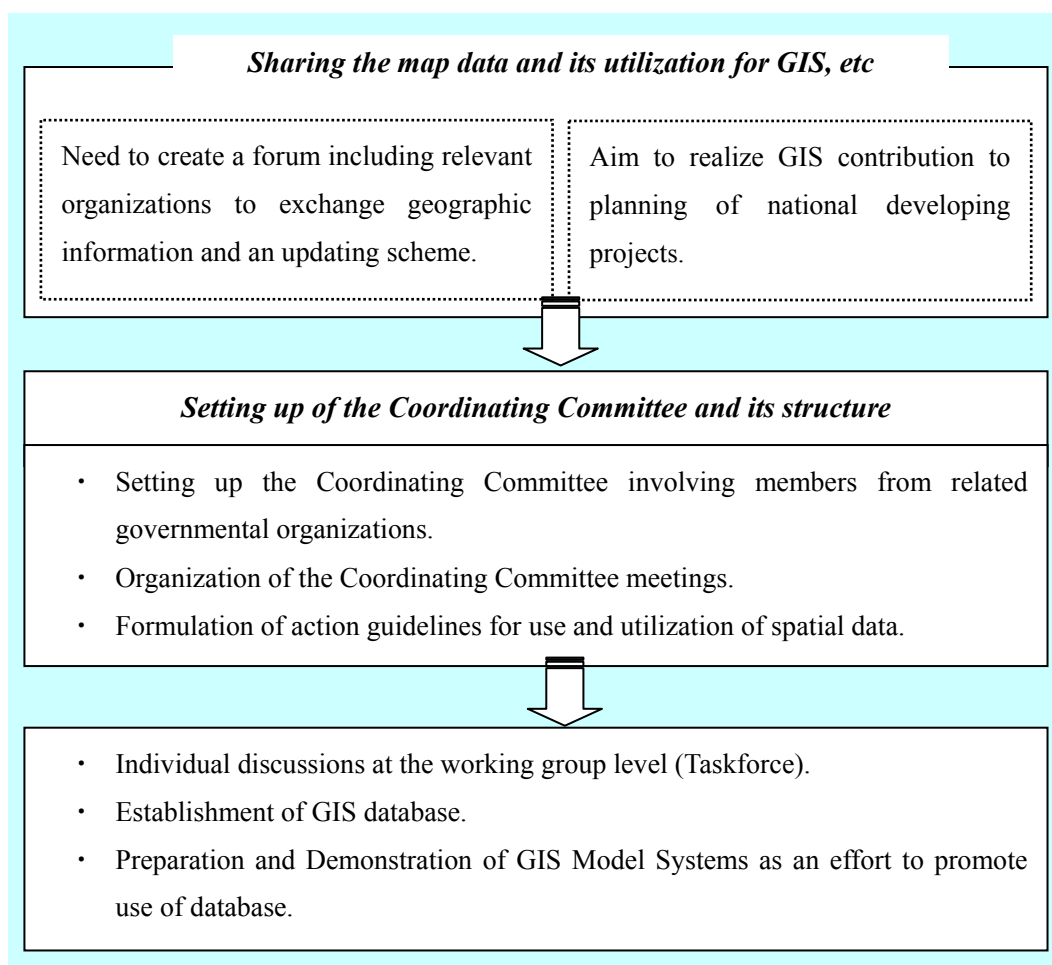# Chapter 5.   Construction of GIS model systems

5.1.   Setting up and Managing the Coordinating Committee

The newly created digital topographic map data with the scale of 1:50,000 will expectedly contribute greatly to political decision-making in Georgia's land development and preservation for not only the GCGS but also for all the other ministries.   Hence, promotion for effective use of the data is highly expected.   For this purpose, a Coordinating Committee, an advisory body on the mechanism of schematic expansion and promotion of the data use, was established as a part of assistance activities of this Project.   This Coordinating Committee is expected to play a central role in leveraging geographic information for facilitating the national-level development programs in each field, refer to Figure 5.1.1.

Sharing the map data and its utilization for GIS, etc

Need to create a forum including relevant organizations to exchange geographic information and an updating scheme.

Aim to realize GIS contribution to planning of national developing projects.

Setting up of the Coordinating Committee and its structure

- Setting up the Coordinating Committee involving members from related governmental organizations.
- Organization of the Coordinating Committee meetings.
- Formulation of action guidelines for use and utilization of spatial data.

- Individual discussions at the working group level (Taskforce).
- Establishment of GIS database.
- Preparation and Demonstration of GIS Model Systems as an effort to promote use of database.

Figure 5.1.1   Coordinating Committee and its Activities

The government of Japan has designated six priority fields to provide assistance for Georgia. These six fields and the corresponding counterpart organizations in the government of Georgia are listed in Table 5.1.1.

Table 5.1.1   Priority Fields and Corresponding Governmental Organizations

Priority Field of Assistance by Japan	Counterpart Organization (Ministry/Agency)
Infrastructure refurbishment and development	Ministry of Economic Development
Forest management/conservation projects	Ministry of Environment Protection and Natural Resources
Tourism development	Ministry of Environment Protection and Natural Resources Ministry of Culture, Monument Protection and Sport
Democratization through land reform	Ministry of Justice Ministry of Environment Protection and Natural Resources
Refugee assistance	Ministry of Refugees and Migration
Map usage in elementary education	Ministry of Education and Science

Thus, the members from all the above governmental organizations have been included in the established Coordinating Committee. This Committee has held gatherings from time to time and prepared minutes of the meetings accordingly. These minutes available so far are attached hereto. During the Project period, the Coordinating Committee's meetings have been held five (5) times (refer to Table 5.1.2), where, upon explanation about the significance of GIS technology, the importance of GIS Models in promoting the effective use of geographic spatial data has been presented. Also, the discussions regarding the formulation of GIS Models have been carried out making them to understand about the nature of GIS Models.

Table 5.1.2   Coordinating Committee Meetings held during the Project Period and the Agenda Thereof

Meetings	Date & Venue	Chairman of Meeting	Agenda
1st Coordinating Committee meeting	May 6, 2005 (Hotel Primavera)	Givi Kekelidze	Initiatives for the Coordinating Committee to create GIS model systems for effective use of topographic data to be newly prepared
2nd Coordinating Committee meeting	July 1, 2005 (DGC Meeting room)	Givi Kekelidze	Overall summary for the first stage of choosing themes for GIS model systems
3rd Coordinating Committee meeting	August 3, 2006	Irakli Lejava	Finalization of themes for GIS model systems
4th Coordinating Committee meeting	February 7, 2007 (MEPNR Meeting room)	Irakli Lejava	Progress about the Creation of GIS model systems
5th Coordinating Committee meeting	May 30, 2007 (MEPNR Meeting room)	(Hisashi Mori) *for* Irakli Lejava	Progress about the Creation of GIS model systems, schedule for this year's work.

In order to make the Coordinating Committee fully function, a working organization to implement the points decided in the Committee meetings was needed. For this purpose, taskforces consisting of personnel at the working level from related ministries and agencies were formed to generate GIS databases and implement specific actions with regard to the use of such databases. Thus, with a view to establishing a thorough scheme covering from generation and maintenance of GIS data to operation of model system applications, the Study Team assisted and advised the Georgian counterparts in terms of both management and technology.

