

WOSSAC: 12553
631
(595)

PETRONAS
PETROLIAM NASIONAL BERHAD
MALAYSIA

**QUALITY CONTROL SERVICES FOR THE
ACQUISITION AND PROCESSING OF
SYNTHETIC APERTURE RADAR (SAR) DATA
OVER SABAH AND SARAWAK, EAST MALAYSIA**

FOURTH QC VISIT REPORT

July 1991

Hunting Technical Services Limited
Thamesfield House
Boundary Way
Hemel Hempstead
Hertfordshire, HP2 6SR
England

QUALITY CONTROL SYSTEMS FOR PHOTOGRAMMETRIC DATA ACQUISITION AND PROCESSING

CONTENTS

1.	INTRODUCTION.....	1
2.	QUALITY ASSESSMENT	1
2.1	Maps	1
2.2	Data Correction.....	2
2.3	Mosaicing	3
2.4	Photographic Processing	3
2.5	International Boundary	3
2.6	Other Checking.....	3
2.7	Mosaics Examined.....	4
3.	FUTURE QC VISITS.....	4

**QUALITY CONTROL SERVICES FOR THE ACQUISITION AND PROCESSING
OF SYNTHETIC APERTURE RADAR
FOURTH QC VISIT REPORT**

1. INTRODUCTION

The fourth QC visit was undertaken by the Consultant's representative, Mr J.W. Trevett from the 24th to 29th June 1991 at the offices of Intera Technologies in Calgary, Alberta, Canada.

During the third QC visit it had been anticipated that most of the remaining data tapes would be with Intera in Canada by July, and that the processing would, therefore, be at an advanced stage. In the event there have been some problems in obtaining security clearance to take the tapes out of Malaysia and it would appear that this problem is yet to be fully resolved.

It was decided that as the priority areas were complete at both of the contract scales (1:100,000 and 1:50,000), this would provide sufficient material to check the production methods and would allow any adjustments to be made to any future processing. It was necessary to work on the original negatives, but this was an advantage since these are the original production materials.

All of the negatives for the two priority areas were examined at both the production scales. A visit was also made to the laboratories responsible for writing the data on to film to verify the reliability of the methods used and to assess the competence of the laboratory.

2. QUALITY ASSESSMENT

2.1 MAPS

The non-availability of maps was referred to in the third QC report; the only maps that Intera had been able to obtain were at 1:500,000 scale. Maps at larger scales do exist, but the survey department was not prepared to release copies and certainly these maps would not be permitted to be taken out of Malaysia. It is not the function of the QC report to comment upon the terms of the main contract, but it is unfortunate that this difficulty had not been foreseen and adequate provision made in the contractual terms for all required maps to be supplied to the SAR acquisition contractor.

It is inevitable that some users will wish to make direct comparisons of the SAR mosaics with maps at the same scale. It would have been a task of the QC assessment to check this potential by examination of SAR mosaics and maps. However, without access to these maps it is difficult for Intera to ensure the fit of their mosaic construction with features of importance and known positional reliability and impossible to run a QC check on the fit.

By reconstructing the sheet layout of SAR sheets at contract scales on the 1:50,000 map, it was possible to make some broad assessment of relative positioning of features. As a result of this comparison there is no reason to believe that any gross positional errors exist.

For comparison of the SAR image mosaics with existing maps it is necessary to consider the nature of relationships between detail on the maps and the SAR mosaics if erroneous conclusion are not be drawn. The areas of difficulty for map/image comparisons are as follows:

i) Draughting accuracy

At 1:50,000 scale, a map will contain a great deal of generalisation; this is particularly evident in the rivers where the course may have been somewhat simplified. A close examination of the basic draughting will show that errors in drawing can also occur. Maps at larger scales may be more accurately draughted but the reliability of positioning will depend upon the survey methods used.

It is assumed that most of the larger scale maps will be produced by examination of the stereoscopic image of air photos using a precision plotter. In dense tree areas the actual line of any river will be hard to define through the tree cover and its position may be inferred from the general expression of the valley shape; roads are harder to define since their position is not specifically related to the relief.

In the areas under study there is very little planimetric information, other than rivers, that can be used for comparison. Towns of any size do not exist, except for the two main towns, and the only other reliable positioning feature is the coast line.

In areas where the maps are a result of plane table surveys then the river courses and roads may be even less reliable.

ii) SAR image geometry

With SAR imagery it should be remembered that the view of the land surface is oblique and not vertical as with an air photography, thus there is a certain amount of terrain distortion in the image which will vary with the amplitude of the relief. The SAR image is reformatted to provide a simulated vertical view but is not accurately rectified to a ground relief model; thus positional errors will be an inherent factor in SAR imagery, increasing with the severity of the relief.

Efforts are made to correct the image in order to minimise these positional errors, by procedures such as the continual reference to the global positioning system (GPS) GPS data. The result is an accurate balance and generalisation of positional accuracy throughout the image. Given the methods used to create the mosaic, this in turn relates to positioning within the whole mosaic.

