Chapter 4. Creation of Geographic Information (Topographic Map)

4.1. Discussion on map specifications and map symbols

The first work in Georgia included discussion with the former DGC held on the surveying standards, map specifications and map symbols. The discussions throughout the 3 years are summarized as follows:

4.1.1. Surveying standards

Survey standards such as map projection, coordinate system, geodetic and photogrammetric accuracy were discussed and decided as follows.

Reference spheroid:	WGS84	
Map projection:	UTM	
Precision of map:	Planimetry	0.5 mm on the map
	Altitude	1/3 of contour interval
	Contour line	1/2 of contour interval

4.1.2. Map specifications

It was discussed and decided that newly created topographic maps with 1:50,000 scale would have the following specifications.

Map sheet size:	0°20'(longitude) x 0°12'(latitude)
Contour interval:	In mountainous areas intermediate contour intervals should be 20 m for the maps to be newly created, and in flattish and/or hilly areas supplementary contour lines should principally be added.
Conversion of zone:	To generate and keep seamless data between zones 37 and 38, the data located in zone 37 should be converted into zone 38 during digitization.

4.1.3. Map symbol and marginal information

(1) Map symbols

Map symbols and marginal information drafted by the Study Team were reviewed and discussed as follows between the Study Team and the counterpart.

- Discussion was held based on a comparison between the proposal by the Study

Team and the result of review by the counterpart on the sample symbols provided by the Study Team beforehand.

- Symbols were individually reviewed in detail so as to decide whether or not they should be adopted or that they should be integrated with others and to confirm the scope of each symbol. In light of the work efficiency, complicated ones were changed or integrated into simple ones with approval of the counterpart.
- The Study Team requested that the following map information should be deleted since it is considered unnecessary for general users. The counterpart accepted the request.

<Major items approved to be deleted>

- Elements of bridges (the materials (steel, concrete, wood, etc.) to be abbreviated and indicated along with necessary values for length, width and weight capacity)
- Elements of roads (annotation for asphalt/concrete pavement and road widths)
- Annotation for settlements and the populations thereof.
- Average height of woods and circumferential length of tree trunks for forestry areas.
- Average height of woods in scrub forest area
- Widths of rivers and waterways, flow rate of rivers, height of filling and cutting, transmission voltage and types of transmission wire, width of railroads, etc.

The existing maps indicated the above information in many places seemingly for the purpose of military use. However, since it is not always necessary as map information for civilians and some of the information are unreliable due to the occasional conditions, these annotations were deleted.

"SYMBOLS SPECIFICATIONS OF 1:50,000 SCALE MAP OF GEORGIA", Provisional version I, was compiled on May 13th, 2005, (as attached as an Annex A hereto) based on the discussions. The symbols that were not adopted or were integrated with other symbols in this symbolization are also indicated in the volume using the identification numbers used in the traditional symbolization.
The table below outlines the basic structure of symbolization.

Table 4.1.1 Basic structure of symbolization

No	Major classification	Sub classification	Remarks
1	Control point	3 items	
2	Buildings and other structures	34 items	Note 1: One item was brought back. Note 3: Three items were added
3	Infrastructures	9 items	
4	Railways	7 items	
5	Roads	12 items	
6	Hydrography and its structures	39 items	Note 2: The name and expression of an item was changed. Note 4: Two items were brought back
7	Topography	18 items	
8	Vegetation	16 items	
9	Ground	4 items	
10	Mixed vegetation	10 items	
11	Boundaries	3 items	
	Total	155 items	Refer to New Symbols in the symbolization
Annotations		19 types	As shown in the Table 4.1.2

(Individual symbols are classified into 227 codes (classified by symbolized expression, realistic features, index/intermediate/supplementary lines, large/medium/small, etc.)

Some symbols that were not included in the provisional version of "SYMBOLS SPECIFICATIONS OF 1:50,000 SCALE MAP OF GEORGIA", dated May 13th, 2005, either have been put back (Note 1) or have been changed the name and expression (Note 2) based on the succeeding discussions.

Note 1) Restored symbol

NAME	CODE	SYMBOL
Plant,factory chimneys	3548	

Note 2) Symbol with a new name and expression

	NAME	CODE	SYMBOL
Original	Steep, scale	7213	

Changed	Beach barriers	7213	

Moreover, the counterpart strongly requested to add newly (Note 3) and to restore (Note 4) the following 5 symbols to the Study Team during the field completion work (from 20th May, 2007 to 27th July, 2007). And the Study Team accepted their request.

Note 3) Added symbols

NAME	CODE	SYMBOL
Castle	4244	
Gas station	3562	
Synagogue	3528	

Note 4) Restored symbols

NAME	CODE	SYMBOL
Under water (stone)	5212	
Above water (stone)	5214	

Table 4.1.2 Category of geographical names grouped

Item	Number of type	Remarks
Name of major cities and towns	5 category	Classified according to population size
Name of villages (large)	2	Classified according to population size
Name of villages (small)	4	Classified according to population size
Name of settlements adjacent to the station	1	
Name of station	1	
Navigable Rivers	1	

Rivers, Canals	1	
Ponds, lakes	1	
Spot name of forest	1	
Name of mountains	1	
Name of Islands	1	
Total types	19	

(2) Legend and marginal information

The counterpart requested to the Study Team to design legends and marginal information separately on the printed map so that the legend is located on the right margin and the marginal information is located in the bottom margin.

The counterpart also suggested including only the symbols that appeared on a map sheet instead of showing all symbols on every map sheet. In that case, the symbol set required for each map set being different, their preparation was time consuming and also one would not be able to know the whole set of symbols by looking at a map sheet. Hence, whole symbol set was decided to include in each map sheet.

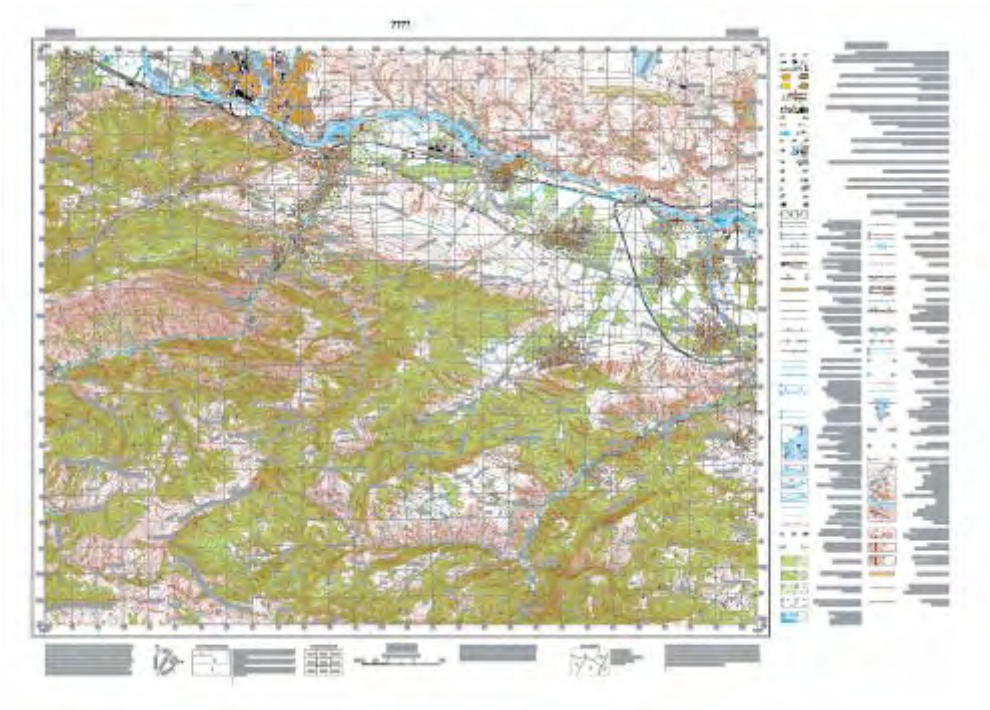
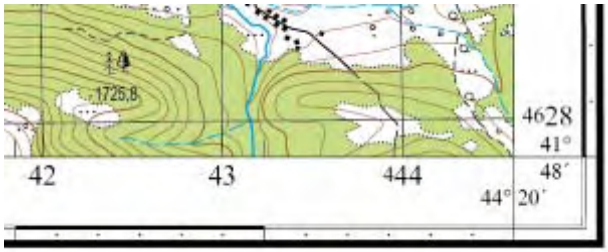


Figure 4.1.1 Layout of a Map Sheet with Legends for All Symbols

In addition, the counterpart raised the following requests concerning marginal

information during the discussion in the 2nd year. The Study Team accepted them.

