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WORKING GROUP 1 REPORT - REGIONAL GEODETIC NETWORK STATUS REPORT

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Permanent Committee on GIS Infrastructure for Asia and the Pacific

Working Group 1

Regional Geodetic Network

STATUS REPORT

FOR 6th PCGIAP MEETING AT 16th UNRCCAP
KUALA LUMPUR, MALAYSIA
11-14 APRIL 2000

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Working Group 1 - Regional Geodetic Network Report

1. Introduction

Regional cooperation in Geodesy at the national level is coordinated through the Regional Geodetic Network Working Group of the Permanent Committee for GIS Infrastructure in the Asia and the Pacific region (PCGIAP). The establishment of the Working Group was approved at the initial meeting of the PCGIAP in Kuala Lumpur in 1995.

The primary role of the PCGIAP working group has been to facilitate a single regional datum and provide a linkage of individual geodetic datums to this regional datum through densification of the International Reference Frame (ITRF). This is fundamental to the development of an Asia Pacific Spatial Data Infrastructure, which requires that:

- A reference regional datum be established, and
- Transformation values are to be determined between the regional datum and the local geodetic datums of the individual countries.

At the inaugural business meeting of the Working Group in 1996 in Sydney, Australia, (for details see http://www.permcom.apgis.gov.au/wg3/syd_anx8c.htm) a number of project responsibilities were identified and a program of regional geodetic activities endorsed. The initial goal of the Geodesy Working Group was to establish a precise regional geodetic reference framework from Central Asia to the Pacific. Another area of activity identified was the investigation of techniques, which could be used to transform national spatial data into a single spatial data set in the region. The current terms of reference for the Working Group are given in Attachment 1.

Detailed reports of subsequent activities of the Regional Geodetic Network Working Group can be found at the following web address:

- Activities 1996 to 1998, as reported at the 4th PCGIAP Meeting in Tehran, Iran - http://www.permcom.apgis.gov.au/tehran/teh/rop.htm
- Activities 1998 to 1999, as reported at the 5th PCGIAP Meeting in Beijing, China - http://www.permcom.apgis.gov.au/beijing/rop/proceedings.htm
- Proceedings of the First PCGIAP Workshop on a Regional Geodetic Network, Canberra July 1998 - http://www.permcom.apgis.gov.au/new-wgs/new-wg1.htm
- Proceedings of the Second PCGIAP Workshop on a Regional Geodetic Network, Ho Chi Minh City, Vietnam July 1999 - http://www.permcom.apgis.gov.au/new-wgs/new-wg1.htm

Since the individual datums within the Asia and Pacific Region differ from country to country, some countries need assistance to connect their local datum to a regional datum and establish datum transformation parameters for dependant spatial data. This assistance ranges from GPS equipment, survey expertise, datum definition to the computation of datum transformation parameters.

2. Activities

The Working Group has established a meta data web site for regional information on geodetic datums in use by UNRCC-AP countries. This information is posted on the PCGIAP Web site, www.percom.apgis.gov.au. The major activity of the Working Group has been to undertake a series of cooperative projects to initially provide a uniform reference geodetic framework across the region.

2.1 The Asia Pacific Regional Geodetic Project (APRGP' 97).

As a step towards the establishment of a precise Regional Geodetic Network, an Asia Pacific Regional Geodetic Project (APRGP97) was undertaken In October 1997. This collected data for an overarching geodetic framework of permanent stations as the basis for the integration of national geodetic datums. In the observation campaign a number of techniques GPS, DORIS, SLR, and VLBI were employed.
The GPS observation data acquired by participating countries during this campaign was assembled in Australia, and distributed on CD-ROM for immediate use by Asia Pacific member countries. The non-IGS GPS sites occupied are shown in Figure 1 below.