5.2.   Creation of GIS Model Systems

With the aim of presenting the capabilities of Topographic data produced under this Project, six (6) GIS Models have been created.   Its general flow-chart is presented below in Figure 5.2.1.
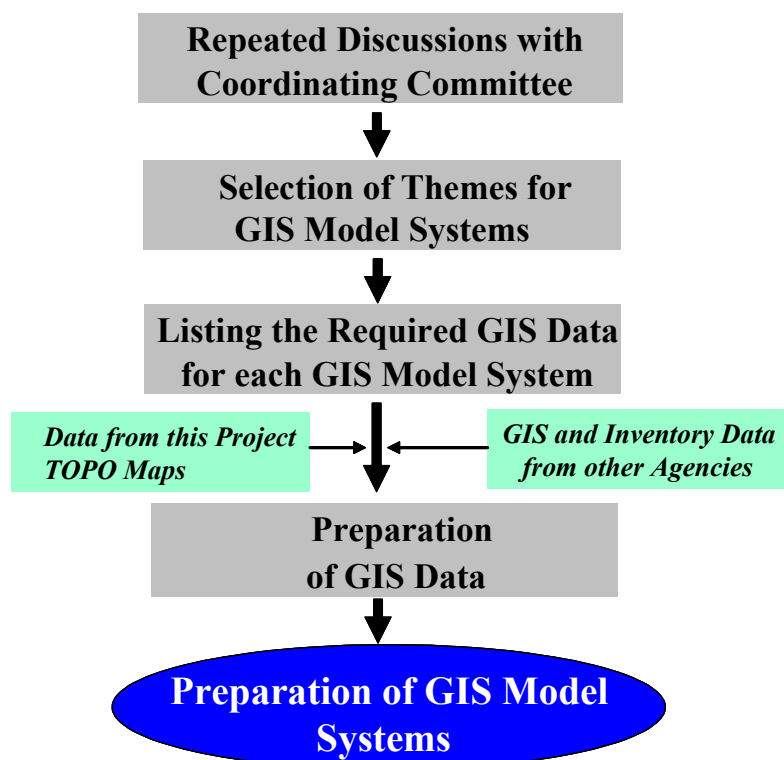

Figure 5.2.1   Flow-chart showing Steps in Creating the GIS Model Systems

In brief, with the repeated discussion with Task force members of the established Coordinating Committee, themes for the GIS Model Systems were selected.   Then, after listing the required GIS data for each model, their preparation was carried out, which besides of data from this Project Topographic maps, also included some data possessed by other agencies.   Lastly, the GIS Model Systems were prepared.   This Chapter includes description of these steps as separate sections.

5.3. Selection of Themes for GIS Model Systems

Through repeated discussions with the members of individual taskforces set up under the Coordinating Committee, themes and topics that each organization was willing to prioritize, were narrowed down. At the same time, GIS model areas best suited to these themes were selected.

Table 5.3.1   Model Area and Theme for each GIS Model

S.N.	Organization in charge	Ministry	Main Theme for GIS Model	Model Area
(1)	Department of Urbanization and Construction	Ministry of Economic Development	Fundamental information to be used for urban planning	*Greater Tbilisi*
(2)	Department of Forest Management	Ministry of Environment Protection & Natural Resources	Forest management for conservation and reforestation	*Zestaphoni*
(3)	Department of Protected Areas	Ministry of Environment Protection & Natural Resources	Prevention from human disturbance	*Kutaisi North*
(4)	Department of Tourism and Resorts	Ministry of Economic Development	Developing cultural resources for promoting tourism	*Borjomi/ Bakuriani*
	Department of Cultural Heritage	Ministry of Culture, Monument Protection and Sport	Developing cultural resources in need for tourism promotion	*Borjomi/ Bakuriani*
(5)	Land Management Service	Ministry of Environment Protection & Natural Resources	Appropriate land use allocation after land privatization	*Mtskheta*
(6)	Department of Policy Making and Strategy	Ministry of Education and Science	Offering useful information on educational facilities including human resources	*Tblisi*

In accordance with the main themes of individual organizations quoted as above, the name of GIS model systems along with best suited location were decided as follows:

> *(1)* **GIS Model for Urban Development** *(Greater Tbilisi)*
>
> *(2)* **GIS Model for Forest Management and Reforestation** *(Zestaphoni)*
>
> *(3)* **GIS Model for Facilitating Environmental Protection** *(Kutaisi North)*
>
> *(4)* **GIS Model for Enhancing Possibility of Developing Tourism**
>   *(Borjomi/Bakuriani)*
>
> *(5)* **GIS Model for Optimization of Agricultural Land Use** *(Mtskheta)*
>
> *(6)* **GIS Model for Contribution to Information of Educational**
>   **Improvement** *(Tbilisi)*

The location map for each of GIS Model System is presented below in Figure 5.3.1.
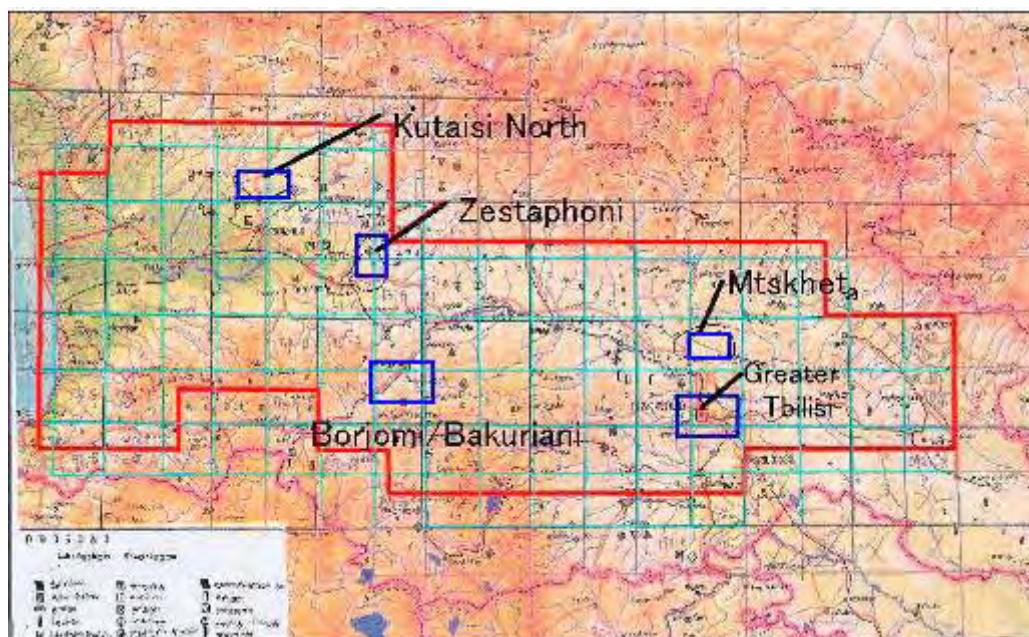
Figure 5.3.1   Location and Guide Areas of Each GIS Model

5.4.   Preparation of Database for GIS Model Systems

Considering the data source, basically two types of GIS data were created for the GIS Models.   One type was that generated for topographic maps prepared under this Project, such as contours, roads, rivers, vegetation, etc.   Another type was that collected from the related organizations such as soil, forest including its inventory, statistics of educational facilities, etc.

For the creation of these GIS layers all sorts of cooperation were obtained from the counterpart personnel and members of the taskforces.   The Study Team tried to work together with all of them to the possible extent.   The taskforce members contributed not only by providing data but also devoting their precious time to explain the nature and details of the data.   Also, they helped obtain the data from the other related organizations.   These all resulted in frequent communication with the taskforce members helping transfer the technology to them.

5.5.   Items and Methodology of Preparing GIS Model Systems

Each GIS model system is equipped with three (3) sub-models.   Each sub-model contains all the steps from the start to the end regardless of some of steps included in

the previous sub-model(s). Thus, during the presentation, if the condition arises, even individual sub-model can be presented to the client(s).

5.5.1. GIS Model for Urban Development (Greater Tbilisi)

- **Purpose:** To serve as guidelines for formulating master plans of different land use types such as:
  - Reallocation of settlements
  - New development avoiding areas prone to disaster
  - More reasonable Road Network
- **Analysis summary:** This model has evaluated the land use suitability that is conducible to restriction and guidance for future urban developments.
- **Main Data used:** As presented in Table 5.5.1

Table 5.5.1   List of Used Major Data in this GIS Model System

Data Name	Source	Created by	Reference Data
Land Use, Contour line and Spot height, Road and Railway data, river	New Topographic Map	JICA Study Team	
Existing Land Use	Tbilisi Municipal Office (Urban planning Div.)	Tbilisi Municipal Office (Urban planning Div.)	