1. To enlarge the map number indicated on the upper right corner.
2. To indicate, similarly to the old maps, a point every 10 seconds near the lineal frame of sheet line and white and black lines by turns every minute. ⇒ A)
3. To indicate a color chart outside the lineal frame of sheet line. ⇒ B)



A)

B)

4.2. Updating of the existing maps

Along with the newly digitized area, the area updated from the existing maps is presented in Figure 1.2.1.

<Contours, waters and forests >

As for the existing data obtained during the 1st year, sampling test (testing only on some randomly selected maps and not on all maps) was conducted by superimposing on raster data of the existing maps with coordinates (Figure 4.2.1), the results revealed followings:

(i) Differences between the existing maps and the data differed among map sheets,

(ii) Differences on one map sheet even differed from location to location, and

(iii) Not all necessary data were available. Additionally, the maximum difference confirmed in this testing was approximately 35m.

The Study Team, though could not determine, attributed cause of the differences of (i) and (ii) to the accuracy of rectification in the raster data that were used in the digitization process.

Furthermore, it was concluded that the data were not complete as in (iii) because (1) the obtained data were vectorized by raster/vector conversion using map printing films

and hence objects that appeared colorless on the film, such as white-on-black roads, etc., were not vectorized, and (2) simply, the data were not digitized.

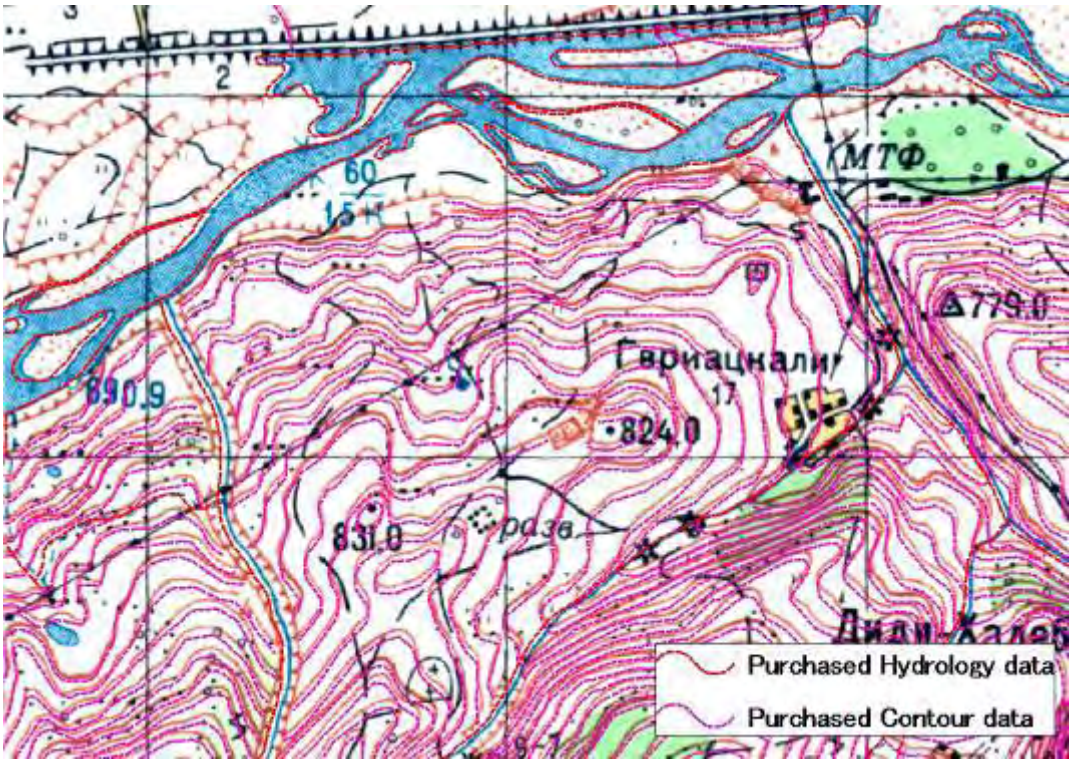


Figure 4.2.1 Comparison of Raster Data with Vector Data

The data obtained are as follows:

Type of data obtained	Data conditions
Contours	✓ Difference with raster data of existing maps ✓ Data are missing on some maps.
Waters	✓ Difference with raster data of existing maps ✓ Data is incomplete.
Forests	✓ Difference with raster data of existing maps

As originally planned, the Study Team ingested the above purchased data into the digital stereo plotter to make corrections necessary to reflect chronological changes in three dimensions. In parallel with the chronological change corrections, the differences with the raster data of existing maps were also corrected in comparison with the current status taken by aerial photography.

When ingesting data in the digital stereo plotter, the data must be three-dimensional,

meaning that the data must contain elevation information in addition to planimetric information. For this, the contour lines having elevation data were used to create TIN (Triangulated Irregular Network) data, and hydrological data were draped over the TIN data to acquire height information.

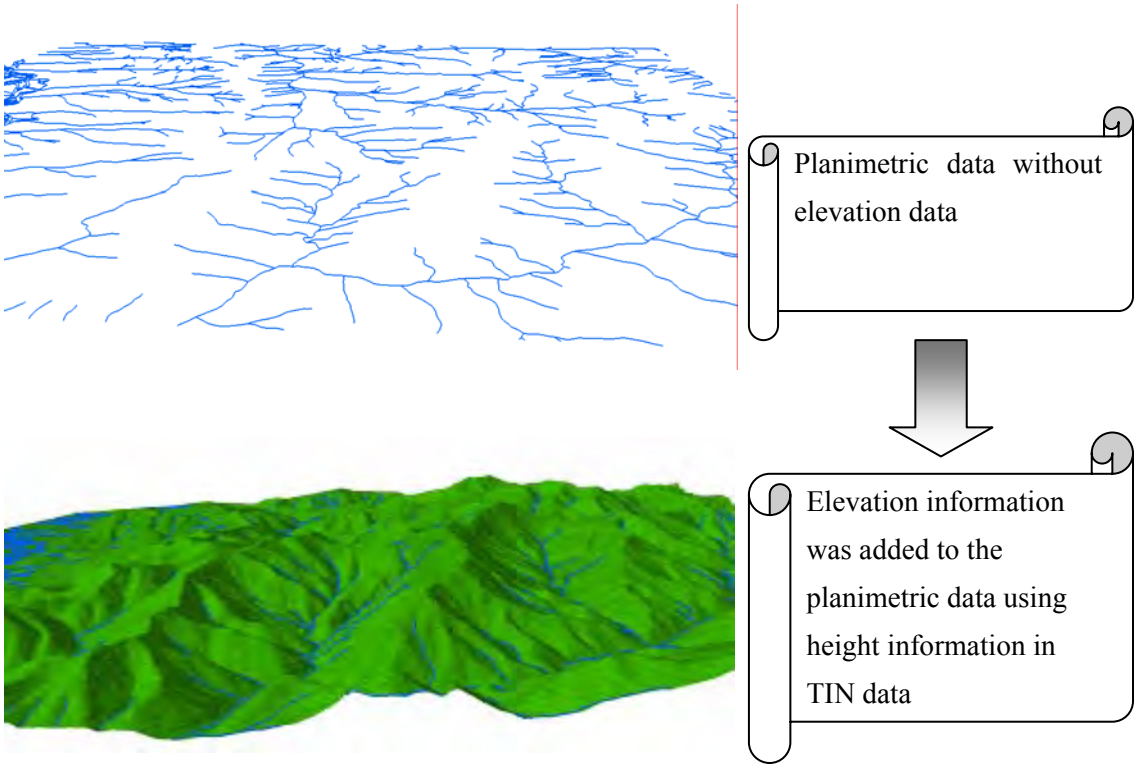


Figure 4.2.2 Drape of planimetric data

<Roads, railways, electric transmission lines and vegetation>

All the other data were digitized from the raster data of existing maps with geographical coordinates and, similarly to hydrological data described above, draped over the TIN data to acquire elevation information for the purpose of ingestion into the digital stereo plotter and make correction in accordance with the chronological changes.

Because the areas to be worked on in Japan extend widely, the Study Team interpreted the orthophotos created for the field survey together with the existing maps, to identify areas assumedly with significant chronological changes and areas without any, before starting the work, in light of the work efficiency. Figure 4.2.3 summarizes the results.