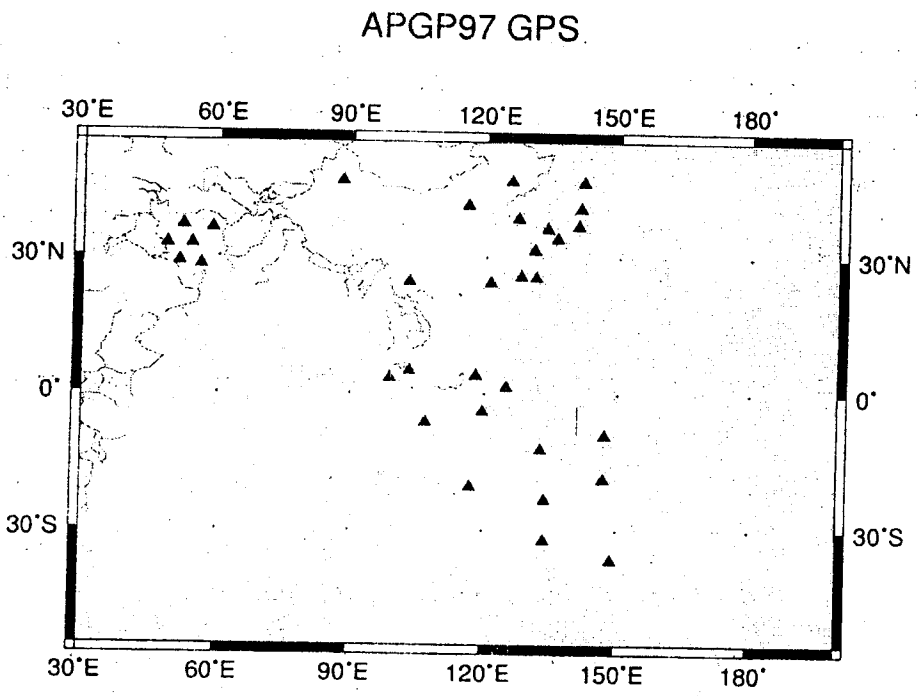

Figure 1 Non-IGS GPS sites occupied during APRGP97campaign

The 1st PCGIAP Regional Geodetic Workshop was hosted by AUSLIG in Canberra 2-4th July 1998 for discussion of results of the field campaign. Representatives from ten member countries of the PCGIAP participated in the workshop. Proceedings of the Workshop were published by AUSLIG and are available through the PCGIAP web sites. Four countries independently presented GPS results from processing the APRGP97 data set, the countries and their processing softwares were :

- Indonesia (GAMIT)
- Japan (GAMIT)

- China (GAMIT)
- Australia (MicroCosm)

The results presented showed good agreement and demonstrated a significant achievement in technology for those involved. The workshop examined the options for definition of a regional geodetic datum in a global setting and recommended use of an interim combined GPS solution in ITRF, pending further work on an integrated solution of all techniques utilising ground ties at collocated sites. After the meeting the observational data set was made available to other regional scientific researchers.

The APRGP97 campaign produced significant results, but also achieved a degree of technology transfer for participating members and the development of a regional capability for high level processing of GPS data. As well as providing an interim horizontal framework the workshop considered the ongoing need for a strategy to link individual vertical datums, such as those used in :

- Land locked countries
- isolated island
- chart datums,
- as well as scientific sea level determinations.

The workshop recommended the concept of a unified vertical datum using data stored in earth-centred Cartesian coordinates or related to an ellipsoid such as the GRS80 ellipsoid in the ITRF system.

2.2 The Asia Pacific Regional Geodetic Project (APRGP' 98).

At the July 1998 Canberra workshop, plans were initiated for an expanded observational campaign to be undertaken in November 1998 (APRGP98). A cooperative strategy was developed with the GEODYSSEA project for a common observational campaign and sharing of data from key sites. Seventeen nations were able to participate and GPS observations from 92 sites in addition to the existing IGS sites were achieved. Sites occupied during the campaign included GPS epoch occupation of a number of sites on national Geodetic networks.

A VLBI campaign was again arranged by China (Shanghai Observatory) through the Asia Pacific Space Geodynamics Project (APSG) cooperation and SLR observations arranged through the Western Pacific Laser Tracking Network (WPLTN), with DORIS participation arranged through CNES. The GPS observation data was collated by AUSLIG and distributed on CD ROMs to all countries for processing, analysis and preparation of results. The non-IGS GPS sites observed during the campaign are shown in Figure 2 below.