- **<u>An Example of Outstanding Result:</u>** Potential area for settlement expansion and new alignment for road development (as shown in Figure 5.5.1).
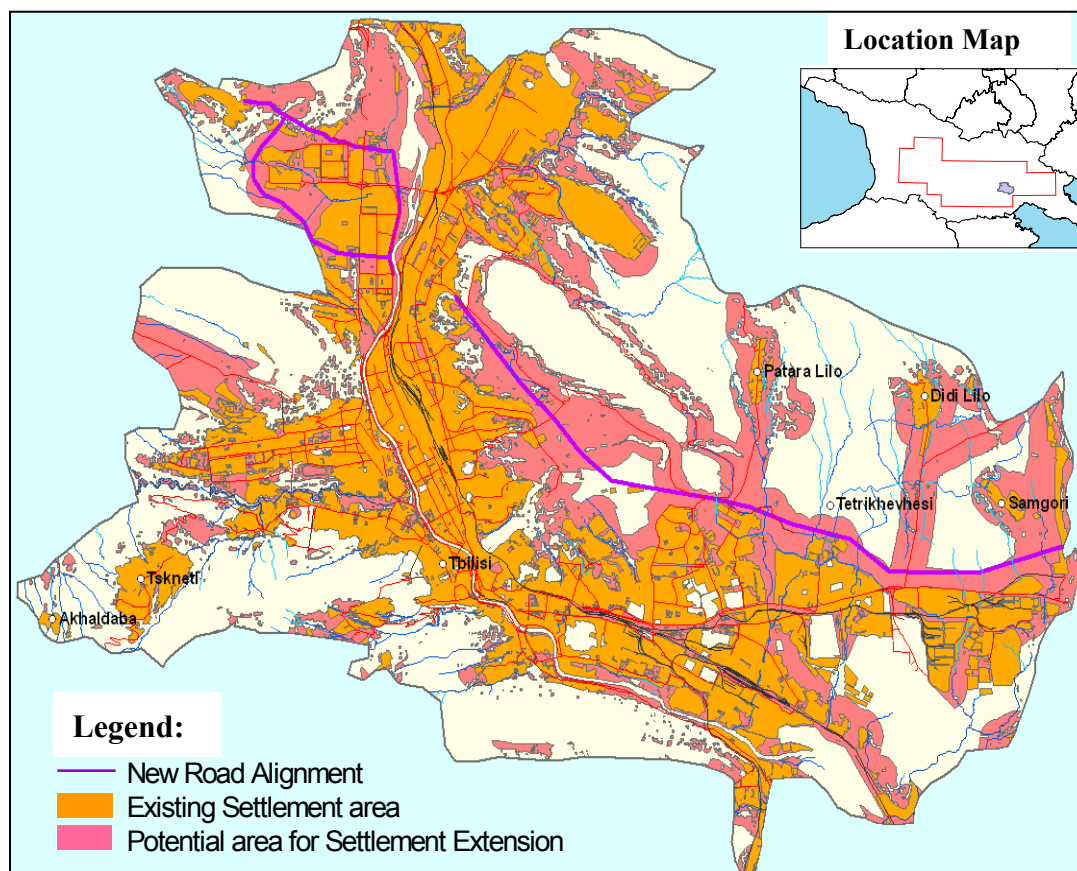
Figure 5.5.1   Potential Area for Settlement Expansion and Alignment for New Road Development

5.5.2. GIS Model for Forest Management and Reforestation (Zestaphoni)

- **Purpose:** To serve as guidelines for generating forest management programs with consideration given to ecology and potentiality of land use, including topographic features, for the purposes of planned and scientific forest conservation and reforestation.

- **Analysis summary:** It has analyzed forest vegetation types by indexing its preciousness, ease of reforestation, danger of deforestation, accessibility, etc.

- **Main Data used:** As presented in Table 5.5.2

Table 5.5.2   List of Used Major Data in this GIS Model System

Data Name	Source	Created by	Reference Data
Land Use, Contour line and Spot height, Road and Railway data, river	New Topographic Map	JICA Study Team	
Addition of Forest categories in Land Use	New delineation	JICA Study Team	New Aerial Photographs
Forest map along with attribute data (forest density, age, tree species and average height) as of 1993	As Paper map and Record book from Department of Forest Management	JICA Study Team	

● **An Example of Outstanding Result:** Forest conservation status between 1993 and 2005 (as in Figure 5.5.2).
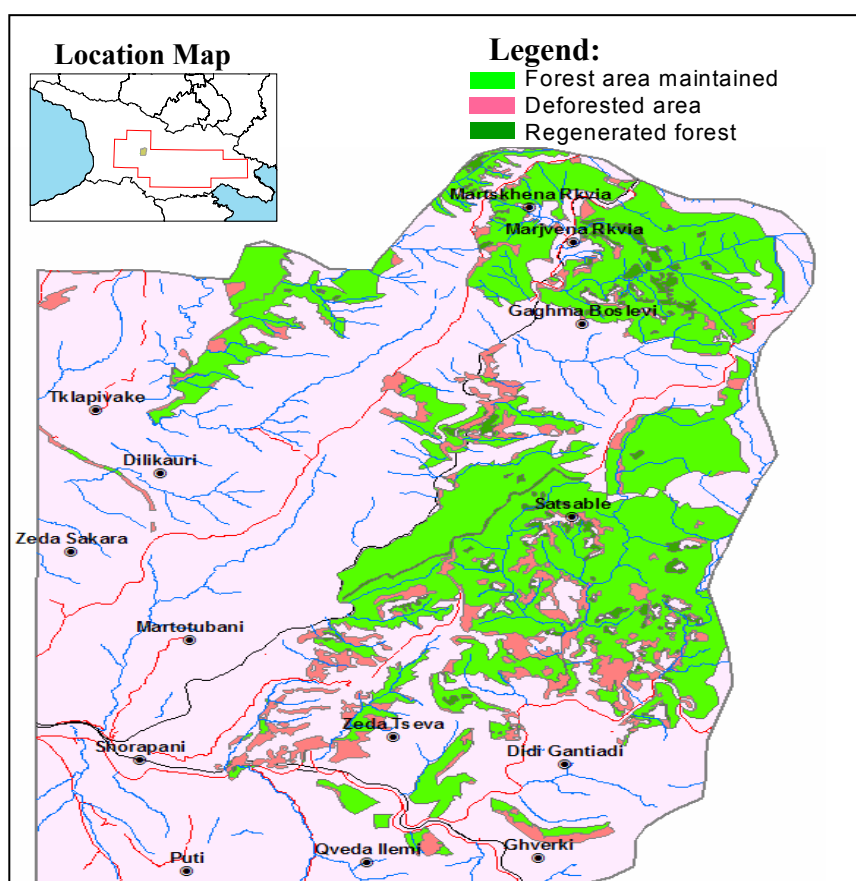
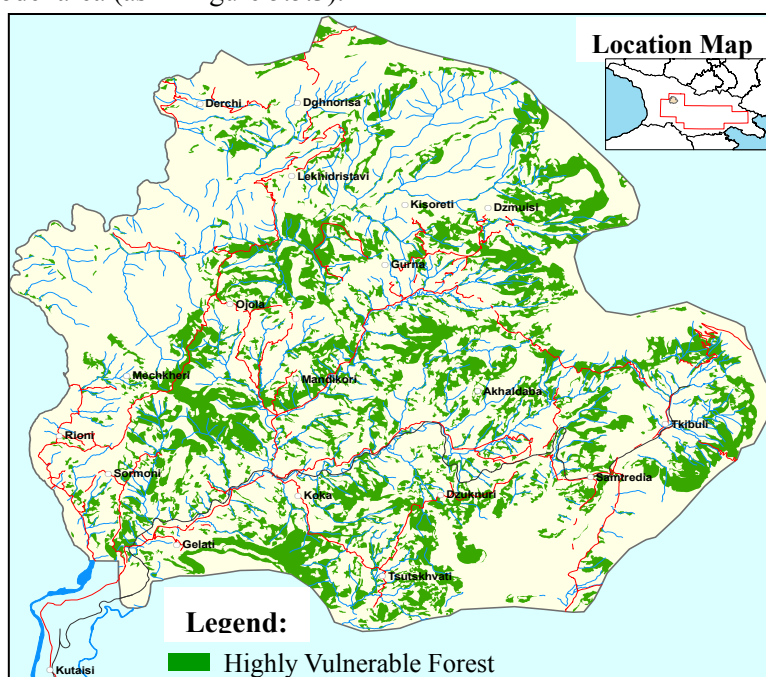**Figure 5.5.2   Forest Conservation Status between 1993 and 2005**

5.5.3. GIS Model for Facilitating Environmental Protection (Kutaisi North)

- **Purpose:** To identify areas to be protected for conserving the ecosystem and valuable nature for drawing boundaries such as natural park zone conserved areas, etc.

