

- ① Points: The positional information of each planimetric feature was given and a corresponding symbol was affixed. The symbols corresponding to individual planimetric features were configured as a library in separate work.
- ② Lines: The technique of giving centerline information (locus information) and adding width information was adopted. A node was created at the crossing point of roads and other lines. In creating the data for printed maps, the road rim lines were created from the width information of the road centerline, but it was processed so as not to represent the road rim lines within crossing roads. The line types and line gauges corresponding to individual planimetric features were configured as a library.
- ③ Polygons: The polygon (closed graphic figure) of an area was entered in the system and the inside of the area was hatched (the inside of the closed graphic figure was patterned). The hatching pattern corresponding to each planimetric feature was configured as a library.
- ④ Other graphic information: Other irregular graphic figures of planimetric features were drawn on the computer.

The attribute information representing the properties of each point, line or polygon was configured as an external database using a universal data format.

Logic errors such as overshoots and undershoots when representing each graphic figure were corrected and the graphic information was configured by map sheet. The graphic elements were structured per layer for GIS use and stored in the GIS database.

(3) Verification of Basic Spatial Information Database

In most digital photogrammetric systems, the software used in the data acquisition process is generally simple and CAD dedicated to data acquisition is used.

In this Project to configure the GIS database and create the data for printed maps, it is essential to configure the topology. However, universal CAD software including MicroStation is not especially efficient in configuring the topology.

Originally, it was intended to use the technique of managing the basic spatial information database as CAD data which can be converted into GIS and printed map data as needed. In the course of analysis and examination of the national base map symbols and the PAABANC specifications for GIS, however, it became clear that a tremendous load would be imposed on the system by converting the CAD data into GIS data and printed map data (configuring the topology).

Whenever the GIS data or printed map data is modified or updated, conversion from CAD data has to be repeated. It is presumed that such repeated conversion will impose a great burden on future updating work. In addition, if the basic spatial information database and GIS

database as well as the printed map data are updated individually, the respective individual data may become incompatible.

Studies were therefore under way whereby the basic spatial information database would not be configured as CAD data, but would be managed by GIS software so that a data structure approximate to that of the GIS database and printed map data could be maintained.

(4) Vectorizing

In the existing national base maps, both NAD27 and WGS84 geodetic systems are used, so complicated conversion was needed to transfer the data between the different geodetic systems. In addition, Guatemala was divided into zones 15 and 16 in the UTM coordinate system adopted in this Study, so the data in both zones could not be adjoined at the boundary of the zones.

In order to solve this problem, it was determined and agreed with the Guatemalan side that the geodetic system used in the basic spatial information database would be standardized to WGS84, recently recognized as the world standard, and that the GTM (UTM) coordinate system unique to Guatemala, in which the origin was shifted to cover the national land of Guatemala in one zone, would be adopted.

The raster data per block that was completed in the previous year's work (Figure 2.1-10, Figure 2.1-11 and Figure 2.1-12) was digitized and vectorized (Figure 2.1-13). The method of entering each vertex with a mouse was used in conjunction with the method of automatically tracing the raster data in linear sequence.

The operators paid special attention to securing the continuity of contour lines which were intermittently omitted in the existing maps. For the vector data acquired through digitization, accuracy control of the following items (per map sheet) was conducted to correct any defective points.

- Faulty entries and omissions of codes (faulty entries include faulty attributes and inaccurate shapes)
- Edge mismatching points



Figure 2.1-10 Raster data (roads and others)

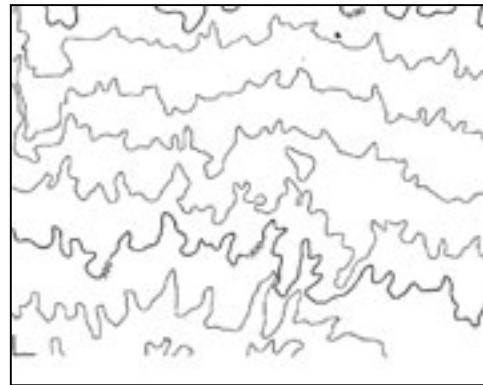


Figure 2.1-11 Raster data (contour lines)

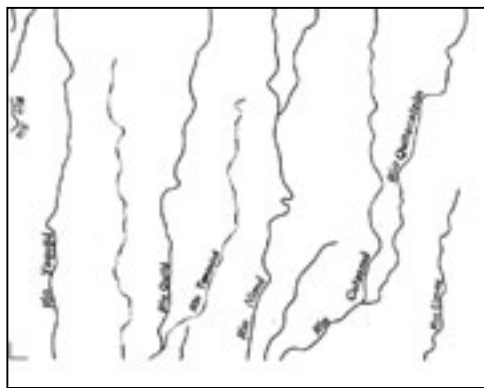


Figure 2.1-12 Raster data (rivers)

