CREATION OF 1:50,000 TOPOGRAPHICAL DATABASE USING ALOS (2.5 M RESOLUTION) SATELLITE DATA

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Abstract: The Survey Department of Sri Lanka is responsible to give accurate & up to date land information since its inception through the professional and dedicated personal. This is mainly done by Surveying and Mapping. Mapping is the main media of giving land information using Airborne and Satellite data. The Survey Department has been using Aerial Photographs for the purpose of preparation topographical maps with the help of Analytical plotters.

Production of 1:50,000 metric maps were commenced in 1980's and the series already completed for the sheets 92 replacing the one inch maps covering 72 sheets for entire country. Currently these maps are out dated and should do the updating to suit the requirements of the users. This is not possible due to non availability of aerial photographs. Hence it is decided to create new topographical data base using ALOS satellite data, (2.5m resolution) for the first time in Sri Lanka

INTRODUCTION:

The Center for Remote Sensing was given the task of data extraction using ALOS satellite images to produce 1:50,000 Topographical data base. ALOS data is having 2.5m and 10m resolution in PRISM and AVNIR images respectively. This resolution is sufficient for 1:50,000 data extraction with field verification. Priority is given to the northern area as there are no latest maps available due to bad situation there in the past.

ALOS data have been rectified by the Center for Remote Sensing itself with the help of GEOVIEW software. Several steps have been adapted to get final geometrically corrected image (as 1:50,000 tiles)

Software Used: Geoview (version 6.3) which operates on Macintosh G5 work station under the Mac OS X operating system with following modules.

1. Multi Sensors Space triangulation Module
2. Stereoscopy
3. Automatic correlation for DTM(Generation of contours)
4. Flexible and Scriptable
5. Photogrammetric Restitution
6. Production of Multi temporal Ortho Images
7. Powerful Mosaic king & Tiling Module
8. Dual screen work station

METHODOLOGY:

Image Rectification:

This is the process to compute a new Geocoded image using radiometric information of the source image and a distortion model. (Figure 1, 2 & 3)

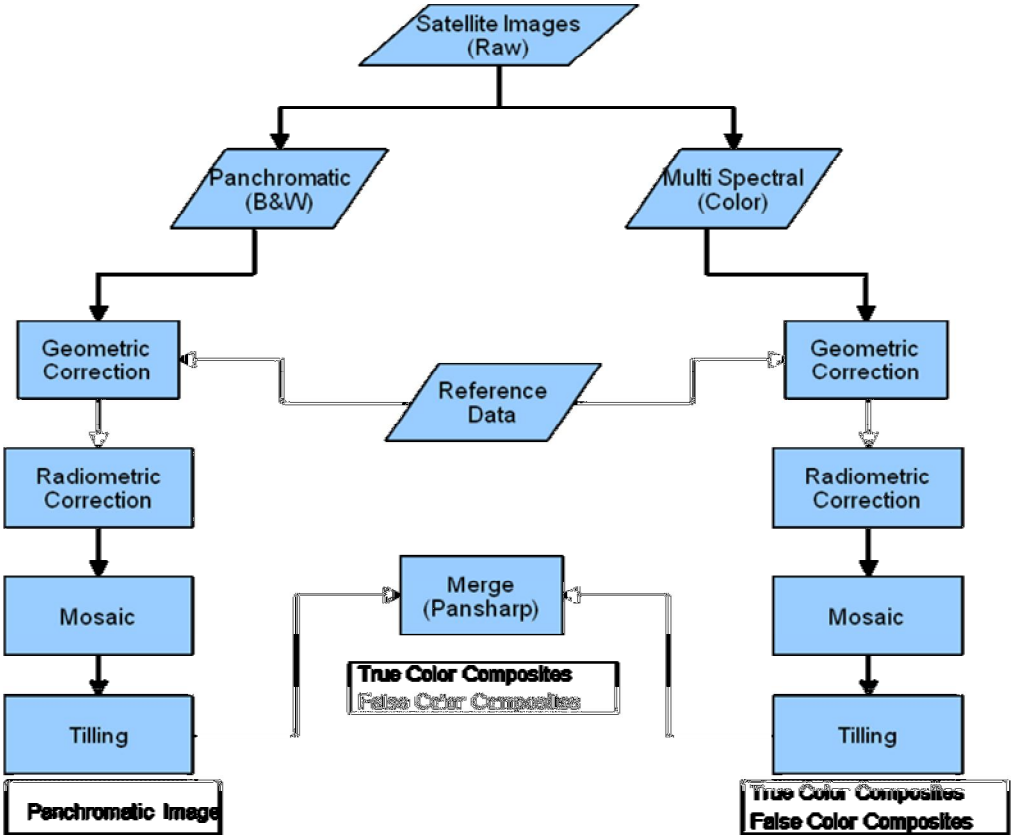
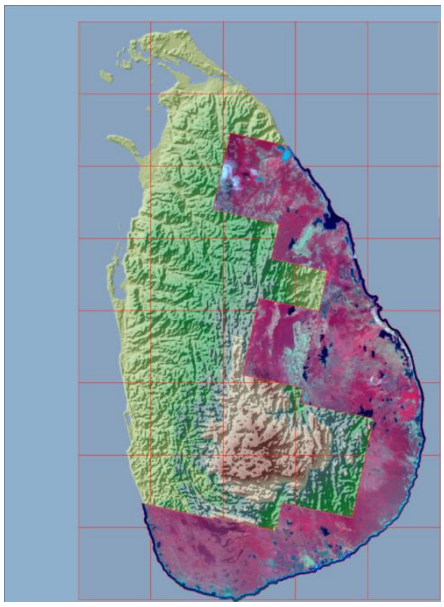