- **Analysis details:** classification of forest vegetation and then overlapping with human and natural factors to which they are susceptible

- **Main Data used:** As presented in Table 5.5.3

Table 5.5.3   **List of Used Major Data in this GIS Model System**

Data Name	Source	Created by	Reference Data
Land Use, Contour line and Spot height, Road and Railway data, river	New Topographic Map	JICA Study Team	
Addition of Forest categories in Land Use	New delineation	JICA Study Team	New Aerial Photographs
Forest map along with attribute data (forest density, age, tree species and average height) as of 1989	As Paper map and Record book from Department of Forest Management	JICA Study Team	

- **<u>Example of Outstanding Result:</u>** Showing the highly vulnerable forest in Model area (as in Figure 5.5.3).

**Figure 5.5.3**   **Highly Vulnerable Forest in the Model Area**

5.5.4. GIS Model for Enhancing the Possibility of Developing Tourism(Borjomi)

- **Purpose:** To serve as guidelines for development of tourism resources in order to facilitate utilization of cultural heritage, historical sites and natural treasures for tourism and utilization of natural landscapes as tourism resources.

- **Analysis details:** It has assessed the use potentiality as tourism resources of relics, natural treasures and natural resources including landmarks, remarkable topographic features, and areas with attractive vegetation, by overlapping them with tourist route, accommodation, and other facilities.

- **Main Data used:** As presented in Table 5.5.4

Table 5.5.4   List of Used Major Data in this GIS Model System

Data Name	Source	Created by	Reference Data
Ortho photo, Road and Railway, Ropeway, Hospital, River	New Topographic Map	JICA Study Team	
Tourist route, Shelter loation, Historical site along with description, Mineral spring site, Ski school, Hotel, Borjomi National Park	Department of Cultural Heritage	JICA Study Team	

- **<u>An Example of Outstanding Result:</u>** Showing possible extension of Tourist route with new additional route in the Model area (as in Figure 5.5.4).

Figure 5.5.4   Possible Extension of Tourist Route

5.5.5. GIS Model for Optimization of Agricultural Land Use (Mtskheta)

- **Purpose:** To contribute to demarcation of preferable land use by assessing the land use potentiality for cultivated land, grass field and waste land, in order to guide proper use of privatized and as a result of land reform. Moreover, it will facilitate, such as:
  - ・ To find out the land to be used more extensively for agricultural yield.
  - ・ To chose the best crops suitable for each farm land.
  - ・ To avoid development of settlements in the area suitable for agriculture.
- **Analysis details:** This model has analyzed Land ownership status and terrain conditions of existing agricultural land and land suitable for potential agricultural development.
- **Main Data used:** As presented in Table 5.5.5.

Table 5.5.5   List of Used Major Data in this GIS Model System

Data Name	Source	Created by	Reference Data
Land Use, School Contour line and Spot height, Road and Railway data, river	New Topographic Map	JICA Study Team	
Soil, Land Ownership	Service of Land Management	JICA Study Team	

- **<u>An Example of Outstanding Result:</u>** Demarcating the land potential for agricultural development (as in Figure 5.5.5).
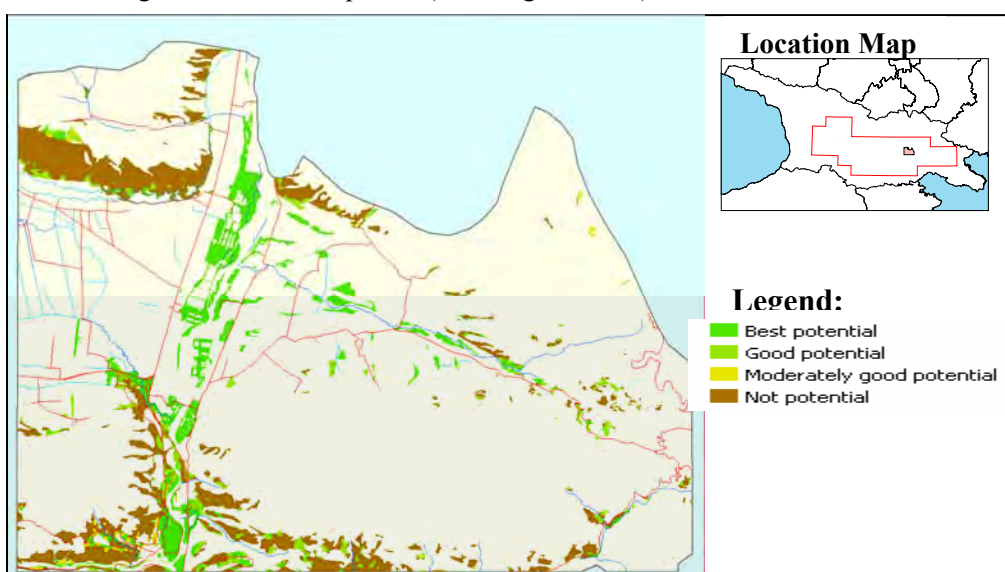
Figure 5.5.5   Potential Land for Agricultural Development

5.5.6. GIS Model for Contribution to Information of Educational Improvement (Tbilisi)

- **Purpose:** To contribute to search systems for the current sufficiency of educational facilities that is conducible to improvement in regional primary educational environments.

- **Analysis summary:** Along with comparison of available schools and their facilities among the districts of Tbilisi City, this model also includes comparative analysis for these facilities as well as accessibility between a district of Tbilisi City and a district in Imereti region highlighting the current sufficiency of educational facilities.

- **Main Data used:** As presented in Table 5.5.6.

Table 5.5.6   List of Used Major Data in this GIS Model System

Data Name	Source	Created by	Reference Data
Land Use, Contour line and Spot height, Road and Railway data, river	New Topographic Map	JICA Study Team	
Administration boundary, Attribute data of schools,	World Bank Project under Minstry of Education and Science	World Bank Poject	

- **An Example of Outstanding Result:** Such as presenting the ratio of students per teacher in each district of Tbilisi (as in Figure 5.5.6).
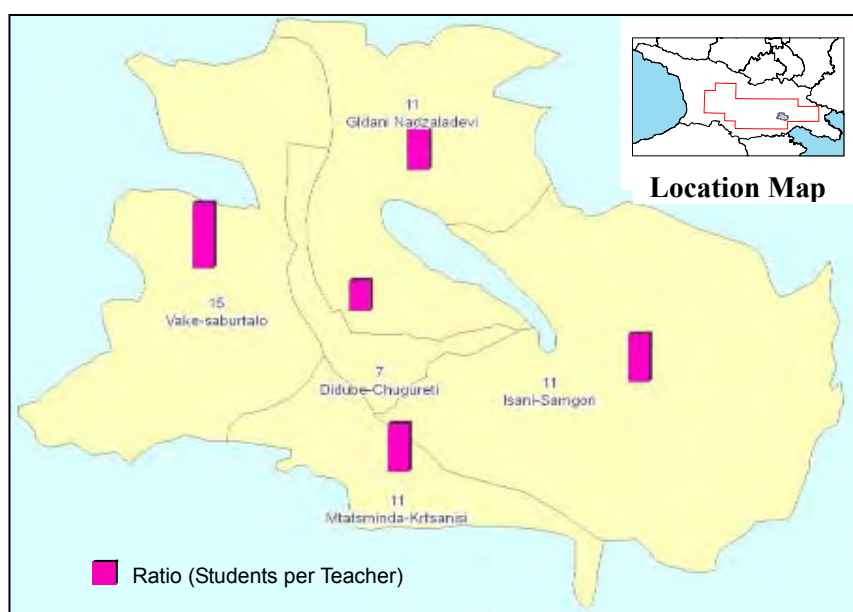
Figure 5.5.6   Ratio of Students per Teacher in each District of Tbilisi

5.6.   Prospects of use of GIS Models

The above prepared GIS Model Systems well reflect the capability of GIS data by presenting some of results as example.   These Models were presented to users in Seminar held in February, 2008.   Besides this, the Study Team is confident that the presentation of these Models in other occasion in future will also be very useful in publicizing the spatial data created under this Study.

As mentioned earlier, throughout the Creation of GIS Model Systems, consultation and discussion was carried out with Task force member as much as possible.   The Study Team presented the model to the related Task force members individually.   Also, the Study Team tried to guide them about some of related operations in ArcGIS.   Thus, the Study Team believes that Task force members do understand about these Models and can present them on other occasions in the future.