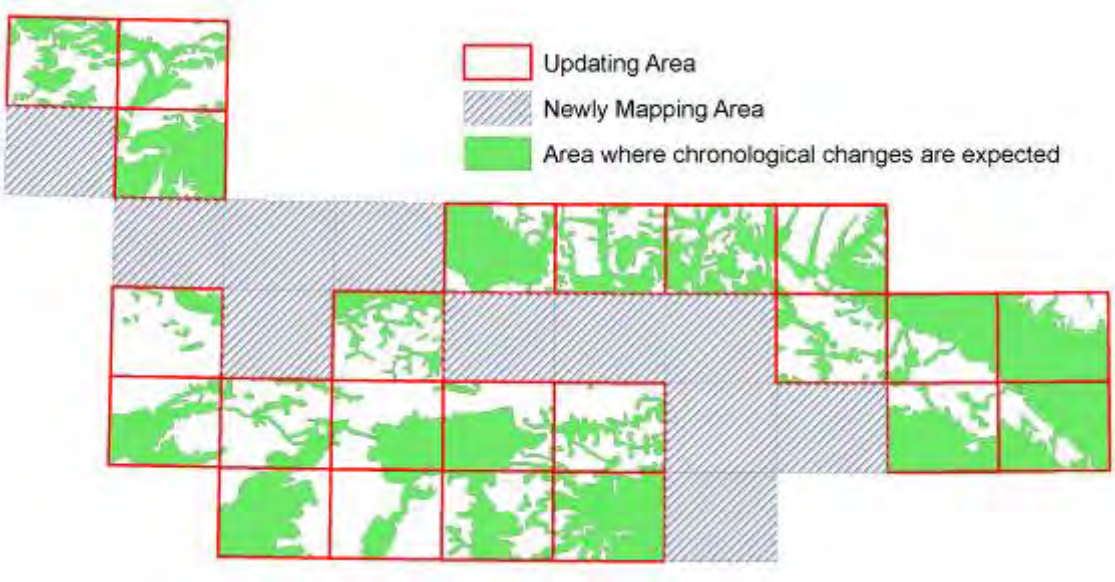


Figure 4.2.3 Area with chronological change

4.3. Newly Creation of Digital Map Data

Based on the 1:40,000 aerial photographs and the outcomes from the aerial triangulation and field surveys conducted during the 1st year of the Project, the Study Team digitized the details and compiled the data covering 6,750km^2 (11 map sheets), conforming to the "Specifications for Digital Topographic Data Acquisition" discussed with the SGC. Approximately 360 photos were used for plotting the details.

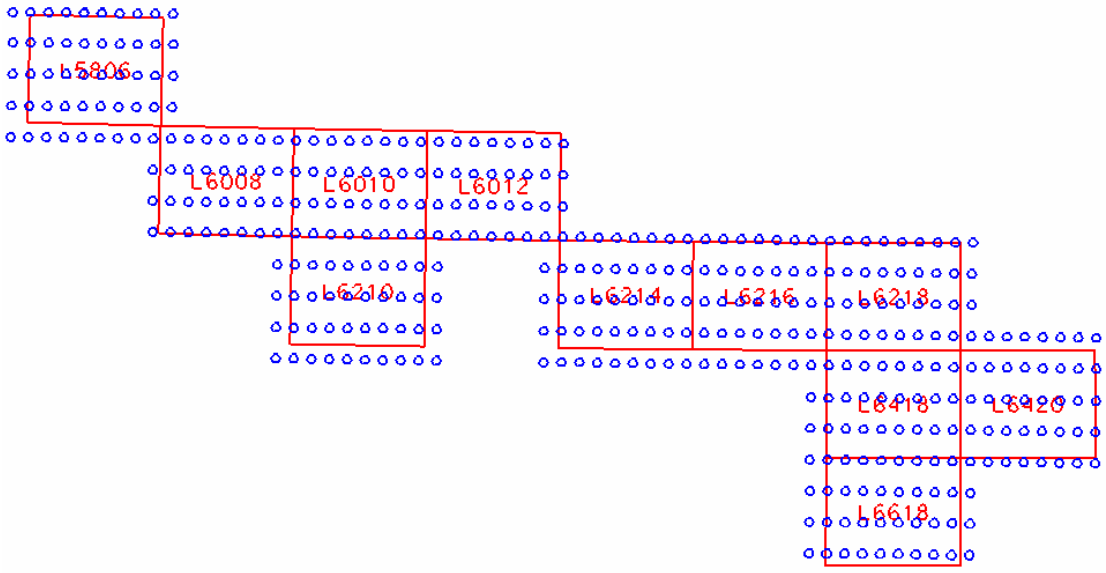


Figure 4.3.1 Positions of Aerial Photographs used for creating new maps

4.3.1. Digital plotting

Digital plotting for newly maps was carried out by measuring and plotting geographic features and contour lines necessary for a 1:50,000 topography through stereoscopic observation of 3D models.

The 3D models were formed on a vectorizer called Summit Evolution, DiAP, using the raster image data created by scanning 1:40,000 aerial photos and the outcomes of the aerial triangulation carried out during the 1st year.

In principle, digital plotting of the topographic features was conducted in the order of (i) roads, (ii) railways, (iii) rivers, (vi) villages, (v) buildings, (vi) symbols, (vii) vegetation and (viii) contour lines. By setting the minimum interval between vertices of acquired lines at 10m（or 0.2mm on the map）and the minimum range of a certain terrain, such as vegetation coverage, etc, at 150m x 150m, data were acquired and digitized to match the scale of 1:50,000.

In acquiring data, particular attention was paid to seamless and consistent matching to the adjacent map sheets, considering that digitization was conducted per map sheet. The following methods were taken as a means to acquire the data.

- Digitization of geographical features was performed using the superimpose function and referring to photos taken during the field surveys and existing maps, so as to prevent any plotting omission and misinterpretation.
- The intervals between intermediate contours and index contours were set at 20m and 100m respectively, and supplementary contours were inserted every 10m in areas with wider contour intervals.
- Summits, cols, and critical points, intersections of trunk roads, confluences of rivers, and change points of gradients were selected as elevation control points so as to make it easy to interpret heights and topography.
- The zones cut off from the negative due to the state's classification reason, including military bases, were filled by estimation from the existing maps, etc.

Figure 4.3.3 is a sample of digitized data by use of the digital plotting equipment.

