GENERATION OF A TERRAIN DATA BASE OVER GREECE FOR TELECOMMUNICATION

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ABSTRACT:

This article presents the technical specifications for the generation of a Terrain Database over Greece for Telecommunication. It also presents the various types of products and specifies some elements of the production process such as the co-ordinate system the data used etc. In the following are described the products as well as, their technical characteristics, the methods, the absolute accuracy of the results and the quality control of the final products. Finally the article presents the maintenance of this database and the management - organisation of the whole procedure.

1. INTRODUCTION

The field of mobile communications is continuing to experience rapid expansion as more organisations recognise the advantages of communication with people on the move, especially in cases such as accidents, natural disasters, crimes, medical incidents, military actions, business, traffic jams etc. This fact forced the telecommunication industry to expand both in terms of area extent and the quality of service provision.

This article will outline how Digital Terrain Data, Clutter Data and Vector Data have been generated for the whole area of Greece for mobile communications and will show how recent technological advances offer a fast reliable and economical solution through the use of Digital Photogrammetry and Remote Sensing.

The Greek private telecommunication company PANAFON SA, in order to plan national and regional network, as well as for the ratio analysis of existing facilities and radio-wave propagation studies required incorporating Digital Terrain Model (DTM), Clutter Data (land use classification) and Vector Data (road network, coastline etc.); the aid was to model the signal loss produced by topographic variation and clutter such as buildings and vegetation in order to calculate radio coverage maps. Then empirical corrections were allocated to each cover type which then will be used to improve the overall accuracy of the model.

The French company ISTAR and the Greek company GEOMET Ltd, within the terms of a co-operation, were contracted by PANAFON SA, to carry out the generation of a Digital Terrain Database including the following items:

1. HEIGHT DATABASE
2. CLUTTER DATABASE
3. VECTOR DATABASE

2. DEFINITION OF THE PRODUCTS

2.1 Coverage

In order to manipulate the height and clutter coverage's data the whole area of Greece were devided in three (3) lots corresponding to the following zones:

1. **Lot 1** - HEIGHT DATA, CLUTTER DATA and VECTOR DATA for the North and Northwest area.
2. **Lot 2** - HEIGHT DATA, CLUTTER DATA and VECTOR DATA for the Central, Central-South area and the Ionian Islands.
3. **Lot 3** - HEIGHT DATA, CLUTTER DATA and VECTOR DATA for Crete and Aegean Islands.

All the data tiled in 100 x 100 Km zones covering whole Greece as described below (Figure 1).

2.2 Co-ordinate System

The co-ordinate system used for the products was the Universal Transverse Mercator (UTM) as well as ellipsoid WGS '84 and zone 34 of the UTM for the whole area of Greece. Then the Transverse Mercator projection was applied to the zone of interest.

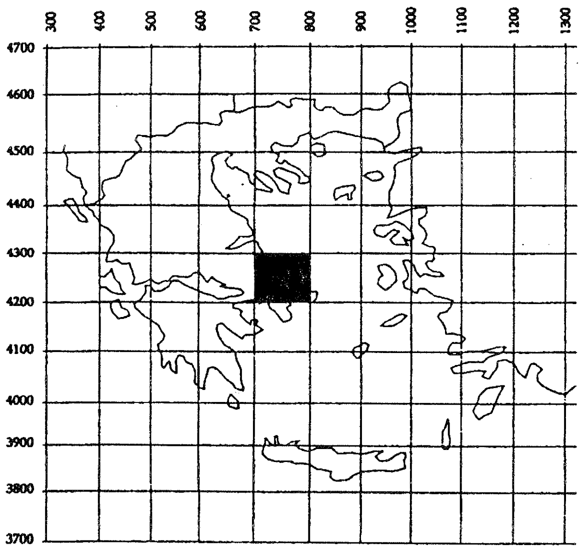

Figure 1 : Tiling the HEIGHT and CLUTTER data

Zone	Central Meridian	Range
34	21 E	18E - 24W

Table 1 : WGS84 parameters

2.3 Data Used

For the generation of the products the following data were used:

1. Panchromatic SPOT stereo pairs (P) from SPOT IMAGE catalogue.
2. Multispectral SPOT images (XS) selected from SPOT IMAGE catalogue.
3. LANDSAT TM images selected from the EURIMAGE catalogue (for some Aegean Islands)
4. Where available 1:50,000 scale topographic maps of the Hellenic Geographic Military Service (HGMS).
5. GPS ground control points for areas where 1:50,000 topographic maps were not available.

