PROPOSED AMENDMENTS TO THE SURVEY DIRECTIONS ON SATELLITE POSITIONING SURVEYS IN PAPUA NEW GUINEA

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BY

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Abstract

A new geodetic datum of Papua New Guinea was officially introduced on the 1st July 1996 as gazetted in the National Gazette No G42 on the 30th May 1996.

"The Datum for the Geodetic Adjustment of Papua New Guinea (PNG94) is realised by the coordinates of the following stations determined from the Australian Fiducial Network (AFN) geodetic stations referred to the GRS80 ellipsoid determined within the International Earth Rotation Service Terrestrial Reference Frame 1992 (ITREF92) at the epoch of 1994.0 ...."

The notice then goes on to list the stations and their coordinates.

Following this announcement the Surveyor General's Office issued Circular SDC 2/96 amending Clause 2.17 of the Survey Directions 1990 which now reads;

2.17 Geodetic Datums
National Mapping Bureau (NMB) have gradually been converting existing networks on various datums to the Geocentric Datum of Papua New Guinea (PNG94) which was officially adopted on July 1,1996 where control is available on PNG94 at NMB and it is connected to in a survey, the coordinates required to be submitted or shown on the plan shall be in terms of PNG94In any case, the notings AGD66,WGS72,WGS84 or PNG94 shall be shown after the coordinate values to reflect the system used.

This paper will consider what issues need to be addressed to allow surveys to be carried out by GPS and in particular what other specific amendments should be made to the Survey Directions and Schedules.

1.0 Introduction

It is envisaged that, from the year 2000,all navigation and most control surveys will be carried out using GPS and as a result many countries have decided to switch their datum from a local geodetic datum to the earth centred global system used by GPS,WGS84.

There are benefits of changing to a common geocentric system, all map and chart users will use the same reference system which will mean that the cartesian or spheroidal coordinates will be compatible and that positions determined by GPS will be expressed directly in this common system. However there are drawbacks, all maps will have to be redrawn and existing coordinates transformed, and a global geocentric datum and associated spheroid may not fit the local geoid, for example the average geoid - spheroid separation in Papua New Guinea is 74 metres.
What this means to the practicing land surveyor in Papua New Guinea is that if measurements are taken conventionally and reduced in the normal way then all distances will have to be "scaled" by 12ppm when reducing measurements from mean sea level to the spheroid and projection. A closer fitting, and still geocentric, spheroid could have been chosen to reduce this correction. It is arguable that 12mm/km could be neglected for most cadastral surveys and this point is raised only as an illustration of one of the disadvantages of global systems.

The main questions are

1. How is such a change implemented?
2. How will the practicing surveyors become competent in the new techniques?
3. How can standards and specifications be drawn up to incorporate the new techniques whilst maintaining compatibility with conventional methods?

The gazettal of the proposed changes in effect brings the changes into operation but the circular states "where control is available on PNG 94 at NMB and it is connected to in a survey" which implies if it can be shown that control "was not available" and was not, for whatever reason "connected to" then the coordinates can be listed in other reference systems provided the system used is noted on the plans or documents.
Perhaps it would be better if it stated that all future surveys **"must"** be tied to PNG 94 control.

2.0 Changes in Legislation

The first thing to look at is the existing legislation with regard to all types of surveying carried out in Papua New Guinea and to make sure it is consistent, where the various legislation refers back to the Survey Act, Regulations and Survey Directions or the Survey Coordination Act and Regulations there is not a problem provided the wording allows for changes.
However in the case of the **Petroleum Act Para 123(1) and (2)** it states;

(1) Where for the purposes of this Act. or for the purposes of an instrument under this Act, it is necessary to determine the position on the surface of the earth of a point ,line or area, that position shall be determined by reference to a spheroid having its centre at the centre of the earth and a major (equatorial) radius of 6 378 160m and a flattening of 100/29825 and by reference to the position of Bevan Rapids (AA070) Geodetic Station in the Gulf Province of Papua New Guinea.

(2) Bevan Rapids Geodetic Station shall be taken to be situated at 7 degrees 21 minutes 34.7974 seconds south latitude and at 145 degrees 15 minutes 52.9878 seconds of east longitude and to have a ground level of 406.30m above mean sea level.