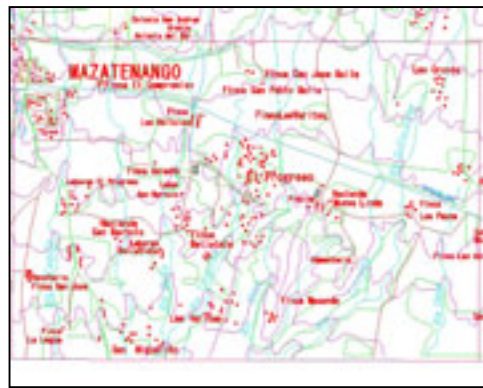


Figure 2.1-13 Vector data (digitized)

2.1.5 Temporal changes detection, photo interpretation and field survey

Temporal changes across the area of 30,000km² to be digitized at the scale of 1/50,000 were extracted through existing topographic maps and photo interpretation using 1/20,000-scale and 1/40,000-scale aerial photos taken in the first year. This work was carried out as a joint task with the technical cooperation of IGN. The work schedule and technical and accuracy control were conducted in consultation with the Study Team members. The details of the temporal change extraction work are described below.

(1) Preparation of mosaic photos

- Before undertaking the extraction work, mosaic photos of the same area at the same scale as the existing topographic maps were prepared to facilitate the task of photo interpretation. (The 1/40,000-scale aerial photos were reduced to 80% and the 1/20,000-scale photos to 40% for copying.)

- 1,366 aerial photos (662 at scale 1/20,000, and 704 at scale 1/40,000) were used for the mosaic, and the same number was used for stereoscopic viewing.
- These color photos were put together to make 74 mosaic photos, with two copies each for the field survey and for editing (one original and one duplicate copy).



Figure 2.1-14 Example of mosaic photo



Figure 2.1-15 Mosaic photo (edited (enlarged))

(2) Extraction of temporal changes

- Temporal changes were extracted through visual comparison of the existing topographic maps with the mosaic photos.
- Temporal changes in vegetation were masked yellow on the mosaic photos for clear discrimination in the field survey.
- Linear objects (roads and rivers) were excluded from the extraction work (because the maps will be compared with new photos when plotting the roads and rivers in Japan).
- Apart from these, buildings, contours, contour values, elevation points and symbols (churches, schools, hospitals, soccer stadiums, graveyards, coffee plantations, etc.) which were scanned by IGN in the First-Year Study will be vectorized in Japan.

The Study Team in cooperation with IGN conducted a field survey of the terrain, planimetric features, etc., which were not interpretable by the aerial photos alone, directly at the site of extracted temporal changes. Other information about administrative boundaries, township names, roads, railways, lakes and swamps, and public facilities was based, as a rule, on materials furnished by the Guatemalan side. The survey results were arranged on the mosaic photos which were made by putting 1/50,000 contact photos together.

(3) Acquisition of administrative boundaries and name data

The administrative boundary data file including national borders and provincial and city boundaries in ArcInfo data format was furnished by IGN. The administrative names were

entered in the data file as attributes. It was agreed with IGN that the positions of the administrative boundaries on the existing maps would not be used as they were, but that the positions in the administrative data acquired this time would be used for revision of the national base maps in this Study. If any boundary position is discrepant from the actual one (if, for instance, an administrative boundary that is meant to pass through the middle of a river deviates from the river), it will be presented to IGN for their decision, and the position will not be changed at the Study Team’s discretion.

Analog maps for the boundaries of nature conservation districts were also made available. The vertex coordinate string of each boundary line, as stated on the map, will be entered on the national topographic map to represent a nature conservation district.

(4) Acquisition of road attribute data

The Study Team received from IGN 71 copies of existing 1/50,000 topographic maps (3 of the 74 copies included no relevant roads) on which roads were marked and numbered, and an Excel file (See Table 2.1-9) in which the road attributes for the numbered roads were entered. The entered road attributes consist of 4 items: classification, number, importance and accessibility.

As the result of marking the position of the roads on the map sheets for extraction, questions regarding road types that were unclear from the existing maps (for instance, the type of road that entered an area densely packed with buildings was difficult to define) were solved. The map sheets used in this work were also used in digitization as reference materials.

Table 2.1-9 Road attribute data

FICHA TÉCNICA PARA LA CLASIFICACION DE CAMINOS						
No. De Hoja	No Secuencial de Camino	Atributo	Atributo	Atributo	Atributo	Atributo
		CLASIFICACION	NUMERO	IMPORTANCIA	VIABILIDAD	INI_FIN
1760_2	1	2	8	4	2	
1760_2	2	2	8	4	2	
1760_2	3	1	CA-2	4	3	

- No. De Hoja → Map sheet number
- No Secuencial de Camino → Sequential road number corresponding with map sheet for extraction
- Atributo → Attribute
- CLASIFICACION → Classification
- NUMERO → Number
- IMPORTANCIA → Importance
- VIABILIDAD → Accessibility
- INI_FIN → Attribute indicating the level of the start point and the end point of each section of a motorway. (No attribute entry in this work.)