3. DESCRIPTION OF THE PRODUCTS

3.1 Height Database

There were two options for the production of the Height Database.

- SPOT_ STEREOPAIRS
- 1:50,000 SCALE TOPOGRAPHIC MAPS

The SPOT_STEREOPAIRS digital elevation model was computed by automatic correlation of SPOT stereo pairs in five (5) steps:

1. Correlation of each pair: Two (2) images of a SPOT stereo pair representing a stereo model were matched by automatic correlation. The result was analysed, validated and archived.
2. Registration of all pairs covering the zone of interest: All pairs were registered from identified points on the images whose UTM co-ordinates were extracted from 1:50,000 scale topographic maps (if maps were available) or from GPS measurement. In the North area of Greece where 1:50,000 topographic maps were not available, GPS technique were used for determination of the ground control points. About 60 ground control points were measured (1cm accuracy).
3. Individual digital elevation model production, one for each pair: Each disparity map was projected with the geometric modelling functions obtained from the previous step. A digital elevation model was obtained.
4. Individual digital elevation models were inspected, adjusted and validated.
5. Individual digital elevation models were combined into mosaics to make one digital elevation model at 20 meter resolution with UTM zone 34 co-ordinates.

In some cases where SPOT_STEREOPAIRS were not available and in cases where there were some "holes" on the DTM (cloud or snow coverage etc.) 1:50,000 SCALED TOPOGRAPHIC MAPS were used. The DTM was obtained by extracting the contour lines from the film of the 1:50,000 topographic maps.

The absolute accuracy of digitised HEIGHT DATA is depended on the contour interval between topographic map contour lines. It was estimated as half of the contour interval (10 meters height accuracy for 1:50,000 scale topographic maps).

The production line process for this product was :

- Scanning the film contour lines from 1:50,000 topographic maps at 250 dots per inch (dpi) resolution (5 meters on the ground).
- Contour line extraction by automatic vectorization and manual height attribution.
- Black and white scanning of 1:50,000 scale topographic maps at 250 dpi resolution (5 meters on the ground).
- Rectification of maps in UTM (zone 34) cartographic co-ordinates.
- Spot height digitization.

- Computation of a 20 meters grid HEIGHT DATA file by interpolating contour lines and spot heights.

The above derived DTM was mosaiced with the existed SPOT_STEREOPAIRS DTM in order to complete the HEIGHT DATABASE.

The absolute accuracy of the SPOT digital elevation model depends also on the scale of the maps used for the definition of the ground control points. SPOT digital elevation model was registered from 1:50,000 scale topographic maps and respectively has 30 meters plane accuracy and 10 meters height accuracy. About 2000 points were checked, distributed in the whole country and the errors in height are summarised at the following table:

5m≤E	5<E≤10m	10<E≤15m	15<E≤20m	E>20m
71%	17%	7%	3%	2%

Table 2 : Errors in height from 2000 checked points

Finally, using the above produced DTM the SPOT-P, SPOT-XS and LANDSAT TM were orthorectified.

3.2 Clutter Database

The CLUTTER DATABASE was extracted from multispectral satellite orthoimages, SPOT XS and LANDSAT TM (Fig.2). by classification and photo-interpretation techniques.