A 2nd PCGIAP Regional Geodetic Workshop was hosted by Vietnam in Ho Chi Minh City 12-13th July 1999 for the presentation of results from the APRGP98 campaign. Fifty people from fourteen member countries of the PCGIAP attended this excellent workshop.

Six independent GPS solutions were presented using the APRGP98 data set and a strategy for a combined solution developed. SLR.VLBI and DORIS results were also presented. Proceedings of the Workshop were published by Vietnam and are available through the PCGIAP web site The1998 observational data set was then made available for use by other regional scientific researchers.

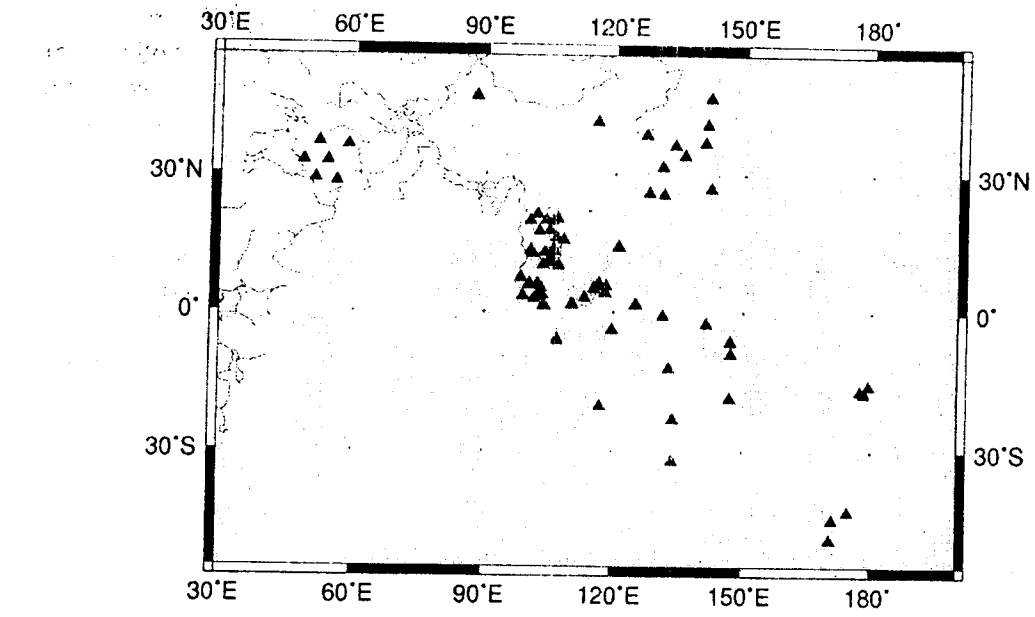

Figure 2 : Non-IGS GPS sites occupied during APRGP98 campaign

The workshop discussions saw the completion of almost all of the project workplan items previously developed at the 5th PCGIAP meeting in Beijing (Attachment 2),. Outstanding items, which will be reviewed at the next working group meeting, are :

- *"Development of a Strategic plan for regional use of GLONASS."*
- *"The development of geodetic network across the Pacific nations* "and
- *"The individual readjustment of local geodetic control networks on to ITRF"*

Outcomes arising from discussions during the Vietnam workshop for action leading to the 6th PCGIAP and 15th UNRCC-AP are summarised as :

- *Completion of APRGP97 and APRGP98 Campaign Computations* ***Status: Completed***

SINEX files to be corrected and sent to AUSLIG for combining results in ITRF

- *Publication of results* ***Status: Completed***

Following combination of results an official set of coordinates for APRGP97 and APRGP98 will be prepared for distribution to member countries.