(5) Acquisition of Annotation Data and Fonts

The work of creating the annotation data was conducted jointly with the technical cooperation of IGN. Annotations were extracted from the 74 map originals (black and blue blocks) of the existing 1/50,000-scale topographic maps. Each map sheet copy was sequentially numbered. These annotations included representations unique to Spanish (such as accent signs), so IGN staff was in charge of all the typing work to create the



Photo 2.1-2 Creating the annotation data

annotation data in Excel file format. (See Table 2.1-10) Serial numbers, annotation codes (on which fonts were specified), character size and color, and annotations were written in the Excel file in accordance with the Table of Annotation Codes in Table 2.1-2.

The annotations in the 1/50,000-scale topographic map database were applied to the annotations in the 1/10,000-scale orthophotos. In addition, annotation data in the portion (8 map sheets) for which no 1/50,000-scale topographic map database had been created was also created in the same way as in the work mentioned above.

All 10 fonts were used in this work, of which 8 fonts were provided by IGN, and it was agreed with IGN to purchase 2 commercially available fonts online.

Table 2.1-10 Annotation data

Nombre de la Hoja: Malacatan No. 1760_1					
No.	CODIGO	PT.	COLOR	NOMBRE	NEW
1	90200	12	Black	MALACATÁN	
2	90200	12	Black	SAN PLABO	
3	90200	12	Black	CATARINA	

Nombre de la Hoja:	→	Map sheet name
No.	→	Map sheet number
No.	→	Sequential number of annotation, corresponding to each map sheet for extraction
CODIGO	→	Code number
PT.	→	Number of points (Annotation font size)
COLOR	→	Color (Azul means blue.)
NOMBRE	→	Annotation

(6) Survey of Topographic/Planimetric Features

Based on the work conducted so far, the topographic and planimetric features that could not be interpreted from the aerial photos for the areas from which temporal changes were

extracted were verified directly in the field survey by joint technical cooperation between IGN and the Study Team.

1) Preliminary Discussions

Before the start of the joint field survey, technical and operational matters were discussed between the Study Team and IGN to confirm the optimum communication system and reliable safety measures, as follows:

- Securing of a means of communication by carrying satellite phones and portable phones
- Establishment of a regular communication system for communication between the advance group and working groups, between IGN headquarters and working groups, and between the Study Team office and working groups
- Dispatch of the advance group for acquisition of safety information mainly for safety management
- Efficient formation of groups and use of vehicles

2) Complete Establishment of Survey Method

The survey groups were formed through joint technical cooperation by the Study Team and IGN. The advance group for safety management was formed as a separate group. Eight working groups were formed for the actual work.

The work area (for 74 1/50,000-scale topographic maps) was divided into five sub-areas, in which the eight working groups conducted the field survey for about one week and editing and arranging work for about one week, total of about two weeks.

The details of the method of surveying the topographic and planimetric features are as follows:

- The places of temporal change in vegetation extracted in yellow on the mosaic photos were verified. For verification of the vegetation, places with good access by vehicle were chosen and interpretation keys were created. Vegetation at places with poor access was defined through photo interpretation using the interpretation keys.
- When a new village was found, its geographic name (village or town name) was confirmed at the municipal office or the provincial capital under whose jurisdiction it fell or at the site.
- Any new church, school or hospital was verified at the site and entered on the mosaic photo.



Photo 2.1-3 Transfer of technology for working methods

- In the event that a village was in ruins, its geographic name (or town name) was changed into an area name, which was entered on the topographic map carried by the working group.
- When a newly constructed road was found, the attribute of the road was surveyed.

3) Technical Training at the Site

For technical training in the working methods, the Study Team members in charge of the field survey made a 3-day survey of the area surrounding the local city (Escuintla) together with all the working members of IGN. The main items of technology transfer were as follows:

- How to look at mosaic photos
- Method of creating interpretation keys
- Method of photo interpretation using mosaic photos
- Method of data arrangement at the site



Photo 2.1-4 Arrangement work at the site

In the course of the field survey, a matter arose involving problems of safety management

and the Study Team was forced to reorganize the working groups with IGN members taking the initiative in the survey. However, all the field surveys were completed without any problem.

4) Methods of Editing and Arranging the Survey Results

Each working group brought their survey results to the Study Team office and transcribed and arranged them on the mosaic photos and existing topographic maps for editing. For editing, red oil-based ink pens were used to fill in the codes (alphanumeric characters) prepared for the topographic and planimetric features and their fields on the mosaic photos. This information formed the materials to be used in the process of “Digital plotting of modifications”.

(7) Preparation in Japan for this field survey

After completion of the works in “Digital compilation of basic spatial information database” and “Digital compilation of printed map data”, the following data inspection and correction works were carried out in Japan prior to this field completion survey:

- Inspection and correction on whether the polygons in the GIS data (ArcInfo) were created properly or not (correction of undershoots and overshoots)
- Checking and correction on the field survey photos on whether the labels (vegetation) in