Figure 4.3.2 Summit Evolution for stereo digital plotting

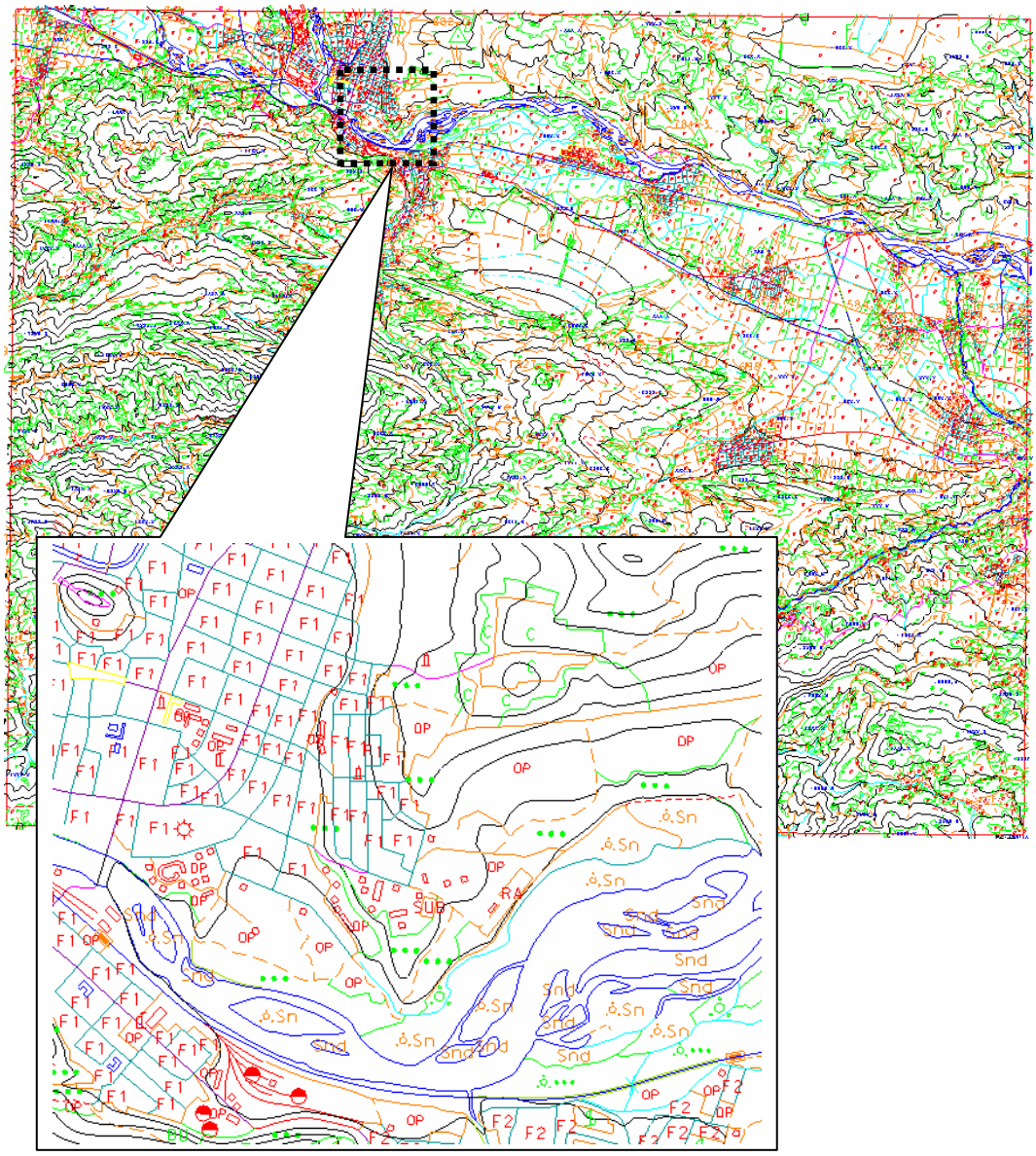


Figure 4.3.3 Digitized Data created by the digital plotting system

4.3.2. Data compilation

In the data compilation work, the plotted data were inspected and corrected as to the layers and data types (points, lines, polygons), based on the "Specifications for Digital Topographic Data Acquisition", by referring to photos from the field surveys, existing maps, and other relevant materials, to clean up the data. Here Data cleanup means deletion of duplicate data, erasing small lines, gaps and dangles, correction of pseudo nodes, and so forth.

Since the cleaned-up data enables creation of polygons as well as the "topology" data that provides the basis for GIS, it serves as the basic data for succeeding works of

mapping for creation of printed maps and GIS data creation. The data compilation work also covered creation of marginal information, such as the 1-km grids, grid scale (10-seconds), meridian convergence, magnetic declination, etc. those were indicated on printed maps.

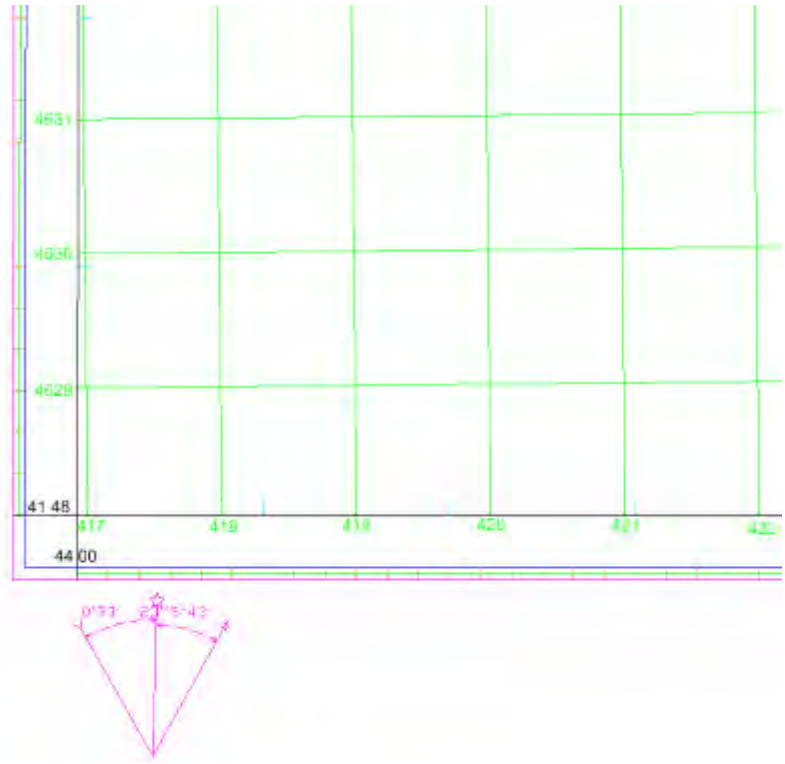


Figure 4.3.4 Sample of Marginal Information

4.4. Field Verification and Completion

4.4.1. Field Verification

(1) Objective and time conducted

The work was carried out during August – November, 2005 for 2.5 months.

The purpose of the field verification in the Study mainly includes field completion of geographical features and description items on the maps using photo images, in preparation for creating new digital maps.

(2) Equipment to be prepared

The following materials and equipments were prepared for the field work.

- Field verification photos covering the target areas (1:20,000 orthophotos were generated.)

- Existing topographic maps with a scale of 1:50,000 covering the target areas
- Existing materials (railway, power transmission line, pipeline, etc.)
- Newly taken aerial photos (to be ready for three-dimensional verification if necessary)
- Handy GPSs

Figure 4.4.1 Scene in filed verification

(3) Preliminary aerial photograph interpretation

For the sake of an efficient field verification, features appearing on existing topographic maps were itemized in comparison with other existing data and written on the photos at the office to help recognition in the field quickly, in accordance with the list of the symbols for field remarks.

Thus the preliminary photo-interpretation was carried out with an emphasis on the followings items.

- Added or demolished buildings
- Grown or waned settlements
- Newly-constructed or demolished roads and railroads
- Supply systems including power, water, public wells, and so forth
- Public facilities such as graveyards, churches and schools

Figure 4.4.2 Scene in preliminary photo-interpretation

(4) Field confirmation of features

With the existing topographic maps and the orthophotographs used in the preliminary photo-interpretation, items to be shown on topographic maps were verified and confirmed on the field. The confirmed information was processed in accordance with the verification symbols prepared in advance and updated items were put on the orthophotos so as to serve as the base data for updating mapping data or newly plotting.

The following works were also conducted in parallel with the field verification.

i) Checking of the field verification results

After the completion of field verification, the results were checked for whether all areas and items to be verified were covered and whether adjacent photos are perfectly joined. If not, re-verification and correction were immediately performed.

ii) Collection of data

It was checked for whether there exist any data on roads, rivers, railways, power transmission lines, pipelines, antennas, etc. In addition, a letter requesting cooperation was prepared with a signature by the Director of the former DGC since collecting such information sometimes required interviewing related organizations. The gathered data was reflected at the times of field verification and digital plotting.

iii) Creation of annotation data

Discussion was held with the counterpart on entering the annotation verified on the field in fixed code, font, point size and spacing using the Illustrator. The annotation was indicated in Georgian so Japan side only participated in the discussion on the contents and specifications.

(5) Personnel in charge of field verification

6 (six) engineers were selected from the former DGC staff and engaged in the preliminary photo-interpretation and field verification works on an OJT basis.

Chief engineer (Geodesy & Cartography)	x 1
Engineers in charge of geodetic survey (Photogrammetry & Geodesy section)	x 3
Map compilation specialist (Cartography section)	x 2

4.4.2. Field Completion

(1) Objectives

Field completion was done for verifying the ground features that were difficult to recognize on the aerial photographs so that plotting data could be completed for printing maps. In addition supplemental verifications were also carried out for the confirmation of annotation data, geographical names and other information expressed on the maps.

(2) Preparation for conducting field completion works

Field preparation was done by confirming the availability of equipments and relevant materials prior to visiting each area planned. The followings were minimum requirements for the implementations.

1) Newly created map sheets for verifying (2 each; 1 for putting comments in the field, another for showing the results of checking properly as a supplementary confirmation map)
2) Hand carried orthophotographs (1:20,000)
3) Collected information (Road types, railways, rivers, power lines and various pipe lines etc.)

4) Specification of symbols (for each group)
5) Handy GPSs (for each group)
6) Drawing boards (for each group)
7) Color Pencils and pens (for each group)
8) Tri-scale measures (for each group)
9) Plastic Bar- Scale (for each group)
10) Compass (for each group)

(3) Methods adopted for field completion

Planning a reconnaissance route was done in advance, in order to efficiently carry out the field verification work.

Newly created map sheets were taken for field checking and photos taken during field surveys, to confirm any questions or uncertainties that came up during digital plotting and compilation works and also to check whether descriptions on the topographic maps are compliant with the facts. Any error had been noted and corrected on the printed maps.

The matters covered in the field verification work were as follows:

1) Verification of questions and uncertainties that came up during the digital plotting and compilation works.
2) Whether major buildings, such as schools, hospitals, churches, railway stations, factories, etc., were indicated at correct locations and fully covered.
3) Whether ground objects including small-scale ground features, such as monuments, tanks, gas stations, reservoirs, water towers, bridges, etc., were indicated at correct locations and fully covered.
4) Whether linear objects, such as railroads, transmission wire, pipelines, etc., were indicated at correct locations and fully covered.
5) Whether the road types were correctly indicated.
6) Whether the types of rivers and water channels were correctly indicated.
7) Whether the types of villages were correctly indicated.
8) Whether the locations and types of graveyards were correctly indicated and are fully covered.
9) Whether vegetation was correctly indicated.
10) Whether annotations, including the names of municipalities, mountains, rivers, etc., were correctly indicated and fully covered.