However, with the varying levels of understanding about GIS system among the Task force members, to modify these prepared GIS models or to create new models right from scratch, their more understanding regarding GIS System including ArcGIS Software will be required.

In short, for the Task force members, following challenges must be considered earnestly:

- During data creation stage, the task force members could not get involved in the actual work of creating the basic map data except for some organizations due to lacking of fundamental knowledge regarding its compiling.
- Thus, to fulfill the merit of the GIS Models, firstly they should train themselves in conducting preparation of the thematic map.
- As they are lacking with the practice of the ArcGIS, it is hoped that after getting the Hardware and ArcGIS Software from this Project, they will do so by making effort to train themselves along with prepare some sample of GIS Models.
- By making abundant efforts as the mentioned above, it is hoped that technical level of members will be gradually upgraded to the professional one and that will work practically in their daily work.

It should be noted that to create application at data users' level, additional spatial data will be required and even this latest data will be required to be updated at regular

interval of time.   Moreover, the type of required additional data will depend upon the field for which the application will be created.   Some examples of such additional data useful to create application in the following fields are listed below:

i)   **Urban Development**: For Tbilisi, the data such as transport facilities and load of transport during various hours of day may be necessary.   Similarly, for other cities additionally the latest data of settlement will be required to incorporate.

ii)   **Forest Management and Reforestation**: Updated detail forest map.

iii)   **Facilitating Environmental Protection**: Updated detail forest map and natural condition such as habitat of wild animals.

iv)   **Enhancing and Developing Tourism**: Additional and latest tourist resources and facilities

v)   **Agricultural Development**: Detailed soil classification map, latest ownership status, and others.

vi)   **Educational Improvement**: Introduction of simple small scaled map to make students its importance.

Chapter 6. Technology Transfer

6.1. Items for Technology Transfer

6.1.1. OJT

The Study Team submitted a "Technology Transfer Detailed Plan" to the former DGC, and discussed the contents of OJT in more detail. According to the detailed plan, the technical transfer items in the form of OJT were as follows in the 1st year, the 2nd year and the 3rd year respectively.
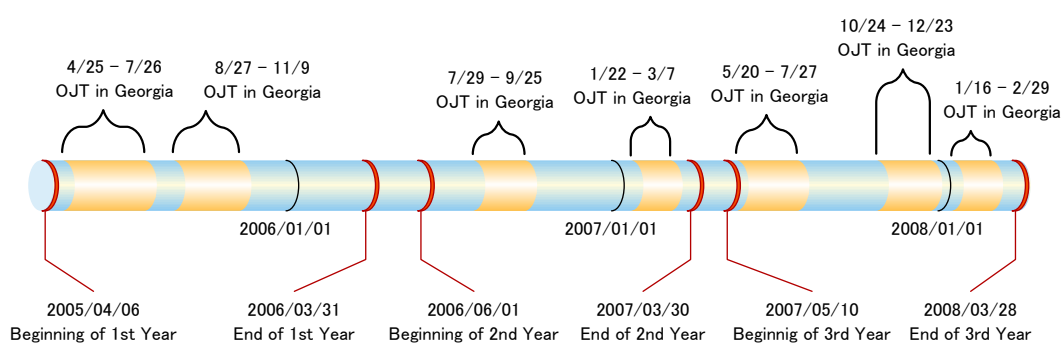
(1) OJT during the first work in Georgia (2005, 1st year)

- Ground control survey (including pricking and GPS analysis)
- Digitization of existing map
- Field verification
- Map symbolization
- Aerial triangulation
- GIS introduction

(2) OJT during the second work in Georgia (2006, 2nd year)

- Stereo digital mapping and compilation
- Revision of existing topographic maps
- GIS structure definition
- Creation of GIS database

(3) OJT during the third work in Georgia (2007, 3rd year)

- Field completion
- Creation of GIS database

● OJT for creation and use of GIS model system

6.1.2. Training in Japan

On the other hand, the counterpart training, in the form of seminars, was carried out in Japan to deepen the understanding of technologies trained throughout the OJT.

Originally four officials, senior engineers and chief specialists, were scheduled to attend the counterpart training in Japan, which was planned as Technology Transfer Seminar I. Unfortunately, however, only two chief specialists, listed below, were able to participate due to the reorganization of the department.

Ms. Sedae Nizhaladze   Chief Specialist in Cartography Section
Mr. Tedo Gorgodze   Chief Specialist in Geodesy and Cartography Section

The above two trainees stayed in Japan between November 14th and December 9th, 2005 for training. In addition to technology transfer practices, the trainees were also provided with an opportunity to visit the following organizations to acquire knowledge and information on the advanced situation in Japan helpful for planning measures on management and utilization of geographic information. Except for the visits to the following places, the training schedule, lectures and exercises for technology transfer were basically held at the International Engineering Department, Overseas Division of Pasco Corporation.

➢ **Geographical Survey Institute:**   Roles of a national institute in creating maps and the current status of technical development

➢ **Japan Map Center:**   Current status of activities related to promotion, sales, management, etc. of geographic information.

➢ **Asia Disaster Reduction Center:**   Current status of the latest disaster-prevention technologies that use geographic information.

➢ **Disaster Reduction and Human Renovation Institution:**   Tour for case examples.

6.2. On-the-Job Training

6.2.1. OJT for Ground Control Survey

(1) Landmark installation

A total of 35 points of white-painted landmark that was composed of rectangles (3m x 1m) made of stones, wood panel or suitable materials were installed before shooting of aerial photograph. The geodetic staff of the former DGC had executed the installation of the landmark according to the following requirements by the guidance of the Study Team.

    a) Put a landmark on the open areas such as the park, the school, the church, the sports ground, private garden, flat roof of a building, top of the hill, grass land and so on.

    b) A high building or trees in the surroundings must not conceal the landmark for taking aerial photograph.

    c) Obtain the necessary approval from stakeholders if any on the site before setting up a landmark.

    d) The landmark should not become obstructive for the traffic of vehicle and person.

    e) Do not choose the place in the dread of damages by the domestic animals.

    f) Choose the terrain that maintains ground as flat as possible.

    g) Do not choose a dry bare land for setting up landmarks as long as you can, such as sandy area, because the halation occurs easily on that condition.

    h) Set up a temporary benchmark at the centre of the landmark for GPS observation.

    i) Keep the shape condition of the landmark for about one month until the aerial photography work comes to complete.

(2) Photo control point survey

Photo control point survey by using GPS was executed for the entire landmark centers by independent work of the former DGC engineer. There was no necessity of the technology transfer in terms of GPS observation because of their matured skills.

(3) Leveling

The operational method in manipulating an electronic level, which was granted by JICA, was instructed in the room and the field as the counterpart personnel had no

prior experience to operate the machines.

(4) Preparation of point description

The format of point description sheet used in Japan as a standard was shown for the creation of point descriptions to the former DGC counterparts.

They learned the skill of forming the new point descriptions with a computer.

Figure 6.2.1   Scene in creating point description

6.2.2. OJT for Filed Verification and Completion

(1) Field verification

  a) Techniques for predictive interpretation with the use of "semi control orthophotos" as well as photo interpretations with stereoscopes and existing maps

  b) Methods to record the results while referring to the position information obtained by handy GPS

  c) Actual work of field verification has been mentioned in section 4.4.1.

Predictive interpretation   Referring position by handy GPS

Figure 6.2.2   Scene in OJT for field verification

(2) Field completion

Most field staff, who was listed in section 4.4.2, did not have sufficient experiences for conducting field completion. Therefore, before getting too far in field completion, the Study Team carried out training of field completion in the suburbs of Tbilisi including all of them for 2 days with manual that the Study Team had prepared in advance.

Main contents were as below.

a) Techniques for identification of own location by using maps, a Handy GPS and/or a compass in the field.

b) Techniques for utilization car's trip meter in order to reach around destination.

c) Know-how of field completion for 1:50,000 scale topographic map

d) How to note corrections on draft topographic map

Know-how of field completion   Noting correction on a map

Figure 6.2.3   Scene in OJT for field completion

6.2.3. OJT for digital plotting (Vectorization; for internal verification)

Technology transfer on digital plotting was carried out in two phases, Phase-1 from August to September 2006 and Phase-2 from January to March 2007, after the introduction of necessary equipment in the 2nd year.

i) Phase-1

The Phase-1 OJT covered digital plotting and compilation techniques, targeting the following five officials in charge of digital plotting of new maps and employing a digital photogrammetric system, LPS (Leica Photogrammetry Suite), which was introduced in August 2006.