In other words positions determined in accordance with the Petroleum Act refer to an earth centred Australian National Spheroid whose position is defined by the position of Bevan Rapids quoted above.

All other Geodetic and Cadastral positions are to be determined with reference to an earth centred GRS80 spheroid, which for the purposes of Papua New Guinea is deemed to be the same as WGS84,whose position and orientation is defined by the positions of the 14 stations held fixed in the PNG94 adjustment (**van der Kevie 97**).
The PNG 94 position of Bevan Rapids is quoted as 7 degrees 21 minutes 29.606409 seconds south latitude and at 145 degrees 15 minutes 57.004069 seconds of east longitude and to have a ground level of 406.857m above mean sea level.

Such inconsistencies in the legislation should be removed. It is evident that the changes that are needed are not simply changes to the Survey Directions alone. Schedule 12 gives an index of the laws of Papua New Guinea applicable to Land Surveyors and these should be scrutinised and any anomalies amended.

3.0 Competency in new techniques

The responsibility for this probably lies with the ASPNG, the Surveyors Board, the University of Technology and the individual Surveyor.
At Unitech both Surveyors and Cartographers are introduced to the PNG94 Datum and the PNG(MG) in the second and third years of their courses, they are also taught GPS in the second, third and fourth years of their courses, so for the "new generation" surveyor GPS and PNG 94 should cause no problem. Those of you that attend the GPS Workshop will see there is a whole range of GPS Equipment and Field Procedures which need to be explained and understood.

The initiative shown by the Board of Surveyors and the ASPNG in allowing time during this congress for a GPS Workshop and for requesting a review of the Survey Directions and Schedules is testimony to their commitment to assist the surveyor in learning these new techniques and for preparing workable standards and specifications for the profession.

It is incumbent on the individual surveyor to continue his or her professional development (CPD) and in many countries the professional institutions make CPD compulsory for all their members and for maintaining a licence to practice. This approach should perhaps be adopted in Papua New Guinea, in many cases CPD Packages are put together by volunteers of the relevant Institutions and distributed at the cost of reproduction and postage only.
It might be worth the ASPNG considering annual workshops and CPD packages on such topics as GIS, Remote Sensing and other areas that the membership feel is necessary to keep them up to date with developments. Surveying is changing rapidly and whilst the colleges and universities can change the syllabus reasonably quickly in response, it is difficult for those surveyors trying to earn a living to adapt as quickly. Most have become self taught on such subjects as automated mapping, total stations, CAD and whatever assistance can be given should be given.

4.0 Proposed changes to the Survey Directions

7.17 The following changes to the Survey Directions 1990 have been proposed and need to be debated and amended or confirmed.

Use of Satellite Positioning techniques for all types and classes of survey referred to in these Directions.

(a) Satellite Positioning techniques include the following:-

(i)	Transit Doppler System	(Past System)
(ii)	Navstar GPS	(Current System)
(iii)	Glonass	(Current System)

and any other future or proprietary system that uses signals from the above constellations of satellites.

(b) The observables used to derive absolute or relative positions include:-

(i) Integrated Doppler Shift

(ii) Pseudorandom Noise Codes (C/A Code, Pcode)

(iii) Carrier phase measurements

or any derivatives or combination of the above.

(c) The receiver make, model and the processing software combination acceptable for the various types and classes of survey are listed in Schedule 26. Use of equipment not listed must have the prior approval of the Surveyor General.

(d) The modes of operation acceptable for the various types and classes of survey include the following:-

(1) Point Positioning (Transit only)

(2) Translocation

(3) Static Differential

(4) Rapid Static

(5) Stop and Go

(6) Kinematic

(7) Real time kinematic

(8) Pseudo kinematic of reoccupation

The types and classes of survey on which each mode of operation may be used and the specification to be adhered to are given in Schedule 26.

Any other mode of operation or variation in the specification must have prior approval of the Surveyor General.

(e) All satellite positioning surveys must be connected to at least three primary network stations, two of which may be the permanent Base Stations at NMB, Port Moresby and Unitech, Lae.

7.18 **Survey Data Processing**

(a) Upon completion of the survey all GPS data shall be output in RINEX format, copied and made available to the Surveyor General on request. In any case such data shall be archived for a minimum of 5 years and should only be disposed of after written consent of the Surveyor General.