- *1999 regional campaign* ***Status: Completed***

A sub committee was established to plan the APRGP99 campaign:

- *Permanent Network of Base Stations* ***Status: Completed***

Establish a list of all continuous GPS receivers in the region together with contact agencies and data availability

- *GPS Observations Specifications* **Status: Completed**

A sub committee was established comprising Australia, China (State Bureau of Surveying and Mapping), Japan and Malaysia to develop standards for the 1999 campaign including:

- *Classification of networks* **Status: Not Completed**

Indonesia to provide a position paper on Accuracy Classification and Standards of coordinates. Interpretation of "Zero Order", "First Order" and "Second Order" in the context of the APRGP results.

- *Development of Transformation parameters.* **Status:Ongoing**

Member countries to consider the precision datum transformation proposals of Iran and Australia for implementation after achieving an adequate densification of ITRF points within individual geodetic networks.

- *Absolute Gravity Network* **Status : Draft Completed**

A subcommittee was established to develop a proposal for a regional Absolute Gravity Observation Campaign to connect relative gravity networks to gravity reference frames

- *Regional Geoid* **Status: Not Completed**

A sub committee was established to study the terrestrial (relative) gravity data weaknesses and developing a work plan for further observational requirements leading to an improved regional geoid.

- *Regional Geoid School* **Status: Completed**

The Workshop supported the arrangements for an International Geoid School to be held in Malaysia in 2000, and strongly encourages member countries to attend. It also encourages the planning and hosting of Tropical Schools of Geodesy with specific reference to a school on GPS.

- *Electronic communications* **Status Completed**

The need for enhanced communication between WG1 members was identified, with a Meta data web site and an email List Server.

The items, which are still in progress, will be reviewed during the Working Group meeting in Kaula Lumpur in April 2000

2.3. The fifth PCGIAP Meeting April 1999, Beijing

At the 5th Meeting of PCGIAP in Beijing 19-23 April 1999 the working group met and reviewed progress with activities. Drawing on the results from the APRGP campaigns, it reached a number of conclusions to set the general directions of the Working Group activities until the 6th Committee meeting is held in the year 2000. These were:

- That the reference frame for geodetic applications in the Asia and the Pacific be the International Terrestrial Reference Frame (ITRF) and that the GRS80 ellipsoid be used for horizontal computation within that reference frame.
- That the horizontal coordinates determined from the APRGP campaigns in ITRF are to be used as the interim datum points pending the determination/verification of the horizontal velocities at those stations.
- That a regional geodetic campaign be undertaken in October 1999 to extend the GPS connections to the geodetic networks in individual countries, unable to participate in APRGP98 such as the Pacific nations, and to enhance the connection of local vertical datums to sea level.

- That the concept of a universal ellipsoidal vertical datum be further investigated as a means of connecting individual vertical datums across the region.
- That the PCGIAP endorses a proposal by Mongolia to hold a regional Technical Geodesy Workshop in Ulaanbaatar in the year 2000 to conclude the APRGP99 campaign.
- Resolution on Regional Datum Geodesy Technical workshop: That further research be undertaken on the development of options for transformation parameters for consideration by the working group following presentation of results from the Technical Workshop in Mongolia
- That the Working Group on Regional Geodetic Network encourages the greater participation of the Pacific Island nations in the Working Group and resolves to look for ways of providing support and technology transfer to the countries in the Pacific sub region.

The PCGIAP subsequently endorsed the following resolution and recommendation from the Working Group

Resolution :
Recognising the need for a uniform geodetic control system across the Asia and the Pacific region, the PCGIAP resolves that :

- *The ITRF system and the GRS80 ellipsoid be adopted as the fundamental datum parameters for regional applications.*

Recommendation :
Recognising the benefits arising from Geodesy Technical Workshops of the APRGP campaigns and the invitation by Mongolia to host such a meeting in UllanBaatar in mid 2000 . The PCGIAP recommends that :

- *The Geodesy meeting to be held in Mongolia becomes an endorsed PCGIAP Technical Workshop.*
- *PCGIAP encourages all members to send Geodesy technical representatives to the meeting in Mongolia.*

Work plans for the Working Group for the next 12 months until 6th PCGIAP were approved as shown in attachment 2