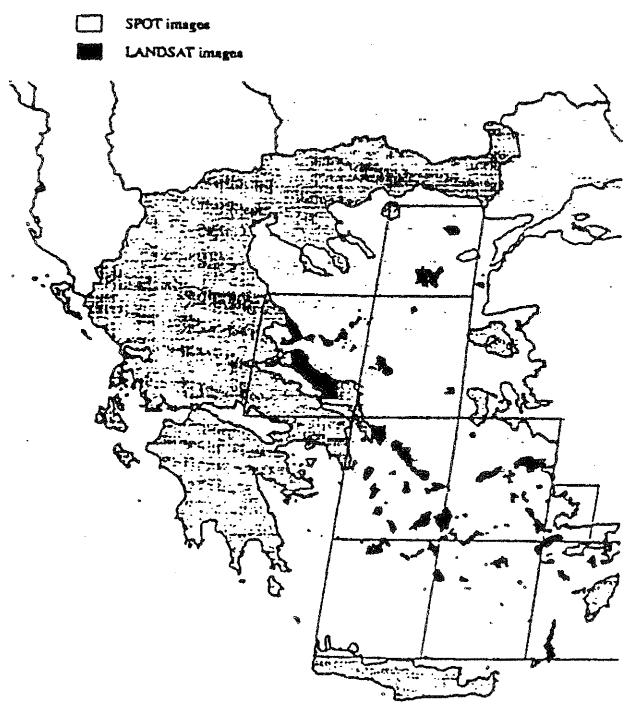

Figure 2 : Clutter Data

The Feature Space (ERDAS Imagine 8.2) decision rule was used for the classification of the multispectral images. Feature space image were used to define the training sample. The advantages of this method over the traditional ones are that feature space is a non-parametric signature, the decisions made in the classification process have no dependency on the statistics on the pixel and helps to improve classification accuracy's for the non-normal classes.

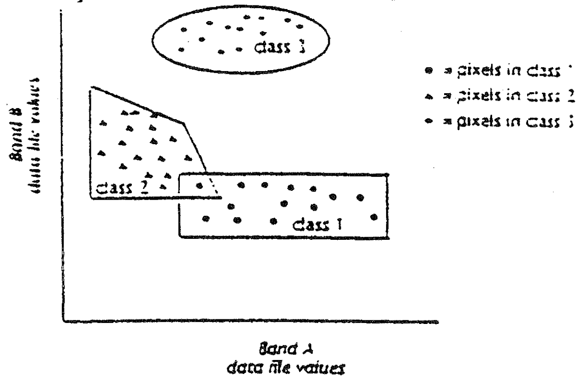

Figure 3

The classified classes were :

- forests
- waters
- open areas
- urban
- suburban

Urban and suburban classes were extracted from the photo-interpretation of panchromatic and multispectral images.

The advantages and disadvantages of using feature space signatures can be briefly presented at the table below:

Advantages	Disadvantages
Helpful for the first pass, broad classification.	Feature Space image may be difficult to interpret.
An accurate way to classify classes with non-normal distribution.	
Features may be more visually identifiable, which can help discriminate between classes spectrally similar and it is hard to differentiate with parametric information.	
Feature space method is very fast.	

Table 3 : Advantages of using Feature Space Signatures

3.2 Vector Map Data

Vector Map Data were extracted from the panchromatic and multispectral orthoimages by interactive on screen digitisation techniques.

The following planimetric features were obtained:

- Coastlines
- Highways
- Major Roads
- Main City Streets
- Minor Roads
- Railway Tracks
- Lakes
- Main Rivers
- National Borders

A complementary file was also created containing the following elements:

- Main City Names
- Town Names

4. CONCLUSIONS

The demand for mobile radio communications is expected to be more strongly realised in the near future and will continue to depend on the accurate prediction of signal strength and coverage for one or more sites. It has been proven that digital data generation, analysis and administration can serve this demand efficiently.

As systems and techniques constantly improve, the telecommunication industry is beginning to benefit from data generation which traditionally has been performed by external methodologies. As costs continues to drop the only limitation on the quality and visual impact of the data is the user's imagination.

5. REFERENCES

ERDAS IMAGINE, 1996. ***Erdas Field Guide***, Atlanta, USA, pp 236, 264,554.

ISTAR/GEOMET, 1994. ***PANAFON TERRAIN DATABASE***, Technical Proposal, Athens, GREECE.