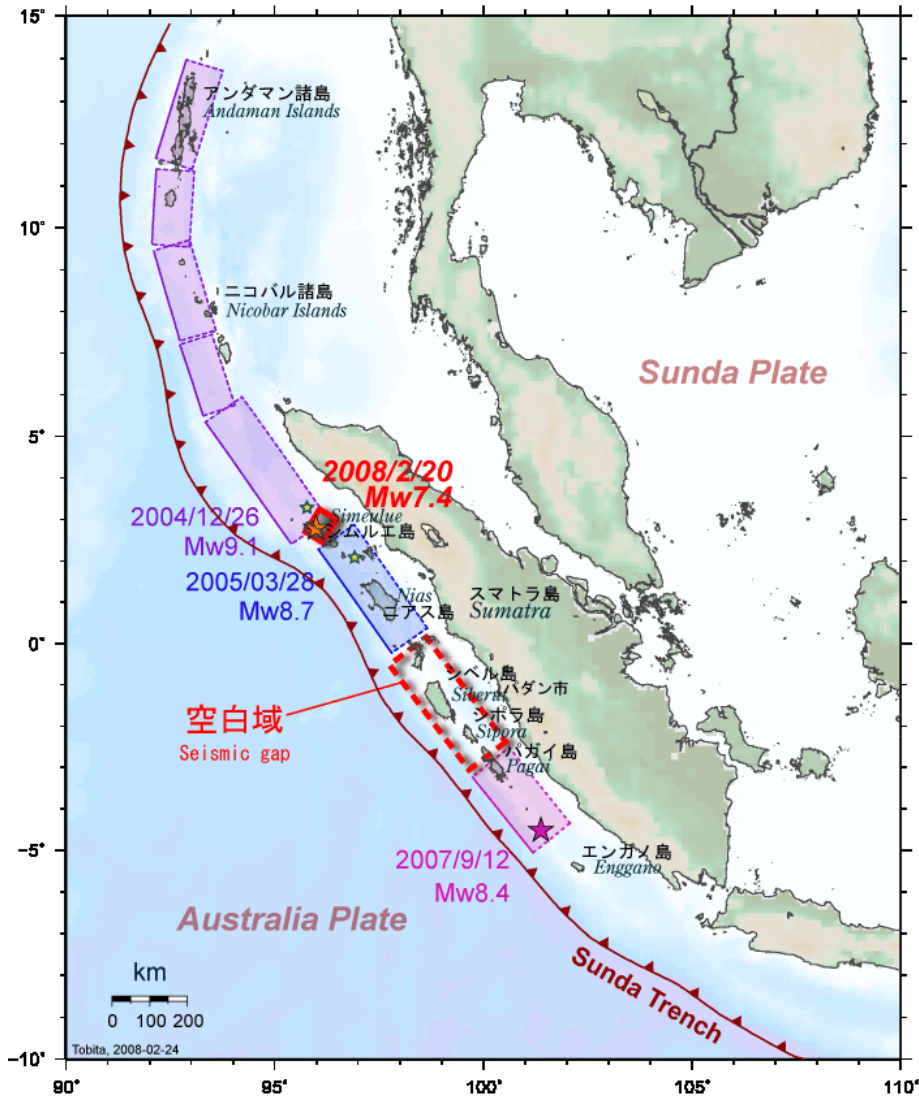


Figure 3. Earthquakes along Sunda Trench. Mega and large earthquakes occurred in 2004 - 2008 covering most of the area (~2,300 km) along the Sunda trench. There still exists a seismic gap about 370 km in length off Padang. An earthquake with magnitude over 8.5 occurred in this area in 1797.