Using the information on items corrected during the field confirmation, the draft topographic maps were marked in the following symbols.

- A･･･Add
- D･･･Delete
- CG･･Change
- M･･･Move

The field completion was carried out during May 20,2007～July 27,2007 by the following 11(eleven) counterpart staff under the supervision of the Study Team.

Overall Field Supervisor:	Alexsandre Avetisov
Advisor	George Mdzeluri
Chief Technical Advisor:	Nodari Kavlashvili
Field Staff:	Shalva Rukhadze
	Tedo Gorgodze
	Zaza Mdzeluri
	Giorgi Peradze
	Otar Demetrashvili
	Irakli Gotsadze
	Maka Devidze
	Mariam Gigauri
	Tamara Onashvili

Figure 4.4.3 Scene in conducting field matching

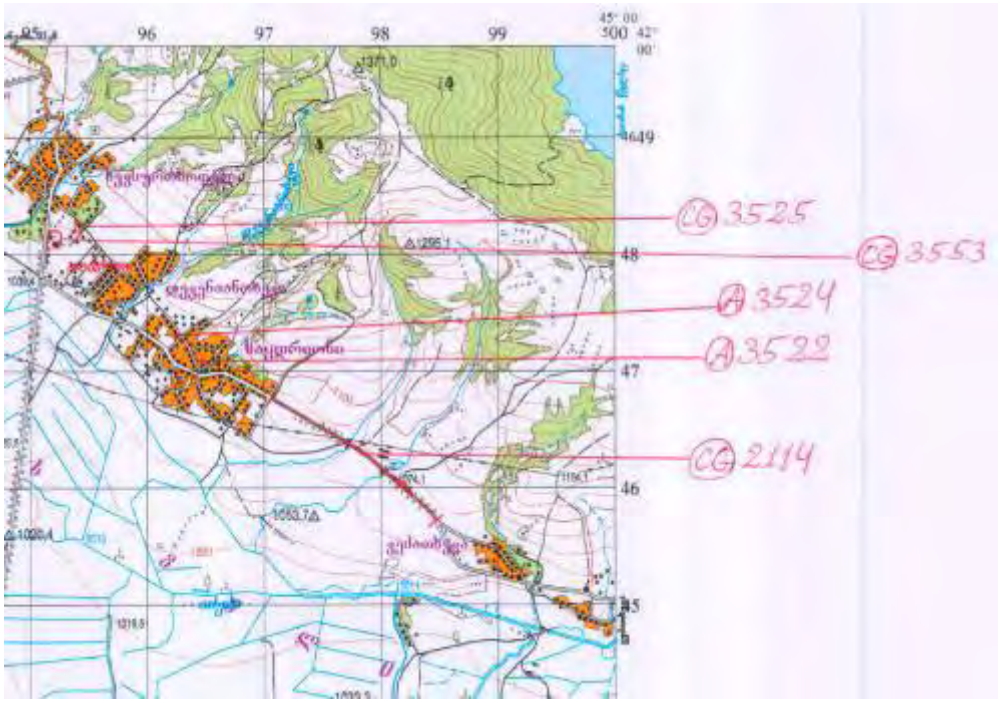


Figure 4.4.4 Sample of draft map with descriptions about corrections

4.5. Construction of GIS

4.5.1. Establishment of a national GIS database

Newly-plotted data and existing data updated with chronological changes were used to construct a GIS database.

The extracted data for the database do not necessarily include all digitized data but only those that are useful as base data. Following the extraction, those data chosen to be included in the database were classified and sorted out according to the data properties. The chart shown below illustrates a conceptual flow of establishing the GIS database from digital data.

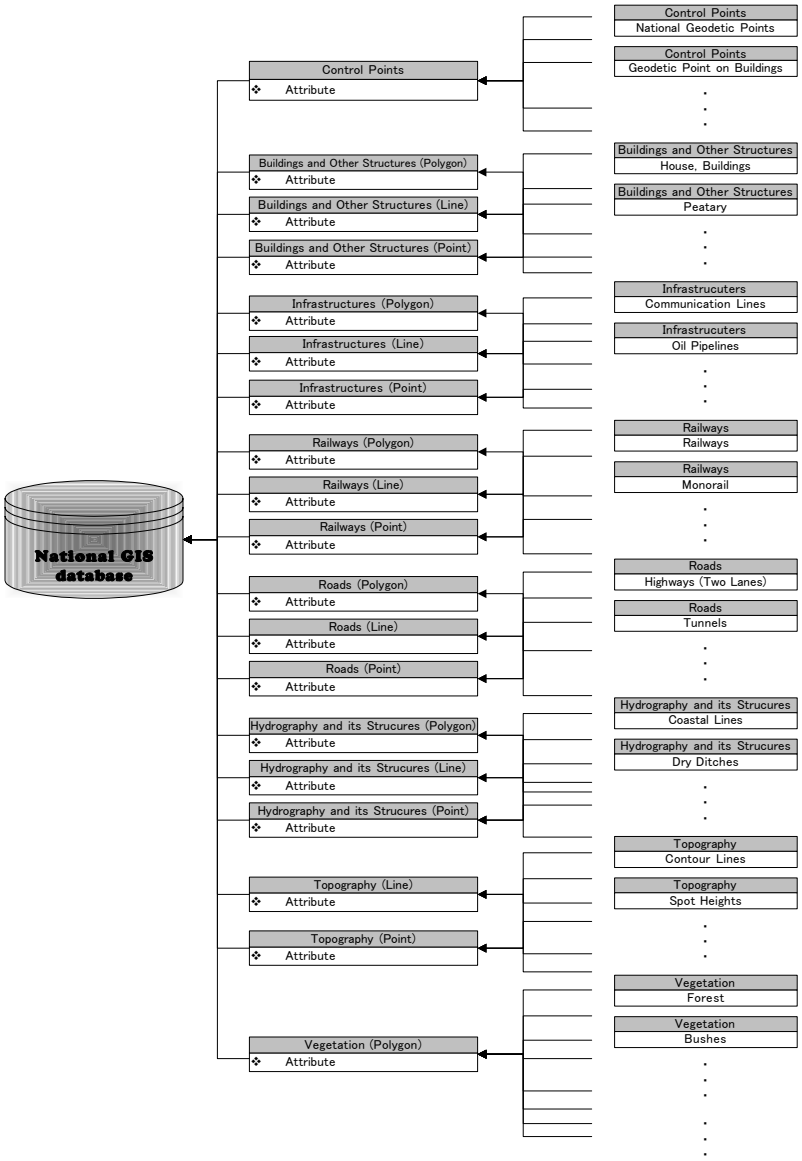


Figure 4.5.1 Concept of GIS Data

The database was created based on the work flow shown in Figure 4.5.2.
From CAD data newly digitized or corrected with chronological changes, specific layers were extracted as GIS data to establish data. Then, data topology was established followed by error checks and necessary corrections, and finally the GIS database was established.

In creating this database, ArcGIS's Geodatabase format was adopted.
Data were sorted out according to data properties so that each dataset forms one feature dataset. Each dataset was assigned with a code number and classified depending on the data type. The relation between the dataset and its constituent data is described below.

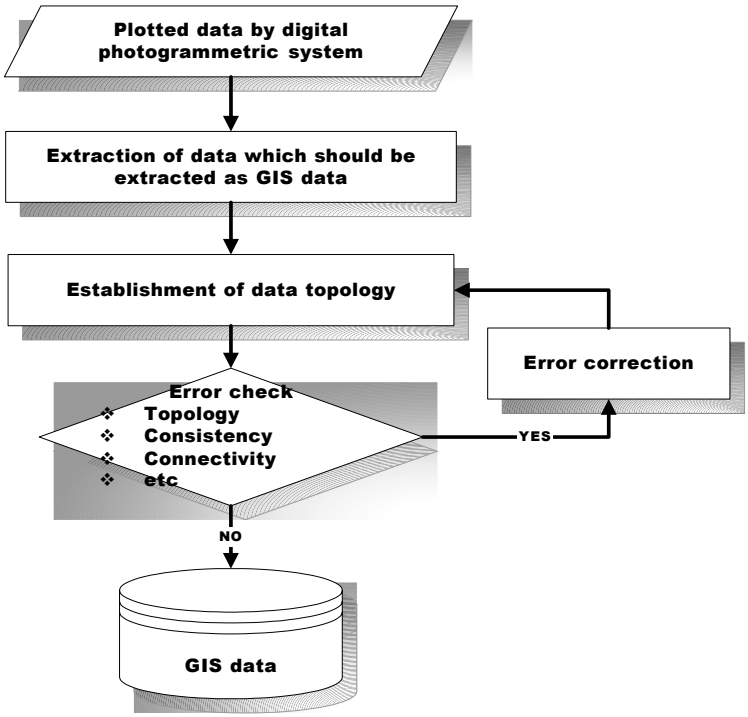


Figure 4.5.2 Work Flow of GIS data Creation

The database for a map sheet consists of 7 feature data sets as below.