The positional coordinates created from the GPS data are used to derive the sheet cut lines on the mosaics. As a result these are precise and accurately relate to the image data. It has to be noted however that at no time is there any reference made to map data, mainly because no map data were made available, and that the mosaic cut lines although using the same projection data as the maps, are not taken from the maps.

If the maps were to be of first order accuracy and the SAR image to be corrected to a digital terrain model to remove all inherent system distortions, then in theory the two sets of data should match exactly. In practice because neither of these two conditions pertain, fit will be general and subject to error related either to deficiencies in mapping or artefacts of SAR.

Taking these factors into consideration the overall fit to the map data at both mosaic scales when compared with the 1:50,000 maps is very good and within acceptable tolerances. It is evident that the drainage on the mosaics shows far more convolutions in the rivers than are recorded on the maps and the general expression of the drainage on the mosaics is consequently much better. Where measurements indicated some discrepancy this was in the main seen to be subject to doubt on the maps rather than on the SAR.

When trying to fit map data to SAR, rather than trying to get an overall fit it is better to fit to as much local detail as possible.

2.2 DATA CORRECTION

When carrying out the QC on the strip imagery in the field, it is necessary to assess what image defects due to antenna pattern, turbulence, or other factors, can only be eliminated by re-

flying and which can be compensated for in the processing. The extent of re-flying required has been discussed in previous QC reports.

In examining the mosaics, it is necessary to ascertain how successful the processing corrections have been in removing any such SAR artefacts.

In all the processed data examined no evidence of any of the above acquisition effects could be detected. It is concluded that the processing methods have been completely successful in removing or compensating for the variations in radiometric balance detected in the original strips.

2.3 MOSAICING

Examination of all the mosaic negatives available showed that the junction between strips used to make the mosaics was often impossible to detect. Only an interpreter with considerable SAR experience would be able to identify any evidence of joins such as a few that occurred in isolated cases. It is possible that in future mosaics of areas with excessive relief amplitude, some indication of joining will be visible; this cannot be avoided.

The radiometric balance between strips and between adjacent mosaics was constant and examination of the grey scales on each of the film negatives showed that the film writing and the processing were to a high and consistent standard.

2.4 PHOTOGRAPHIC PROCESSING

The production of the photographic strips and the mosaic sheets from the digital data by the use of a laser film writer and the printing of the sheets from the negatives, are not undertaken by Intera. These operations are carried out by external subcontractors. It was therefore considered advisable to visit these subcontractors to be satisfied on the capability of the systems used.

In both cases the firms used were well acquainted with the requirements of the imagery and with the overall technology. In the case of the film writing, for instance, the subcontractor was used to the demands and tolerances required by continuous tone reproduction rather than the dot matrix system usually required by the graphics arts industry for commercial printing. This experience is vital if a reliable and constant grey scale is to be maintained.

No adverse QC comments are therefore applicable to the photographic processing.

2.5 INTERNATIONAL BOUNDARY

Examination of those sheets with an international boundary showed that there was adequate coverage of the boundary area. It is stressed however that this is only known to apply to the sheets examined in this report. Further sheets will be examined at the next stage.

2.6 OTHER CHECKING

During discussions with the scientist responsible for system development at Intera, it was possible to examine some experimental results on single pixel data to determine what resolution had been obtained. It was clear from the results that a six metre pixel had been obtained. But it should be noted that this means that there is a six metre pixel resolution and that this is not the same as the resolution of individual items of detail on the ground as the rules of radar resolution still apply, i.e. the resolution of SAR is the distance apart that two good radar reflectors must be to be resolved as two distinct records.

A further test to measure the number of pixels along the length of the Kota Kinabulu airport runway and from these to calculate the runway length for comparison with data given in the international guide to airports, resulted in measurements well within the requirements of the system.

It is emphasised that without setting out measured radar reflectors during the flying, and imaging these at regular intervals, it is almost impossible to verify all the system parameters. The

tests referred to above are the nearest one can get to measuring the system and although not perfect or conclusive, satisfied the QC Consultant that the system was operating within the specifications.

2.7 MOSAICS EXAMINED

The following mosaic sheets were QC examined during the visit:

1:100,000 scale

3/114/SE, SW, NE, NW

4/114/SE, SE

5/118/SE, SW, NE

5/119/SW

1:50,000 scale

3/114/1-16

4/114/4, 9, 10, 12, 13, 15, 16

5/118/7, 8, 9, 10, 11, 12, 13, 14, 15, 16

5/119/9, 10, 13, 14

3. FUTURE QC VISITS

It is evident that as a result of delays in obtaining security clearance, the project is now behind schedule and final delivery is dependent upon receiving the data tapes for processing. It is also clear that in order to minimise delays, Intera intend to carry out more of the processing at their own location.

A final QC visit now seems more likely in the end of October/November in KL when it will be possible to examine all the delivered materials and possibly to compare them against larger scale map sheets. This timing may be more suitable to obtaining a user response and it may be desirable to give a short presentation on the quality of the data and some guidelines as to its use for various interpretative requirements.

Intera have agreed to keep the QC consultants advised of progress and a final QC date will be proposed as progress becomes clearer.