Figure 1: Flow Chart of Image Rectification



Geometric Correction

Figure 2: Reference Image

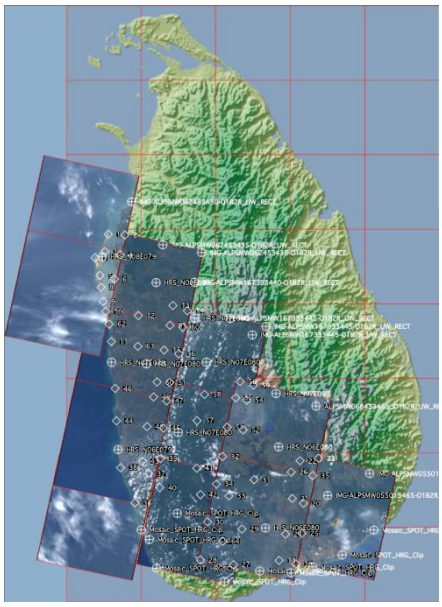


Figure 3: Raw Image with GCP & Tie points

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Accuracy of Geometry:

After applying the GCP's and Tie points should check the accuracy of the model by examining the Log file (result) which gives the RMS value, whether if it is within the acceptance range by means of less than 10 m. (Table1)

Table 1: Part of the log file
Iteration 3: Measurement RMS: 5.604348 (32 valid GCPs)

PtNb	ImageName	Measure	Code	XCalc	YCalc	ZCalc	dXY	dX	dY
1001	ALAV2A239393430	157	3	109100.663	394204.277	2.000	18.418	1.689	18.341
1002	ALAV2A216783440	158	3	159660.346	337895.052	92.949	3.518	-0.901	-3.401

Data Utilized:

True and False color images also have been used in addition to PRISM images to have better visualization especially in identification of Landuse categories. Pan-sharpened images given a valuable contribution to identify Landuse, roads and hydro features. Scanned 1:50,000 topographic maps also have been used as a reference source for other data such as Administration Boundaries, Names of Hydro features, Villages, Towns, Junctions, Administrative areas, etc, were obtained from existing data base in GIS branch. (Figure 4, 5, 6, 7 & 8)

Figure 4: PRISM Image

Figure 5: AVNIR True Color

Figure 6: AVNIR False Color

Figure 7: Pansharpened True Color

Figure 8: Pan sharpened False Color

Digitization:

Mainly three layers have been digitized with the help of ArcGIS software as given below.