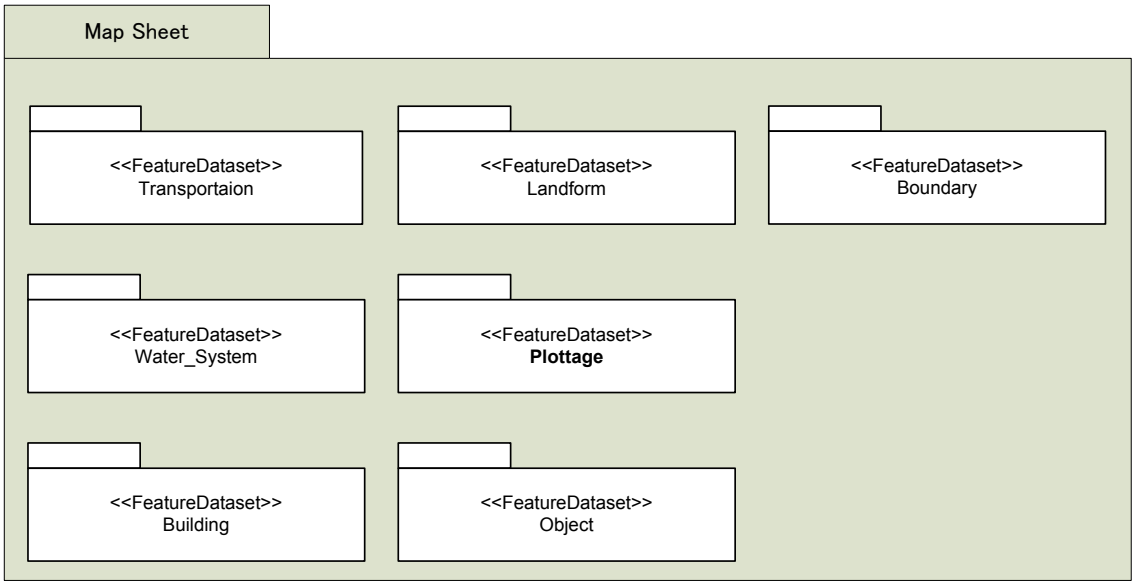


Figure 4.5.3 UML class diagram of GIS database

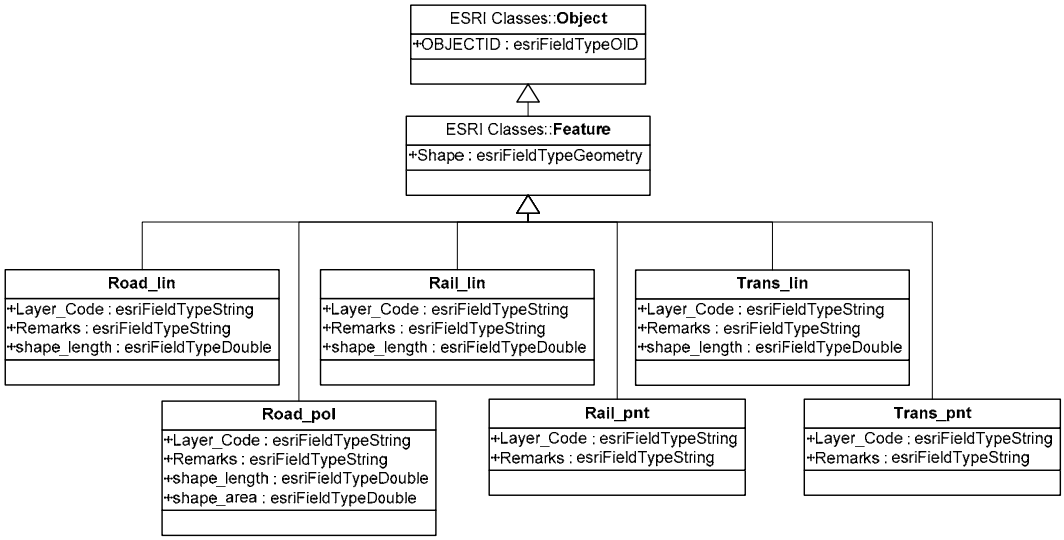


Figure 4.5.4 UML model of Transportation Package

Table 4.5.1 List of GIS data for Transportation

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Road_lin	Polyline	2112			Highways with more than two lanes per section

		2113			Highways with more than two lanes, with improved covering
		2114			Motorways* with covering (* Minor order roads other than Highways)
		2115			Motorways without covering (improved country roads)
		2116			Cart tracks
		2117			Forest and country roads
		2121			Streets in built-up estates (medium)
		2122			Streets in built-up estates (small)
		2131			Pedestrian paths
		2142			Roads under construction (highways)
		2143			Roads under construction (motorways with covering)
		2147			Roads under construction (motorways without covering)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Road_pol	Polygon	2101			Streets in built-up estates (large)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Rail_lin	Polyline	2301			Railways
		2320			Suspension ways included aerial cableways, ski lifts and conveyer belts.
		2310			Railway siding

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Rail_pnt	Point	2421			Railway stations
		2422			Subway Stations

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Trans_lin	Polyline	2721			Railroad tunnels and tunnel trunk ways

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Trans_pnt	Point	2701			Airports
		2702			Railroad tunnels and tunnel trunk ways (small)

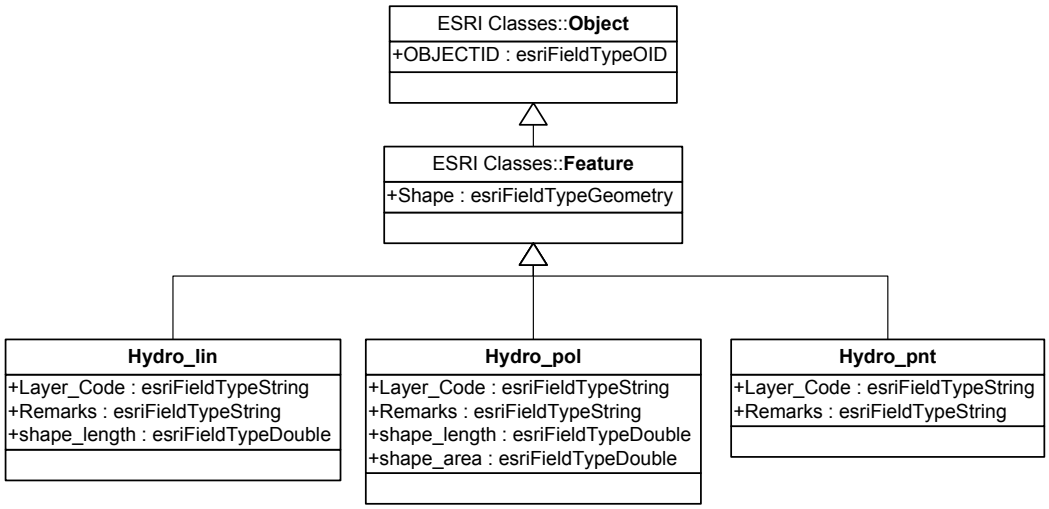


Figure 4.5.5 UML model of Water_System Package

Table 4.5.2 List of GIS data for Water_System

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Hydro_lin	Polyline	4286			Overland water pipelines
		4287			Underground water pipelines
		4288			Inverted siphones on water pipeline
		4530			Aqueducts
		5101			Permanent rivers and streams (less than 5m in width)
		5102			Permanent rivers and streams (from 5 to 30 m in width)
		5107			Underground parts of canals, less than 3m in width
		5108			Underground parts of canals, from 3 to 5m in width

