Process and Adjustment of the Portuguese First Order Network

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Summary

The Portuguese First Order Network was built and observed for the first time in the XIX century. Nowadays our Institute was feeling the necessity to have precise geocentric coordinates because more and more people are working with GPS. So in 1995 IPCC and IGN have done the campaign IBERIA95 as an effort to have a Primordial Network accepted by the EUREF. After that, IPCC started to observe with GPS the first order network. 5 teams did these observations with Trimble receivers. The campaign was performed in 1997 and 1998. In 1999 some more supplementary observations were performed in order to complement the network.

This paper wants to present the processing and adjusting results of the Portuguese First Order Network. The software used to perform all the necessary steps was GeoGenius.

In the processing of each baseline, the results obtained were the expected. For the planimetric confidence ellipses, at 95%, the maximum value was 4,8 mm, and for the altimetric component the maximum was 6,8 mm. In the adjustment of the whole network, constrained to the eleven points of the IBERIA95 solution (WGS84/ITRF96), the maximum values of the confidence ellipses were 5,5 cm for both components. These values are perfectly acceptable for our network.

1. Introduction

The National Geodesic Network (RGN) is a group of coordinated points (geodesic pillars), relative the several Date and reference ellipsoids, which coordinates are well known. This group is represented graphically by a triangular mesh designated by geodesic network.

Its creation and observation was begun in the end of the 18th century, being only ended in 1888. Starting from this date, RGN has been objective of periodic works of construction, conservation and observation, with the purpose of guaranteeing its functionality and the quality of the positioning data that are obtained starting from her, because the National Geodesic Network is a public infrastructure of national ambit.

Since 1994, that began a project of integral recovery and systematic re-observation of RGN. Nowadays, the National Geodesic Network are divided in three orders, the total number of existent pillars in the territory is about nine thousand. For the 1st order are about 120, for the 2nd order about nine hundred and the remaining ones are of 3rd order, with a density of a pillar for each 10 Km2.

The network of 1st order is constituted by triangles whose sides measure among 30 to 60 Km. In our country, the pillars of first order are, generally, materialized by great stonework pyramids, of square section, with nine height meters and three for three base meters, being towed and whitewashed of white, with black horizontal strips.

This work consisted of the processing and adjustment of the National Geodesic Network (RGN) of 1st order observed with GPS. The software used in its accomplishment was GeoGenius. The used observations were accomplished in the field during the years of 1997, 1998 and still some new ones in 1999.

126 geodesic pillars of 1st order were used and calculated about 560 vectors. The reference system that was used in this calculation, was the *ITRF96*, in agreement with the solution *IBERIA95*. The adjustment was accomplished with eleven points observed in the campaign *IBERIA95*.

2. Purpose of the Work

The final purpose of this work was the treatment of the GPS observations with the program GeoGeonius tends in view, to verify the adaptation of this new program to the calculation of precision and its eventual option as standard program.

3. GPS Field Observations

The field observations elapsed from 1997 to 1999. 5 receiving GPS of double frequency were used on 5 pillars by session, with 1 baseline common to two sessions. These consisted in observations of 4 hours using the static positioning. The interval of reception of data met was of 15 seconds and the elevation mask was 15 degrees. In the total 126 geodesic pillars of 1st order were observed.

4. Processing of the Observations

The processing with GeoGenius began with the choice of the used system of reference base - WGS84, being opted by inserting the observation files, session by session, in the way that we wouldn't loose any baseline and without generating confusion. To obtain better precision, ephemeris of precision were used in this work.

The data used by the processor for each baseline can be graphically selected through the function scan, becoming quite easy to remove and to ignore any undesirable data. The processing of the baselines was accomplished like this, processing line by line until reaching a good result. They were made corrections to the field data and to the centers of phase of the antennas (the used type of antenna height was Vertical True). In a total of 560 vectors 16 baselines were deactivated due to the rejection of the software.