1. Main & Minor roads, Tracks & Footpaths

2. Hydrology (Major rivers, streams, cannels both irrigated and natural & Reservoirs including tanks)

3. Landuse (Table 2)

The following Legend has been defined in order to perform the task. Some additional classes have been added as given below. These classes have been identified under level ii.

Table 2: Existing & possible Landuse Legend for 1:50,000 New Database

Existing Legend (1:50,000)	Possible Landuse patterns from Satellite Images
Paddy	Paddy
Tea	Tea
Rubber	Rubber
Coconut	Coconut
Other plantation	Other plantation(chilies, Banana, Corn etc)
Garden	Garden(with homes)
Built-up Areas	Built-up Areas
Forest	Forest (Dense & Open Forest)
Scrub	Scrub
Grassland	Grassland
Chena	Chena
Marsh	Marsh
Mangrove	Mangrove
Sand/Beaches	Sand/Beaches
Rock	Rock
	Sparsely used cropland
	Playground
	Forest plantation
	Barren land
	Aquatic farms
	Sugar cane, Palmyrah and Oilpalm may be possible

Creation of 1:50,000 Topographical Database:

The aim was to create the 1:50,000 database to compensate non availability of updated topographical maps, specially in the Northern part of Sri Lanka due to the bad situation prevailed there during last 30 years. This was scheduled to do in a short time with satellite data producing only digital data without going into the convention method.

Time frame to complete one 1:50,000 Sheet (1000km^2):

Digitizing of roads: 4 weeks

Digitizing of Land use: 4 weeks

Field verification 4 weeks

Completion & adding to the database 4weeks

1:50,000 Topographical mapping has commenced in end of 2009. This mapping series is involved the following procedure.

A. Digitizing of Roads, Hydro and Landuse

B. Topo line Checking (Dangles checking)

C. Landuse labeling

D. Editing with high resolution image (why?) some roads & hydro features are not clear on low resolution images so it is recommended to use high resolution images to correct them and to confirm what digitized and also clear the clouds area. This reduces the amount of field work

E. Error Checking by Senior Remote Sensing Technician

F. Field Checking/Editing

G. Polygon Creation & editing (Landuse and Hydro/Toponomy /Admin editing)

H. Topology checking & correction

I. Quality assessment

J. Edge matching & create seamless Geodatabase

Reference Data:

1:50,000 scanned (Georeferenced) map was used as a reference data while digitizing to minimize the errors.

Data Capturing:

This is done according to the data model (structure) which has been prepared according to the rules and regulation of the department.

All the visible roads including foot paths were digitized and categorized according to the Road Development Authority.(RDA) Some of the road segments could not extract due to cloud and canopy cover of the trees. Multi Temporal satellite data were used to clear the questionable areas where the Images are available.

Hydrology also digitized according to the visibility of both color and B/W images. It has been noticed that some of the hydro features in existing 1:50,000 maps are not visible on the image as well as some tanks are missing. Sometimes connectivity of streams was difficult to identify on images. Those problematic areas have been verified during the field verification.

Landuse boundaries also demarcated according to the different tones on the image and experiences to suit with our legend. It has been categorized into level I and II. It was obvious that the color images gave us easy identification of landuse patterns rather than using B/W images. Other croplands, sparsely used cropland, Chena and Forest Plantation are little bit difficult to separate. But all the problems were cleared by the field verification.

Updating the Captured Data with High Resolution Data:

IT has been decided to use high resolution satellite data for updating the data that has been digitized using ALOS satellite images to minimize the amount of field work and as well as to identify landuse patterns more precisely of the area.

Field Work:

Mainly field work was carried out to solve the following problems

1. Global Position System(GPS) observations to trace road segments (mentioned above) covered by clouds and trees.(where necessary)
2. To locate Schools, Temples and other religious places which are missing in 1:50,000 existing map.(using GPS)
3. To take GPS points where the special type of vegetation such as Forest plantation, Coconut, special type of vegetation, Cashew etc (Coconut is not very much in everywhere) Photographs are taken simultaneously with GPS observation to identify the objects.
4. Photographs were taken to separate such as, Other Croplands, (from paddy) Forest plantation (from natural forest), Barelands (from Grasslands) and gravel areas.
5. Conformation of landuse patterns which are digitized, verification of questionable areas and to clear wrong classification.
   Paper prints of digitized areas were obtained at the scale of 1:10,000 for easy orientation and prints of ALOS & Quick Bird images of each area at the scale of 1:50,000 were also taken to the field. Grid lines are drawn on the image to identify each of the paper print mentioned above for easy orientation

The following three main tasks have been done in the field

1. Navigation
2. Handling 1:10,000 sheet and do the editing (All three layers) with the help of others.
3. GPS observation and taking photographs when necessary and note down.
   Special findings were written in back side of the print.