The Work Plan for WG 1 was subsequently reaffirmed by the PCGIAP Executive Board – at the Executive Board meeting in Melbourne, Australia on 28 October 1999.
http://www.permcom.apgis.gov.au/new-wgs/new-wg1.htm

2.4 The Asia Pacific Regional Geodetic Project (APRGP' 99).
The third observational campaign was approved by PCGIAP at the previously held 5th Meeting in Beijing in April1999 as above and planning commenced at the 2Nd Workshop in Vietnam in July1999. Again geodetic techniques of GPS, VLBI, DORIS, and SLR were employed as with previous campaigns using cooperative arrangements with WPLTN, APSG and CNES to avoid duplication.

Data from 90 non-IGS sites is now with AUSLIG for distribution, altogether several sites are still to be received (e.g. 10 sites from Iran) before the data is circulated on CD-ROM. In addition there a number of sites which are now listed as permanent IGS sites in the region and this data is available from the IGS data centres.

Twenty-one nations participated in the observation campaign this time and a number of ties to level benchmarks at sea level sites were observed. A results based Regional Geodetic Workshop will be hosted by Mongolia in August to complete the APRGP99

campaign. The non-IGS sites are shown in Figure 3 below. Note some sites are now listed as IGS sites whereas they were shown in previous campaigns as non-IGS sites.

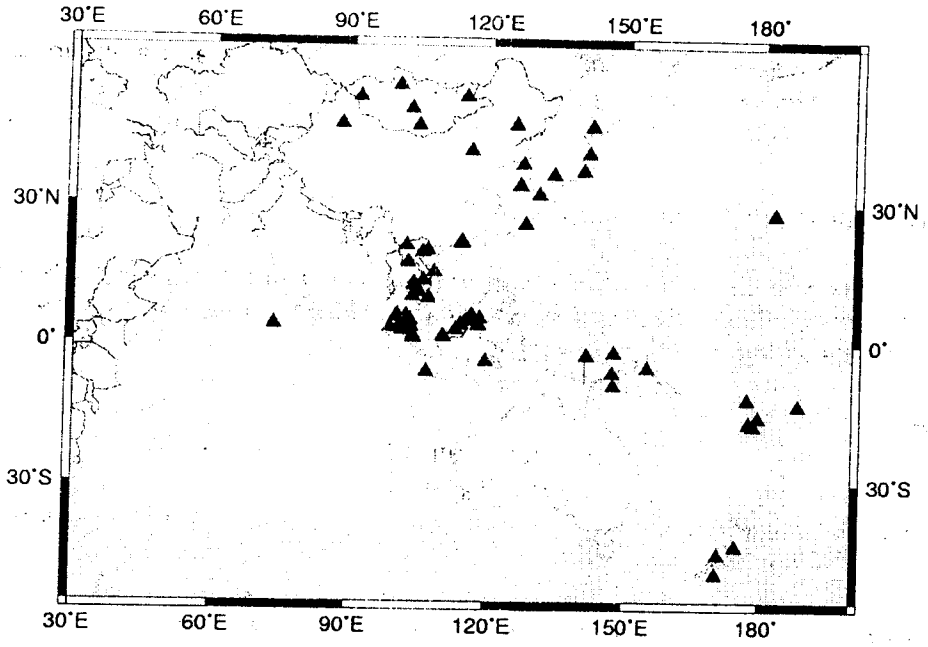

Figure 3: Non-IGS GPS sites occupied during APRGP99 campaign

It was not possible to involve many Pacific Island nations directly in the observational campaign, and another targeted campaign will be required when equipment and logistic support are available. It is hoped to mount such a campaign in October 2000. However it was possible to identify a number of continuous GPS base stations established for geophysical purposes in locations across the Pacific as shown in figure 4. Data from some of the sites was made available for the 1999 campaign for inclusion in regional solutions and it is intended to gain access to all sites for use in future campaigns.