It just comes the final result of the processing, although the calculation of a lot of baselines had been repeated. The

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processing of many baselines was repeated, changing the following: altering the parameters of the filter, removing satellites, altering the beginning of the observations, removing cycle slips, etc., due to the obtained solutions weren't fixed the ambiguities.

Following the illustration 1 with the numbers of the active baselines and the disabled ones for the adjustment of the network of 1st order.

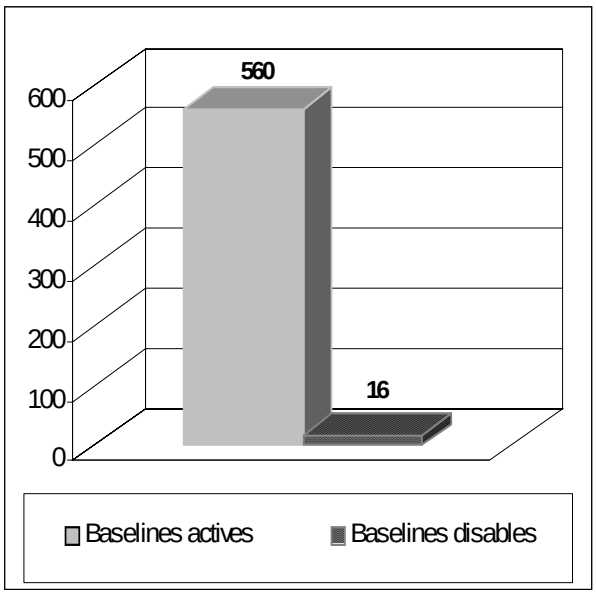


Figure 1 – Number of Processed Baselines

5. Adjustment of the Observations

In GeoGenius, the used standard method of adjustment is the Method of Least Squares in the system WGS84.

The adjustment of the network with GeoGenius was made in two phases:

The 1st phase consisted in an adjustment of the free network. The geodesic pillar Melriça-TF4 was fixed in the way to detect some rude mistake.

The 2nd phase consisted in a constrained network adjustment. And the following 11 (eleven) points of the IBERIA95 campaign were fixed:

– IP01-Santa Luzia;
– IP02-Leixões-TGGS;
– IP03-Lagoaça-Pilar Astronómico;
– IP04-Caramulo;
– IP05-Monsanto-TF8;
– IP06-Melriça-TF4;
– IP07-Cascais-TGGS;
– IP08-Lisboa;
– IP10-Poldra;
– IP11-Lagos-TGGS;
– IP12-Cabeça.

The coordinates of these eleven points are in ITRF96. When fixing these eleven points we have previously to guarantee that its coordinates in ITRF96 are rigorous, because otherwise that constrained will do some geometric distortions in the network.

Several selections or all the baselines been able to not for the adjustment of the network, being possible active/disabled the baseline in agreement with the quality obtained in the processing.

6. Analysis of Results

6.1 Obtained results in the Processing

In this work was necessary to process each baseline 3 to 4 times to obtain the best solutions, becoming a quite slow work. As final results we have the following table:

Table 1 – Characteristics of the Network Process

Network of 1st order	
Processed Vectors	576
Vectors Actives	560
Vectors Disables	16
Number of solutions used	560
Maximum Value in Planimetric	4,8 mm
Maximum Value in Altimetric	6,8 mm