All the field information stored in GPS and the camera were downloaded in the evening to the Laptop to clear the memory for the following day.

Editing with Field Information:

All the GPS data which are in WGS84 Coordinate system have been converted to local coordinates system (SLD95) and the photographs which are taken in the field are linked to the GPS points to make easy to edit the map. Specially roads captured by the GPS were transferred in to Geodatabase and edited. Other field observation such as segment of streams and roads also transferred. GPS points of special locations such as schools, hospitals, temples and other religious places also added to the Geodata base. Training samples from the field were introduced to image and did the reclassification where necessary.

Edge Matching:

Edge matching should be done to have seamless data base by checking all the four sides of their adjacent sheets to ensure the continuous lines (vector) are formed. This is done two sheets at the time and their relevant images to avoid wrong interpretation within the same category.

RESULTS

Database Creation:

After checking Topology, Attribute tables of each feature class and incorporate with existing Administrative Boundaries, Toponomy with relevant marginal information the final data base is prepared.

Creation Seamless Topological Database:

Sheet No's: 1- 33 have been completed and the seamless Database already created for the first time in the Department. Users can have the data by Province, District, Divisional Secretariat and Sheet basis in separate layers according to the user requirements. This database will be amended from time to time when the updating is done using high resolution data and the field verification. (Figure 9)

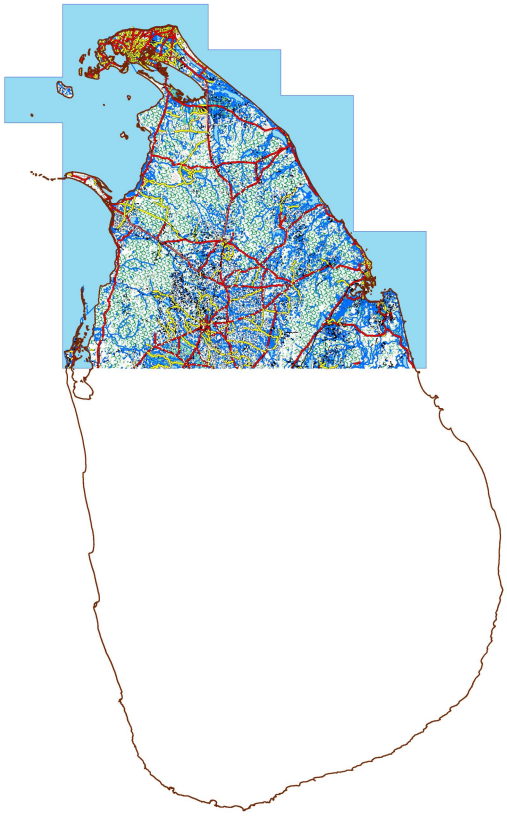

Figure 9: Final Seamless Database

CONCLUSIONS & RECOMMENDATIONS

1. Both Panchromatic and Multispectral images should be used. (Some areas having only Panchromatic)

2. AVNIR images should be purchased in a different date from PRISM images to avoid cloud cover. (Approx. one week)

3. High Resolution **Google Earth Images** are very useful to have as reference images for clear cloud areas and to reduce the amount of field work by minimizing number of questionable areas in land use categories.

4. High resolution images should be used instead of low resolution data.

5. Field work is very essential to clear the questionable areas and to confirm the extracted data.

6. Reconnaissance field visit will help to improve the image readability and make easier land features interpretation.

7. Three quality checks are recommended for each task when completed (digitization, updating & field work)

8. Hard copies also should be published as earlier as possible to reach to the users.

REFERENCES

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References from Other Literature:
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