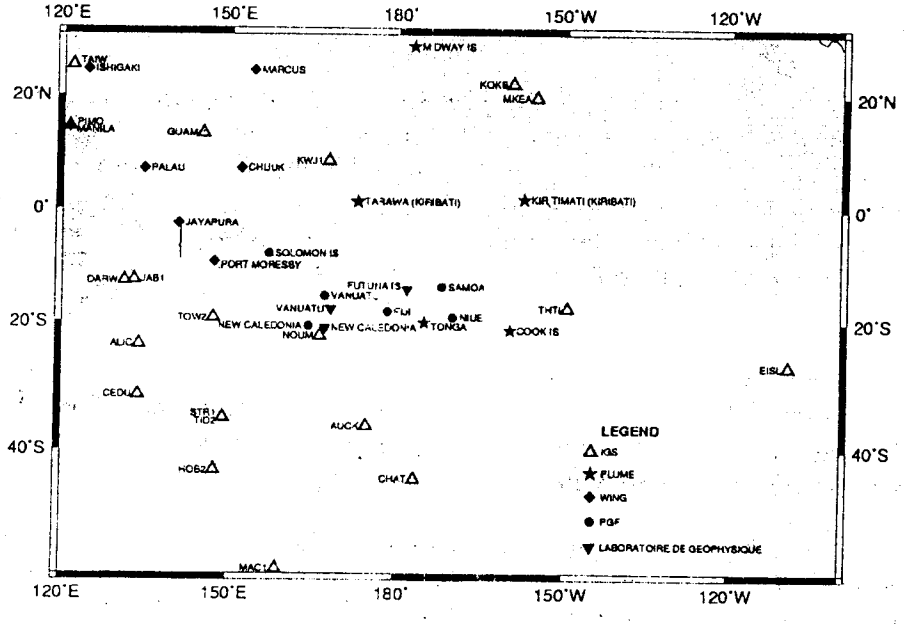

Figure 4: Continuous GPS base stations now established in the Pacific region

2.5 ITRF 2000 Densification

AUSLIG is combining the GPS results for the three APRGP campaigns in conjunction with participating countries for submission to ITRF2000. This will produce official IERS values for all sites in the global framework as the culmination of the regional campaigns.

3. Suggestions for future activities

Several activities identified in workplans in the last two years are incomplete and some others are ongoing. Progress on these activities should be reviewed at the Working Group meeting in Kuala Lumpur

Incomplete:

- Prepare position paper on Classification of geodetic networks
- Develop work plan for improved Regional Geoid
- Prepare position paper on the application of GLONASS to the region

Ongoing :

- Develop an enhanced regional network of GPS base stations
- Individual countries readjust networks to ITRF datum
- Develop application strategy for horizontal transformation parameters

Other new major project activities to be considered at the meeting could be

- Identification of a Project to connect individual height datums to a Universal height datum
- Another regional geodetic campaign in October 2000 focused on the Pacific region
- A regional Absolute Gravity strategy to connect individual countries gravity networks

4. Summary

The work of the PCGIAP Working Group on Regional Geodetic Network has been successful in establishing an overall geodetic framework. Three multi technique campaigns have been undertaken and two excellent workshops have been held. A strong working relationship has been developed amongst the regional geodesists in national agencies, and a degree of technology transfer has been achieved. This is particularly evident in GPS campaigns in the comparison of results delivered at the technical workshops.

The regional reference framework still needs consolidation in general but special consideration needs to be given to west Asian area and particularly to the Pacific sub region. The issue of connecting individual local height datums through a universal vertical datum also remains to be addressed.

Existing linkages need to be enhanced between national Geodetic application bodies represented by the PCGIAP and scientific research bodies such as those represented by the Asia Pacific Space Geodynamics Project (APSG) and the International Association of Geodesy (IAG). This will enable geodetic networks to eventually take advantage of

scientific information gathered on differential tectonic movement of the landmasses in applying geodetic datums.

To enable maximum benefit to be achieved from the application of Space geodesy techniques, such as GPS, an improved Geoid needs to be developed to enable sea level heights to be produced from observed GPS ellipsoidal heights. This will involve the need to strengthen the existing gravity network in many countries, and offshore areas with acquisition of aereogravity and satellite gravity data as well terrestrial observations. Additi onally ties between different networks need to be made using absolute gravity instruments.