(b) In the case of Real Time kinematic surveys points that are to be used as control or boundary markers must have the data recorded as in Para 7, 18(a) above.

(c) All computations must be carried out in WGS84, which is the same as PNG94, for the purpose of these Directions.

(d) Base stations used for different positioning must be part of the PNG94 Primary Network and only PNG94 adjusted co-ordinate values shall be used.

(e) Additional Base Stations may be established but these must be connected by a network to the Primary Control.

(f) The use of satellite techniques for determination of azimuth is acceptable provided the procedures detailed in Schedule 26 are followed.

(g) Reduction of spheroidal heights to orthometric heights must be done using the PNG94 Geoid supplied by NMB unless a local geoidal model can be established using the techniques defined in Schedule 23.

7.19 **Survey Lodgement**

(a) A survey report must be lodged with the Surveyor General on completion of the survey.

(b) The format and content of the report should follow the example given in Schedule 26.

(c) Satellite derived vectors must be clearly shown on all plans using the notation laid down in Schedule 26.

7.20 (a) Surveyors must satisfy the Surveyor General that they have the required knowledge and experience to carry out surveys using satellite techniques.

(b) If the Surveyor General is not satisfied that the survey has been carried out in accordance with Schedule 26 he may instruct the Surveyor to supply the raw data in a form indicated in Para 7.18 (a) for reprocessing.

(c) If the Surveyor General is still not satisfied after the reprocessing, he may instruct the Surveyor to redo the survey in accordance with the specification in Schedule 26 and may instruct another Surveyor to supervise to supervise the work.

5.0 Additional Schedules Required

Given the proposed amendments in Para 4.0 above and the foregoing comments on training there needs to be a decision made on what information should be included in current or additional schedules to help the surveyor carry out the surveys to a standard acceptable to the Surveyor General.

It should be stated from the outset that a single GPS receiver in standalone mode doing point positioning or pseudoranging cannot achieve the accuracy requirements for any class of survey.

For surveying accuracies differential positioning using at least two receivers is required, however differential positioning can be done using the code only observable or the carrier phase observable or both.

If the carrier phase observable is used then all accuracies of all classes of survey can be achieved routinely provided certain parameters and procedures are adhered to, if only the code observable is used then positional accuracies achievable vary significantly, from +/-10cms to +/-10m depending on the equipment used, the source of the differential corrections and the real time or postprocessing techniques used.

It is this area that causes most concern. **Omnistar** is one such commercially available system and RACAL's **Landstar** is another, both are available in Papua New Guinea.

A table could be produced giving a list of parameters for each class of survey, this table could include:

Type, make and model of receiver

Observables to be used

Minimum number of satellites common to both sites

Elevation cut-off angle

Length of data set, i.e. number of epochs

Epoch interval

Software package to be used

Tropospheric correction to be used Yes/No

Ionospheric correction to be used Yes/No

Maximum baseline length

Checks to be employed Network/two base stations etc…

It would be for the surveyor to show that he had adhered to the recommended specifications in the same way that he shows that he has complied with the requirements for conventional measurements.

Just what schedules should be provided and what they should contain is open to debate but whatever is decided has to be clear, concise and workable for the practicing land surveyor who is not a geodesist or satellite positioning specialist.

It is hoped that the GPS Workshop will provide enough information for the membership to decide what is needed.

7.0 Conclusions

(a) Papua New Guinea has adopted a global geocentric datum PNG94.

(b) The use of GPS or other satellite positioning techniques will increase and control and cadastral surveys will be carried out using these methods.

(c) There is a need to review all the legislation relating the carrying out of surveys to determine the positions of points, lines and areas.

(d) That legislation needs amending to allow GPS to be used for such surveys.

(e) Surveyors need to have guidelines, parameters, specifications and instructions for carrying out such surveys.

(f) The opportunity has arisen to review the present seven classes of survey and to consider a reduced number with a move to a positional cadastral system as opposed to a direction and distance based system.

References

Van Der Kevie. J *The Papua New Guinea Map Grid (PNGMG) & Datum (PNG94)* Proceedings of the Thirty Second Survey Congress of the Association of Surveyors of Papua New Guinea, Port Moresby, June 1997