		5111			Rivers and streams that gets dry. (less than 5m in width)
		5112			Rivers and streams that gets dry. (from 5 to 30 m in width)
		5121			Canals and ditches, less than 3m in width
		5122			Canals and ditches, from 3 to 5m in width
		5123			Canals and ditches, from 15m to 30m in width
		5125			Irrigation canals (aryks)
		5131			Canals under construction, less than 3m in width
		5132			Canals under construction, from 3 to 5m in width
		5151			Dry channel (less than 5m)
		5152			Dry channel (more than 5m less than 30m)
		5256			Dams (Vehicle passable)
		5257			Dams (Vehicle not passable)
		5258			Dams (small)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Hydro_pol	Polygon	5103			Permanent rivers and streams (over 30 m in width)
		5105			Coastal line of lakes, ponds, reservoirs (permanent and certain)
		5106			Coastal line of seas (permanent and certain)
		5113			Rivers and Streams that gets dry. (over 30 m in width)
		5115			Coastal line (not permanent)
		5116			Coastal line (uncertain)
		5124			Canals and ditches, over 30m in width
		5155			Dry channel (more than 30m)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Hydro_pnt	Point	4224			Concrete wells with mechanical elevation system
		4226			Reservoirs
		4271			Water sources (springs, streams)
		4272			Equipped sources

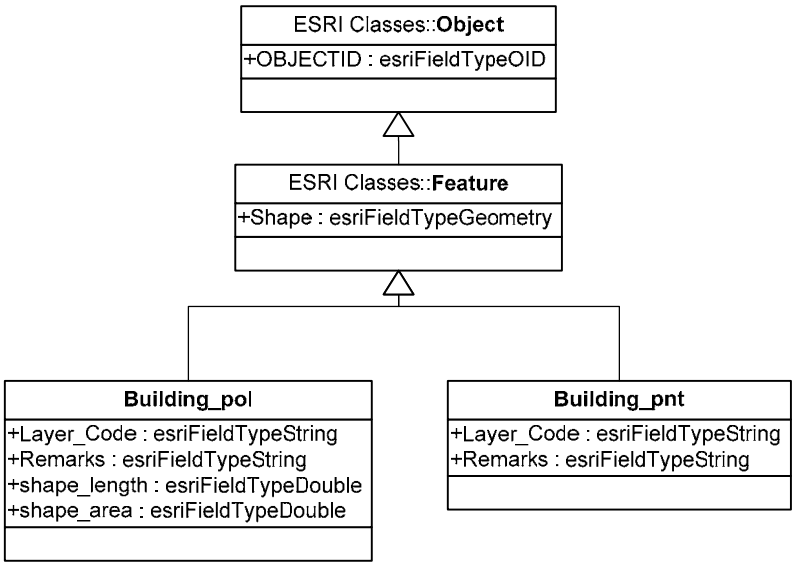


Figure 4.5.6 UML model of Building Package

Table 4.5.3 List of GIS data for Building

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Building_pol	Polygon	3004			Houses, buildings (large)
		3006			Remarkable fire-proof buildings (large)
		3011			Built-up estates with predominance of fire-proof buildings in large cities
		3012			Built-up estates with predominance of fire-proof buildings in not large cities

		3013			Built-up estates with predominance of non fire-proof buildings in large cities
		3014			Built-up estates with predominance of non fire-proof buildings in not large cities
		3015			Scattered buildings or rarely built-up estates in cities and other settlements
		3016			Wrecked and half-wrecked estates
		3017			Suburban settlement estates with lots of trees
		3521			Mosques (large)
		3523			Churches (large)
		3525			Schools (large)
		3532			Hospitals (large)
		3548			Plants, factories, mills with chimneys and other pipes (large)
		3552			Electric Power substations (converter substation)
		3553			Electric Power substations (large)
		3554			Electric power stations (large)

		3586			Ruined and half-ruined buildings (large)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Building_pnt	Point	3001			Houses, buildings (small)
		3005			Remarkable fire-proof buildings (small)
		3511			Meteorological Stations
		3520			Mosques (small)
		3522			Churches (small)
		3524			Schools (small)
		3528			Synagogue (small)
		3531			Hospitals (small)
		3546			Palnts, factories chimneys and other pipes
		3547			Plants, factories, mills with chimneys and other pipes (small)
		3549			Electric power stations (small)
		3550			Electric power stations (very small)
		3551			Electric Power substations (transformer)
		3585			Ruined and half-ruined buildings (small)

		4235			Radio stations
		4236			Television towers

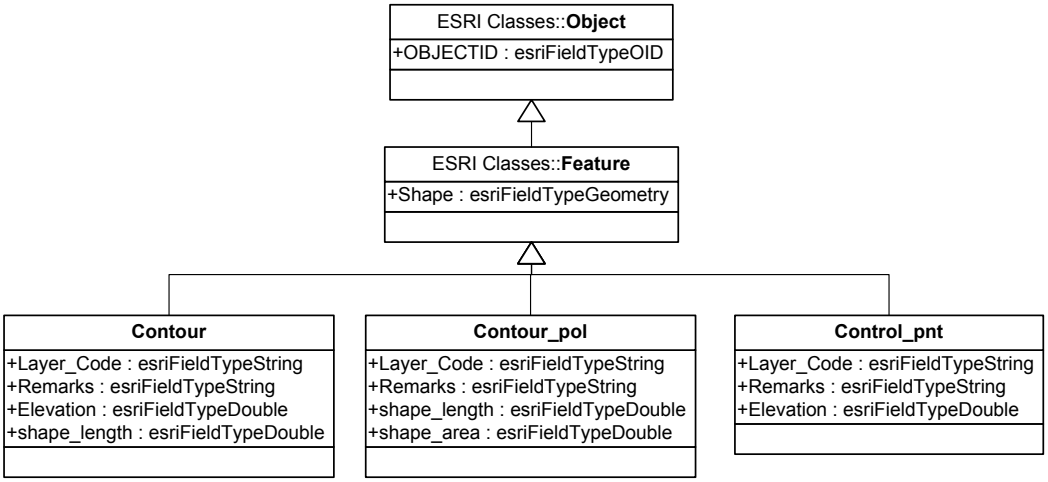


Figure 4.5.7 UML model of Landform Package

Table 4.5.4 List of GIS data for Landform

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Contour	Polyline	7101	value		Index contour lines
		7102	value		Regular contour lines
		7103	value		Additional contour lines
		7104	value		Supplementary contour lines
		7111	value		Index contour lines (depression)
		7112	value		Regular contour lines (depression)
		7113	value		Additional contour lines (depression)
		7114	value		Supplementary contour lines (depression)
		7121	value		Glacier relief (index contour lines)

		7122	value		Glacier relief (regular contour lines)
		7123	value		Glacier relief (additional contour lines)
		7124	value		Glacier relief (supplementary contour lines)
		7131	value		Isobaths and their signs (index)
		7132	value		Isobaths and their signs (regular)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Contour_pol	Polygon	7203			Rock-out crops

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Control_pnt	Point	7301	value		National geodetic points
		7305	value		Survey network points
		7307	value		National bench marks
		7312	value		Spot height
		7319	value		Markings of the depths

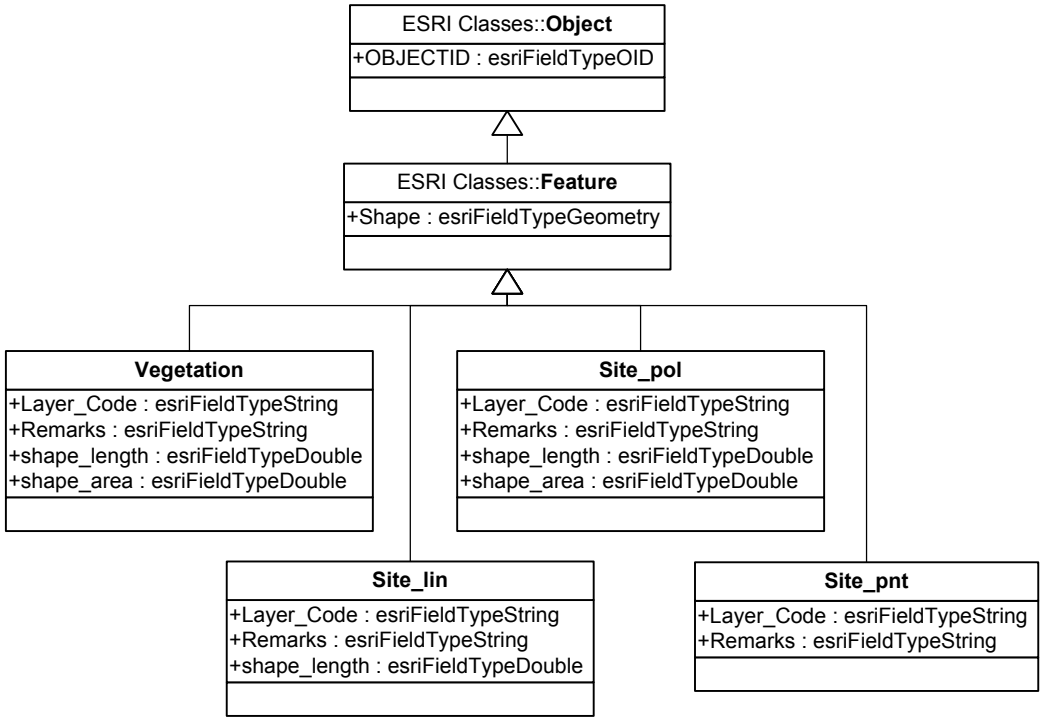


Figure 4.5.8 UML model of Plottage Package

Table 4.5.5 List of GIS data for Plottage

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Vegetation	Polygon	6311			Upland rice fields: 1) moisturized, 2) submerged
		6314			Cane and reed thickets
		6334			Meadow grass
		6335			Stone surface
		6337			Swamps without vegetation
		6338			Swamps with vegetation
		6339			Passable salines