Further work on the readjustment of local geodetic networks onto ITRF and the development of transformation parameters and application of DGPS is needed, but a strong cooperative mechanism to provide the homogeneous base for a regional GIS infrastructure has been established.

Terms of Reference of Working Group on Regional Geodetic Network

Objectives: To assist the Permanent Committee in the development and maintenance of a regional geodetic infrastructure as the basis for a regional GIS.

Structure: Membership will be open to representatives from each member country of the Permanent Committee.

Operation: The business of the Working Group will be carried out under the chairmanship of a person appointed to the position by the Permanent Committee at each three yearly UNRCCP meeting.

Within the Working Group, vice chairpersons and coordinators of major projects will be nominated as appropriate. These elected persons will form the executive of the Working Group.

The chairman with concurrence of the working group may invite observers to meetings to provide specialist advice on specific issues. Observers may speak on specific issues when invited, but input will normally be through the national member.

The business of the group will be undertaken in a workplace that describes individual project milestones and completion dates and identifies responsibilities associated with these activities.

The forward workplace will be subject to endorsement/approval by the Executive Board subsequent to each meeting.

Reporting: A report from the working group will be prepared for each Executive Board Meeting. The report should address action on all issues referred to the Group, progress on current workplace and suggestions for forward work programs.

Issues

- Determine the optimum geodetic infrastructure necessary to support a regional GIS.
- Research and document the general status of national geodetic networks within each member nation.
- Determine and implement appropriate transformation strategies to integrate local datums into regional datums by developing transformation parameters for individual countries so that spatial data can be made available in a homogeneous regional data set.
- Support activities leading to the development of a regional vertical datum.
- Maintain a schedule outlining the individual activities, milestones, responsibilities, and completion dates associated with the above activities.
- Each member makes available and also takes advantage, where appropriate, of opportunities for the exchange of personnel to contribute toward training and education and to improve regional cooperation in Geodesy.
- That the Working Group through the Permanent Committee liaise with the International Union of Geodesy and Geophysics (IUGG) and other such bodies for the utilisation of advanced space technology (VLBI, SLR, etc) to facilitate the integration of the GPS networks within the region.

Working Group 1 – Regional Geodetic Network

Project Work Plans

Project 1 – Regional Precise Geodetic Network - Coordinator Australia

The aim of this project is to establish positional values, within a global reference frame, for a fundamental network of permanent geodetic stations across the Asia and the Pacific region. This project will additionally develop strategies for incorporating additional permanent stations. It will provide the basis for monitoring the positional movement of these geodetic stations on an ongoing basis using all geodetic techniques including VLBI and GLONASS. The processed solutions developed from the data will be delivered to IERS as a regional contribution to the global reference frame. These SINEX solutions will be submitted to IGS and ILRS, made available to member countries of the Permanent Committee and referenced on the PCGIAP Geodesy Networks Web page.

Details of permanent stations, organizations responsible for operation, and access to data will be published and maintained on the PCGIAP Geodesy Networks Web page.

Workplan summary

Item	*Responsibility*	*Target Date*	*Status*	*Comment*
1. Finalise APRGP98 collection and distribution of GPS data	Australia,	30 April 1999	Completed	Data collated and distributed on CD-ROM
2. Individual countries process and present results for combined solution	Participating members,	12/13thJuly 1999	Completed	Five GPS solutions presented at regional workshop
3. Arrange Technical Workshop for presentation of results from APRGP98	Vietnam	12/13thJuly 1999	Completed	Very successful workshop hosted by Vietnam
4. Prepare strategies to maintain precise reference framework and further develop the regional network of permanent sites	Australia,	12/13th July 1999	Started not completed	Pacific region will be addressed during Cook Islands regional conference 3-7 April 2000
5.Publish proceedings of Technical workshop and enhance directory of permanent network sites, and details of access to data, on WWW	Australia, Vietnam	September 1999	Completed	Proceedings published by Vietnam in conjunction with Australia and available from the PCGIAP web site.
6. Monitor development of GLONASS and present strategy for using GLONASS global base station observations for Working Group consideration	Russia	12/13thJuly 1999	Not Started	No activity reported from Russia
7. Investigate regional capability for ongoing VLBI for WG1 discussion and submission to the Permanent Committee	Japan	12/13thJuly 1999	Completed	Japan, China and Australia have completed three VLBI campaigns in conjunction with USA