The major contents of the technology transfer included 1) creation of virtual 3D space

and aerial triangulation; 2) automatic generation of DTM and contour lines together with interactive compilation for each; and 3) plotting of ground features（feature extracting）.

＜OJT staff＞

Mr. Zaza Mdzeluri
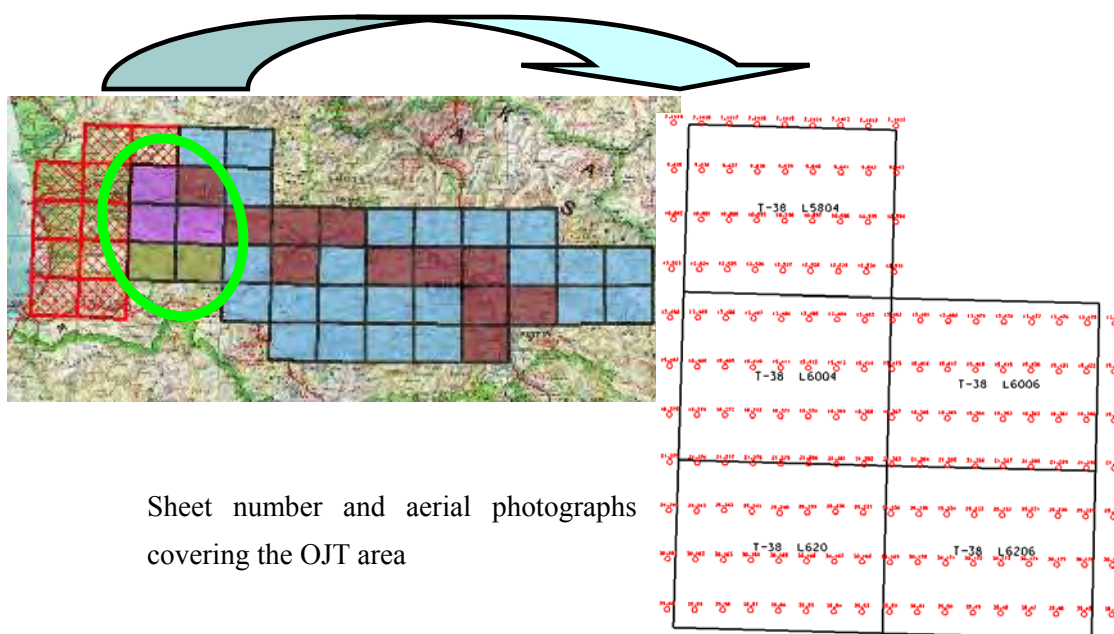
Mr. Otar Demetrashvili

Ms. Galina Matchabeli

Ms. Bela Chalauri

Ms. Maka Devidze

Figure 6.2.4   Technology transfer on digital plotting using the digital photogrammetric system

The range and area included in the OJT were for three map sheets, totaling to 1,800km^2, as shown in Figure 6.2.5.

Sheet number and aerial photographs covering the OJT area

Figure 6.2.5   Map sheets adopted for OJT in digital plotting

The following equipment and materials were used in the OJT.

Table 6.2.1   Equipment and Materials Used in the OJT for Digital Plotting

Equipment & Materials	Type and/or name	Notes
Hardware (Digital photogrammetric system)	LPS(Leica Photogrammetry Suite)	Digital mapping system
	Leica Photogrammetry Suite Automatic Terrain Extraction	LPS ATE
	Leica Photogrammerty Suite Terrain Editor	LPS TE
CAD Software	MicroStation	Data compilation
GIS Software	ArcView	Data compilation
Input data	Scanned aerial photographic data	1:40,000 resolution:20 μ m
	Camera calibration data	
	Results of aerial triangulation	PAT-B format
Reference	Specification for digital topographic data acquisition	Table for criteria for feature extraction
	Raster images from existing paper maps	With world file
	Results of field verifications	For photo interpretation

ii) Phase-2

In addition to the works conducted in the Phase-1 OJT, in Phase-2, the trainees tried to create ortho photos using the DTM data prepared during the preceding OJT. As for data compilation, the trainees checked and corrected the contents of map interpretation and expression of symbols on the vector data newly plotted and performed data cleanup, using MicroStation and ArcGIS (ArcView).

(2) Details of technology transfer at each Phase

The technology transfer with regard to aerial triangulation, digital plotting and data compilation was carried out based on the following work flow.

```
┌─────────────────────────────────────────────┐
│   Aerial triangulation (Used module: LPS)    │
└─────────────────────────────────────────────┘
                      │
                      ▼
┌─────────────────────────────────────────────┐
│  Generation of DTM & orthophotos (LPS ATE, TE) │
└─────────────────────────────────────────────┘
                      │
                      ▼
┌─────────────────────────────────────────────┐
│      Digital plotting (LPS, PRO600)          │
└─────────────────────────────────────────────┘
                      │
                      ▼
┌─────────────────────────────────────────────┐
│ Data compilation (MicroStation GeoGraphics, ArcView) │
└─────────────────────────────────────────────┘
```
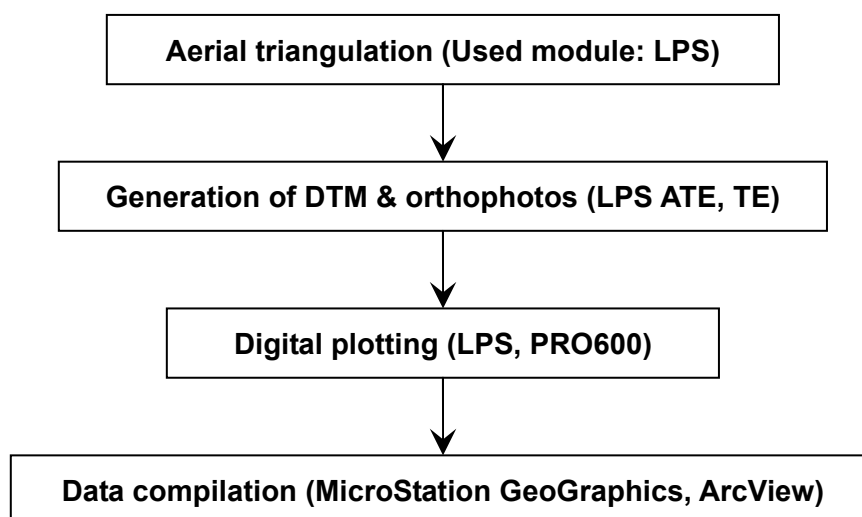
Figure 6.2.6   Work Flow of Digital Plotting and Compilation in the OJT

The following describes each work covered in the OJT in depth.

(3) Aerial triangulation

Technology transfer of aerial triangulation was scheduled for January to March 2007, due to the conditions surrounding the equipment to be delivered. The details of OJT were as follows:

● Creation of camera files and data files of ground control points
● Inner orientation
● Observation of pass points and tie points

- Observation of control points
- Adjustment computation

(4) Generation of DTM and orthophotos

Elevation data for Digital Terrain Models (DTMs) was automatically extracted using the LPS ATE, followed by interactive compilation of the terrain data using the LPS TE. In addition, the DTMs were used to rectify distortions in aerial photos thereby creating orthophotos.   The details of OJT were as follows:

Generation of DTM

Elevation data was automatically extracted from a pair of images using LPS ATE (AutomaticTerrain Extraction), to automatically generate DTMs with a 20m grid interval.   The parameters adopted in generating DTMs were based on topographic feature types, such as flatland, hills, mountainous areas, etc., or ground feature types, such as building crowds, forests, etc.   Further, depressions and protrusions due to errors were removed through filtering.

DTM compilation

Generally speaking, it is difficult to automatically extract topographic data of heavily-shaded areas or forests, waters, and those other areas that would appear differently on different photos.   Hence, topographic compilation was performed by expressing terrain data where the accuracy of automatic image matching was low in three dimensions in a stereoscopic observation environment using the LPS TE (Terrain Editor).

Generation of orthophotos

Aerial photos are accompanied with geometric distortions caused by the attitude of the camera and height differences in the terrain.   In order to eliminate such distortions and produce image data (ortho photos) with geographical accuracy, the images were orthorectified using the DTMs created with the LPS ATE/TE.   The pixel size was set as a GSD（Ground Sample Distance）of 80cm, equivalent to the scanning resolution of the aerial photos.