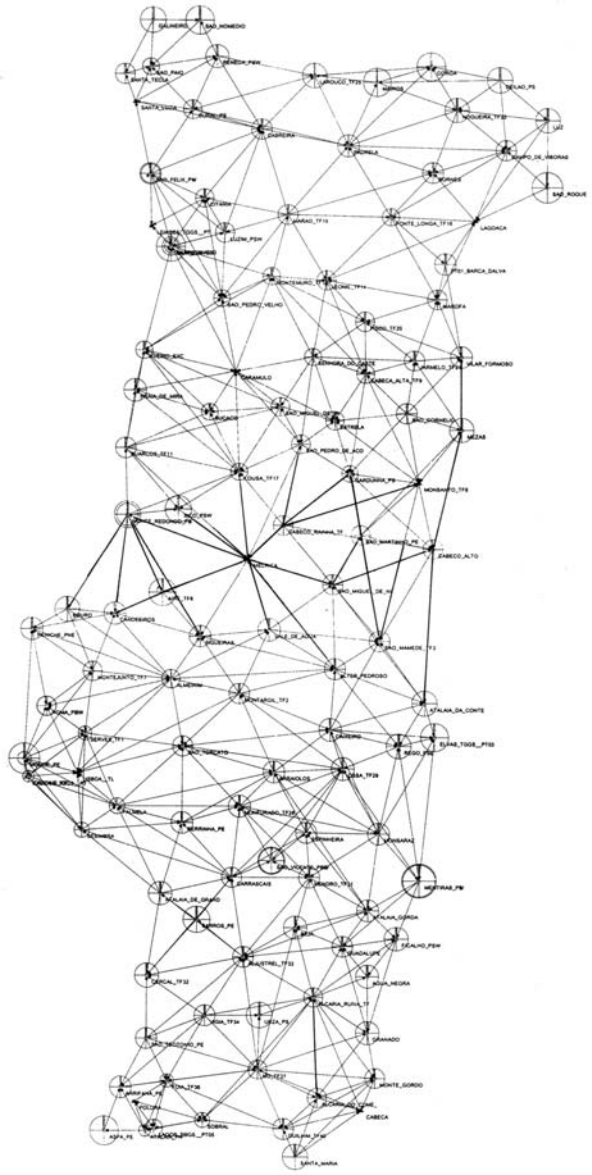
The results obtained in the processing are quite good, because the values of the trust ellipses are at the most 4,8 mm for the planimetric and 6,8 mm for the altimetric with the confidence level at 95%. These values are the expected ones.

6.2 Obtained results in the Adjustment

It was also necessary to repeat the adjustments, for several times, due to the high values obtained for the trust ellipses, being necessary to change the values of the fixed pattern deviations where it was thought that the standard mistake of unitary weight was near one. The obtained results are acceptable, because the maximum value of the trust ellipses is 5,5 cm for the planimetry and also for the altimetry, with the confidence level at 95%. These obtained values are the expected for this kind of network. As you can observe in the illustration 2.

Table 2 – Characteristics of the Network Adjustment

NETWORK OF 1ST ORDER
Option – Deviate Pattern Fixed
Standard Deviation in *X* $\mathcal{A}$ *20 mm ± 1 ppm*
Standard Deviation in *Y* $\mathcal{A}$ *20 mm ± 1 ppm*
Standard Deviation in **Z** $\mathcal{A}$ **20 mm ± 1 ppm**
Standard Error of Predefined Unit Weight
Static GPS/GLN $\mathcal{A}$ **1,38**



Legend |---| 5,5 cm

Figure 2 - Final Results of Adjustment at 95%

7. Conclusions

Of this work in GeoGenius is possible to know that:

– At level of the processing

A vector of 4 hours of observation delays about 30 seconds to 1 minute.

The processing of all the observations delay about 3 to 4 hours, demonstrating like this its processing speed, what becomes an advantage.

Relatively to the treatment of the observations, GeoGenius allows to accomplish those operations referred individually to each satellite, allowing with great easiness the court of intervals of time and elimination of cycle slips to obtain a good result when it acts directly on the satellites.

– At level of the adjustment

GeoGenius allows to do the adjustment of the processed baselines using the matrix of variance/covariance of each baseline obtained in the processing or to fixe all standard deviation values and the scale factor (in ppm), predefined by the user.

These alternatives should not be exclusive, but to be the possibility of:

For certain baselines to use the variance/covariance matrix and for others fixed the standard deviation values and the scale factor predefined.

8. References

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