Project 2 – Linkages from Local to Regional Horizontal Geodetic Datum - Co-ordinator - Australia

Project design

The APRGP campaigns form Project 1 will provide the key reference geodetic network for the region. Beyond this primary reference framework the objective of Project 2 is to link national Geodetic datums together, so that all spatial information from individual countries can be readily assembled into a unified regional spatial data infrastructure for GIS purposes.

Field GPS campaigns will assist in linking individual networks to the regional datum. These field observations from both permanent base stations, and epoch sites on local geodetic points, will be processed in terms of the regional reference frame and the results compared to the values from local geodetic networks. Initially, indicative block shifts for each country will be compiled.

This will allow the development of appropriate transformation parameters to be determined for the conversion of spatial data from individual country databases to a regional spatial data infrastructure. Member countries are encouraged to publish transformation values and to post computational parameters to the PCIAP Geodetic Networks home page.

Where appropriate, the precise regional points established in ITRF from the core APRGP campaigns could subsequently be used to constrain a geodetic readjustment of the local terrestrial network.

Workplan summary

Item	*Responsibility*	*Target*	*Status*	*Comment*
1. Develop Observation campaign strategy and workplan for APRGP99	Australia	August 1999	Completed	Observation campaign implemented with GPS, VLBI, SLR, DORIS through newsletters
2. Arrange epoch campaign to link with international projects in the region	Australia,	October 1999	Completed	Good participation by 15 counties
3. Undertake processing of APRGP98 observation campaign	Australia, in parallel with other countries	Sequentially from April 1999	Completed	Results delivered to IERS for inclusion in ITRF 2000
4. Prepare papers on strategy for computation of transformation parameters	Australia, China, Iran	12/13 July 1999	Completed	Papers presented by Iran and AUSLRALIA published in proceedings of second workshop. Implementation of options remains with individual countries
5. Individual countries readjust geodetic network to regional points	Individual countries	UNRCCAP 2000	Started not completed	Implementation timetable varies with individual countries
6. Individual countries publish results, post to WWW	Individual countries	UNRCCAP2000	Started not completed	Implementation varies with individual countries

Project 3 Regional Vertical Datum Coordinators: Japan and Australia

Project Design

The Asia and the Pacific region has a wide variety of landforms, isolated islands, and water bodies. Digital spatial data includes various digital terrain models, local sea level land datums, and unique hydrographic chart datums. To establish a regional spatial data infrastructure across the region there is a need to be able to combine the various individual height datums.

The objective of the project is to develop a strategy, for the most appropriate regional vertical datum, to be applied to the Asia and the Pacific region. This will involve investigating the most appropriate approach to an optimal seamless geoid and the concept of adopting a reference ellipsoid to link individual datums to a regional datum. Consideration of the relationship between a regional geoid and the national/local vertical datums in use in the region is an important element in this project.

Workplan summary

Item	*Responsibility*	*Target*	*Status*	*Comments*
1. Prepare discussion papers on aspects of vertical datum for consideration as possible approaches for establishing a regional vertical datum	Japan, Australia, China	12/13th July 1999	Completed	Paper presented by Iran at the Vietnam workshop, highlighting the need for a new project and the inclusion of GPS observations at a number of sea level tide gauges for inclusion in Year 2000 regional campaign
2. Represent the WG on IAG Special Study Groups on sea level. Prepare progress reports to WG	Vietnam	Ongoing	Completed	Ongoing communication item . IAG groups are being reorganised in 2000.Commission X sub commission on Asia and the Pacific reformed. Report presented to IAG July 1999