(5) Digital plotting

Using the LPS PRO600, the method of acquiring 3D ground feature data was

instructed as follows. In addition, the contour lines, namely index (100m) and intermediate (20m) lines, were first created in an automated manner from the DTMs generated using the LPS ATE/TE and compiled in three dimensions by superimposing contour line data onto stereoscopic data for stereoscopic observation using LPS and PRO600.

The trainees were trained on the acquisition of digitized data（roads, railways, waters, buildings, villages, vegetation, vegetation boundary, contour lines, elevation control points）, based on the precautions listed up in the attached technology transfer manual.

6.2.4. OJT for Updating of the existing map

Updating the existing map data started with digitization of existing paper maps as necessary.

Technology transfer regarding digitizing was provided to five staff members responsible for digitization using the ArcGIS (ArcView) software introduced.

＜OJT staff＞

Mr. Zaza Mdzeluri
Mr. Otar Demetrashvili
Ms. Galina Matchabeli
Ms. Bela Chalauri
Ms. Maka Devidze

i) Phase-1

Prior to OJT, a few out of the five trainees had some experience in digitizing with ArcGIS. Accordingly, the training commenced directly with OJT, skipping an explanation on fundamental elements about the software.

However, since they did not have sufficient knowledge on coordinate indexing of raster data, which is closely related to digitization work (head-up digitizing), the five officials underwent a separate session on indexation of geographical coordinates on raster data, which was conducted as a part of the technology transfer pertaining to structuralization (to be explained later).

The included ground features roads, railways, electric transmission lines and vegetation.

The digitization work was carried out on the conditions that the display on the monitor

should be zoomed in to approximately 1:6,000 in the light of data quality and that the interval between vertices on vector data was at least 10m in actual distance. These rules enabled to minimize differences with the raster data of existing maps and create data with a moderate roughness.
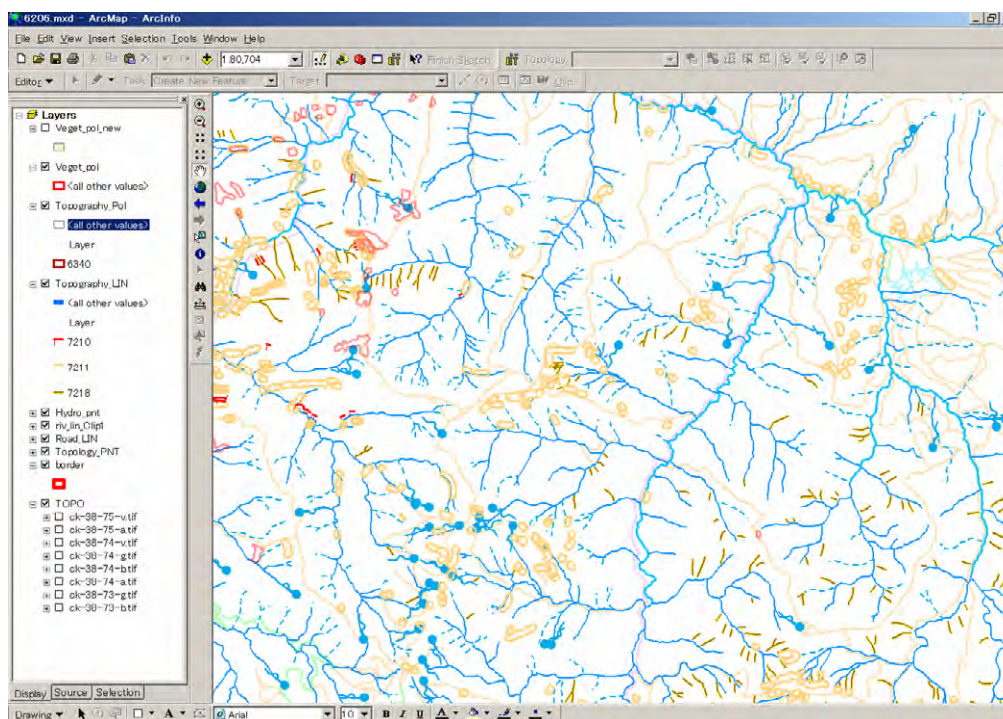
Figure 6.2.7   Data digitized by ArcGIS

ii) Phase-2

Digitizing was carried out in the procedures described above in Phase-1. The counterpart side continued the work by themselves even while the Study Team was not in Georgia and had completed the work by the time the Study Team visited Georgia again for Phase-2.

Since there was only one set of digital photogrammetric system introduced which was also used for the digital plotting of new maps, correction necessary for roads and other ground features was made on the digitized data by comparing with ortho imagery where discernible. As for those features difficult to distinguish on ortho imagery, such as hydrological data that required stereoscopic data to interpret because of consistency of rivers with valleys, etc., correction was made using the stereo digital plotter when it was not occupied by the new map digital plotting work.

Also, technology transfer in conjunction with how to assign heights to data without

elevation information（Refer to Figure 4.2.2, section4.2:）was given.　It should be noted that the technology transfer items for correction work using the digital plotter were the same as technology transfer on digital plotting of new maps.

6.2.5.　OJT for Establishment of GIS database

Structuralization of GIS data is indispensable for establishment of a GIS database. Accordingly, technology transfer related to methods of structuralizing and creating GIS data was provided to four staff on the counterpart side who were in charge of structuralization.

＜OJT staff＞

Ms. Nino Khidirbegishvili

Ms. Tamar Onashvili

Mr. David Svanadze

Ms. Sopio Khorbaladze

Ms. Mariam Gigauri

(1)　Phase-1

In order to determine an effective means of technology transfer, the Study Team surveyed the current status and requests of the counterpart via a brief questionnaire beforehand.　The technology transfer method was determined based on the results.

The results revealed that they seemed to have a certain degree of understanding on the coordinate system (map projection, etc.), which the Study Team had considered the most important to be aware of before starting creation and use of GIS data. Therefore, it was concluded that it was not necessary to schedule an explanatory session about it but to explain the details through OJT.

Moreover, it was clear from the results that they had basic knowledge on computers and that they were requesting for specific information on the software introduced in the Project, including how to use it.　Thus, the Study Team decided to immediately jump to technology transfer by actually using the software.

i)　Vector data

The structuralization of GIS data was performed using ArcGIS (ArcInfo) introduced by the Project.　Since the training period was not long enough to prepare data

covering a range to be created by the counterpart in the OJT, the Study Team brought data of the Japanese portion that was already created in Japan to use in the technology transfer.

Following explanation and demonstration on the structuralization work by the Study Team, the counterpart exercised the work in the presence of the Study Team.

In the initial exercise, the Study Team figured out that they did not fully understand the significance, etc. of individual processes that they were actually performing on data. Therefore, the Study Team conducted exercises on various case studies by making errors to sample data on purpose, to deepen their understanding.   The following describes how the technology transfer was carried out.

| Study Team member explaining to the counterpart | Exercise by the counterpart |

Figure 6.2.8   Technology transfer

ArcGIS (ArcInfo) Workstation used in the technology transfer was CUI (Character-based User Interface), which, unlike GUI (Graphical User Interface) that is in general use today, requires entry of commands using the keyboard.

Table 6.2.2 below lists up major commands used in the technology transfer.

Table 6.2.2   List of ArcInfo command

Command	Description
BUILD	Create or update the attribute table for ground features of a coverage.
CLEAN	Create a coverage with polygons or arc node topology.

CREATE	Create a blank coverage.
COPY	Copy a geographical dataset.
DESCRIBE	Display detailed information on the geographical dataset.
GENERATE (fishnet, lines, points, polygons, etc.)	Add graphic data to the coverage
KILL	Delete a geographic dataset
LISTCOVERAGES	List coverages
LISTWORKSPACES	List workspaces
PROJECT	Convert a geographical dataset between two coordinates.
PROJECTDEFINE	Enter projection information into a dataset.
QUIT	Exit from ArcInfo.
WORKSPACE	Display the workspace or jump to a designated workspace.
ARCEDIT	Jump to the session for coverage correction.
TABLES	Jump to the command for editing attribute data of a coverage.
NODEERRORS	Check node errors in a coverage.
LABELERRORS	Check label errors in polygon data.