6340			Pebble and gravel surface
6341			Plain sands
6348			Surface with hillrocks
6360			Forests
6361			Dense brushwood of bushes
6362			Separate bushes and groups of bushes
6363			Thinly growing trees, thinly growing dwarf trees
6364			Plantations of industrial crops 1)trees, 2)shrubs, 3) grass
6366			Fruit and Citrus Orchard
6367			Vine yards, fruit and citrus orchards with vine yards
6389			Cane with separate bushes and gropes of bushes on swamp
6390			Grass and bushes
6391			Separate bushes and groups of bushes on swamp
6392			Dense brushwood of bushes on swamp
6395			Separate bushes and groups of bushes on stone surface
6396			Separate bushes and groups of bushes on sands

		6397			Sparse growth of trees with bushes
		6398			Sparse growth of trees with grass
		6399			Sparse growth of trees with bushes and grass
		6400			Sparse growth of trees on dense brushwood of bushes
		6500			Open space

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Site_lin	Polyline	6231			Areas for output of minerals by open cut operation (Quarries)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Site_pol	Polygon	6216C			Cemeteries (large): Christian
		6216M			Cemeteries (large): Muslim
		6216CM			Cemeteries (large): Christian and Muslim
		6250			Salt exploitation (large)
		6251			Peat bog (large)

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Site_pnt	Point	4203			Remarkable statues and monuments
		6215C			Cemeteries (small): Christian

		6215M			Cemeteries (small): Muslim
		6215CM			Cemeteries (small): Christian and Muslim
		6240			Entrance to mines and adits (operating)
		6241			Entrance to mines and adits (abandoned)
		6242			Salt exploitation (small)
		6243			Peat bog (small)

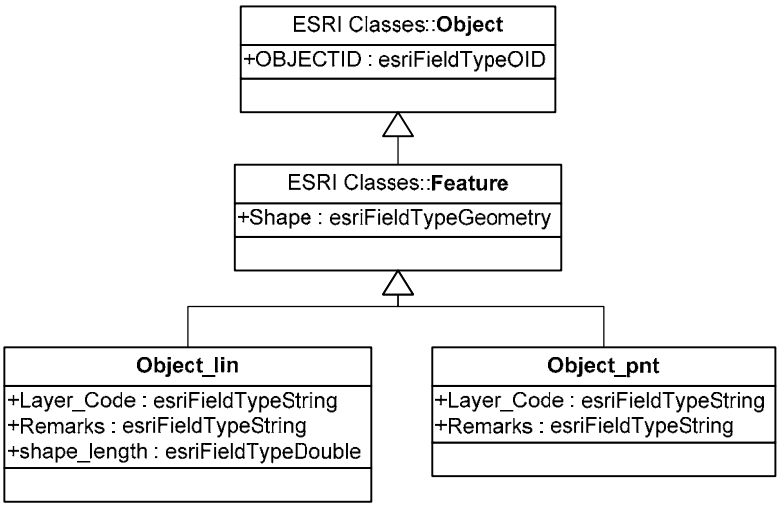


Figure 4.5.9 UML model of Object Package

Table 4.5.6 List of GIS data for Objects

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Object_lin	Polyline	2205			Foot bridges
		2401			Road bridges
		4131			Communication lines (telephone, telegraph, broadcasting)

		4132			Sub water communication cables
		4265			Electric transmission lines of less than 14m in height on wooden stands and iron concrete posts
		4266			Oil pipelines: surface
		4267			Gas pipelines: surface
		4270			Inverted siphones on oil and gas pipelines
		4276			Oil pipelines: underground, underwater
		4277			Gas pipelines: underground, underwater

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Object_pnt	Point	2205			Foot bridges
		2402			Road and rail bridges (less than 50m)
		3560			Petrol pumps and filling stations
		3562			Gas station
		4225			Oil, gas and other wells with derricks
		4231			Fuel stores and gas holders
		4232			Capital structures of tower type (water towers, etc.)
		4239			Water mills and saw mills

		4241			Beacons and lights
		4244			Castle
		4252			Water gauge station
		4253			Remarkable lime charcoal kilns

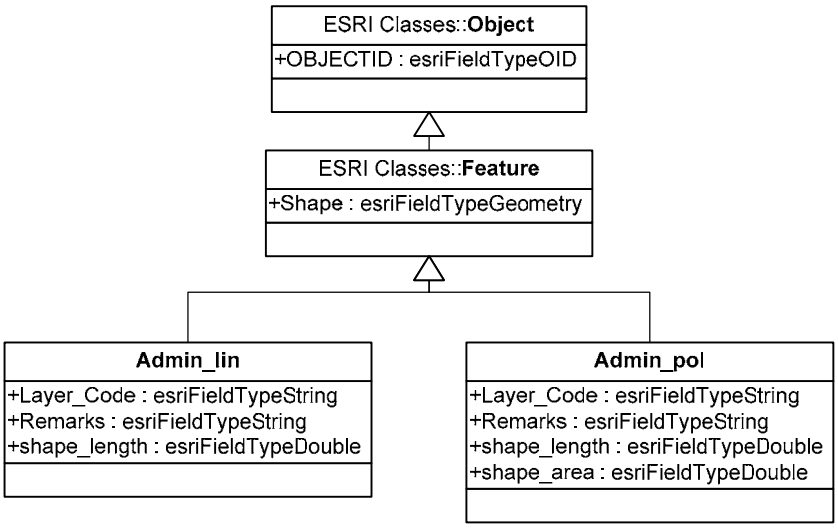


Figure 4.5.10 UML model of Boundary Package

Table 4.5.7 List of GIS data for Boundaries

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Admin_lin	Polyline	1110			State Boundary
		1103			Boundaries of autonomous republic
		1111			Boundaries of national reservation

Feature Class	Geometry	Layer_Code	Elevation	Remarks	Description
Admin_pol	Polygon	1110			State Boundary
		1103			Boundaries of autonomous republic

		1111			Boundaries of national reservation

The following table presents the coordinate system of this database.

Map Projection:	UTM
	Zone 38
Referenced Spheroid:	WGS 84
Map Unit:	Meter
Data Unit:	Map sheet (20' X 12')

In creating GIS data, errors listed below were examined with extra attention, in order to assure data quality.

- Node error（mainly dangle nodes）⇒ By software or visual check

This error was not permissible in polygon data. On the other hand, line data had such an error as an exception at the location of dead-end streets.

- Presence of data topology ⇒ By software

It was checked if line data, polygon data and point data constructed line topology, polygon topology and point topology respectively.

- Matching to the adjacent map sheets ⇒ By visual check

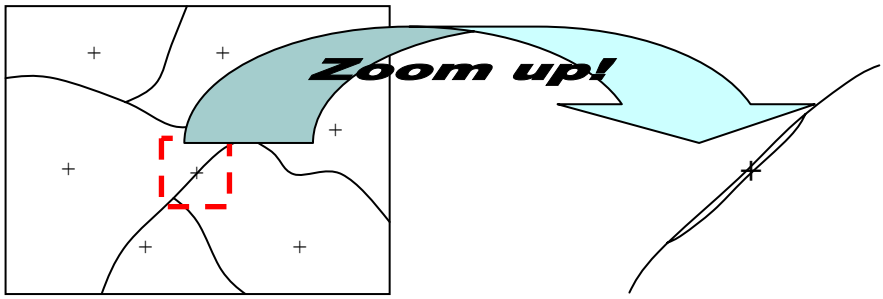
The data continuity among neighboring map sheets was checked.

- Code number ⇒ By visual check

It was checked if there was any input error of codes in individual data.

- Sliver polygon（polygon data only） ⇒ By visual check

Unnecessary sliver polygon data may exist, formed by the surrounding line(s) forming a polygon and unnecessary line(s).



<example of visual check for errors>