To users, GUI is easier to use with better operability but has a disadvantage in case of batch processing or continuous operation of a series of complicated processes.   On the other hand, CUI has a critical disadvantage that a user cannot operate it without knowing the commands, but as long as they know them, it is easy to work on complex procedures and continuous processing of those processes.

In case of creating GIS data of dozens of map sheets, as in this Project, the Study Team deemed it better and decided to use a workstation with CUI.   However, GUI-based ArcMap was mainly used in the data use after creating it.

Figure 6.2.9 below compares the screens of CUI-based ArcInfo Workstation and GUI-based ArcMap.
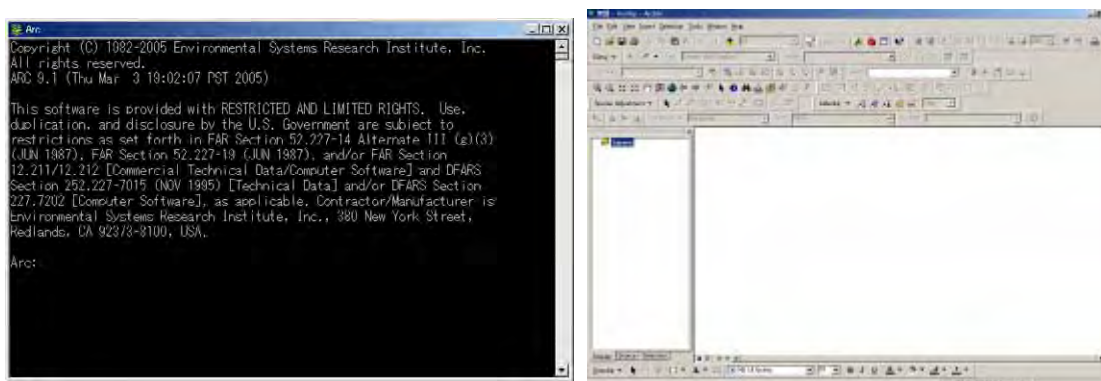
ArcInfo Workstation (CUI)	ArcMap (GUI)

Figure 6.2.9   Aspect of CUI and GUI

ii) Raster data

It was needed to check structuralization of GIS data and digital plotting of new maps or correction of existing map data based on the existing paper maps.   Therefore, for the purpose of indexing geographical coordinates on the existing map data scanned and rasterized, technology transfer using ArcGIS ArcMap and ERDAS IMAGINE was carried out.

Both ArcMap and IMAGINE were introduced in this Project, with the former being advantageous in handling vector data and the later raster data.   Despite the slight difference, both programs basically take similar steps in indexing geographical coordinates.   Shown on the right is a rectification flow.

Furthermore, a comparison between raster data before and after the rectification is presented in Figure 6.2.11.   From this, it is obvious that the raster data has revolved after having the coordinate values.

```
        ┌─────────────────────────┐
        │   Raster data of        │
        │   existing map          │
        └─────────────────────────┘
                    │
                    ▼
        ┌─────────────────────────┐
        │ Read the coordinate value of │◄──┐
        │ 4 corners of the existing map│   │
        └─────────────────────────┘       │
                    │                       │
                    ▼                       │
        ┌─────────────────────────┐         │
        │ Digitization of 4 corners on │    │
        │ the raster data              │    │
        └─────────────────────────┘         │
                    │                  Over tolerance
                    ▼                       │
        ┌─────────────────────────┐         │
        │ Input coordinate value which │    │
        │ was read into digitized 4    │    │
        │ corners                      │    │
        └─────────────────────────┘         │
                    │                       │
                    ▼                       │
             ◇ Check RMS (Root Mean ──────┘
               Squire) error ◇
                    │
              Within tolerance
                    ▼
        ┌─────────────────────────┐
        │ Execution of the rectification │
        └─────────────────────────┘
                    │
                    ▼
        ┌─────────────────────────┐
        │   Rectified raster      │
        │   data of existing      │
        │   map                   │
        └─────────────────────────┘
```
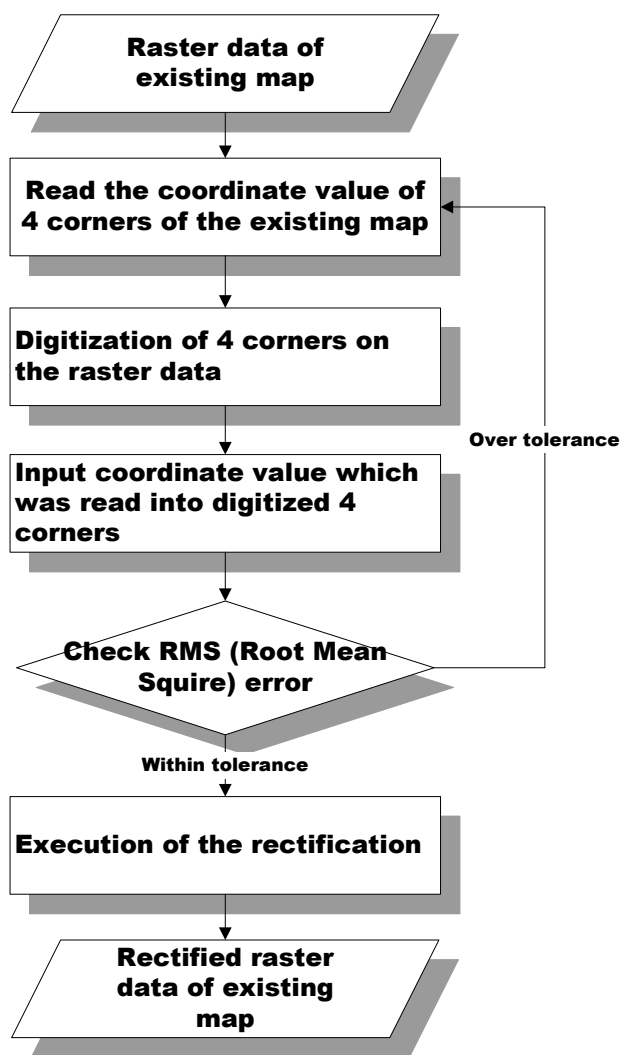
Figure 6.2.10   Work Flow of Rectification
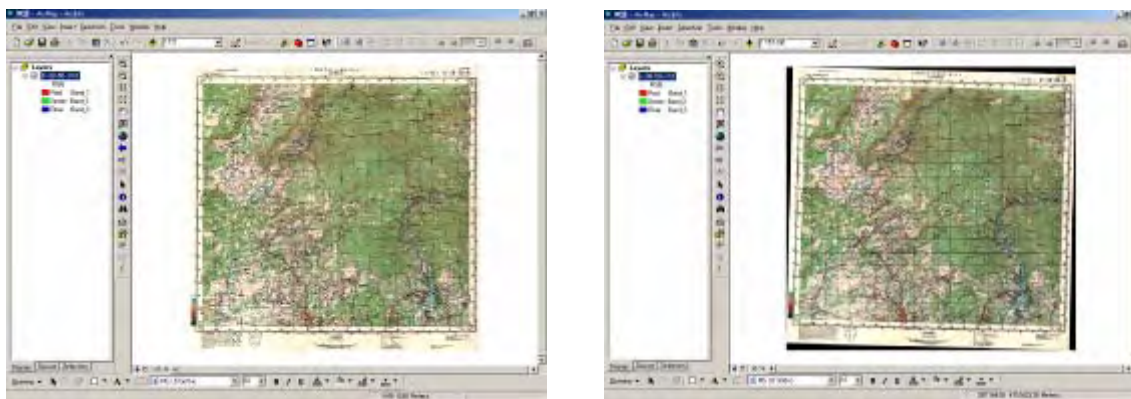
| Raster data before rectification | Raster data after rectification |

Figure 6.2.11   Comparison of Original Raster Data with Rectified Raster Data

(2) Phase-2

Following Phase-1, technology transfer in association with how to create and structuralize data was carried out.

While Phase-1 focused on basic items, Phase-2 asked the counterpart to create data for their portion by themselves. Thus, in addition to mastering data creation, this technology transfer included the detailed data check and correction.

First of all, the session started with reviewing the items trained during the Phase-1 technology transfer, and shifted to self-exercise by the counterpart using data created by themselves in the presence of the Study Team members. The work was carried out in accordance with the flow presented in Figure 4.5.2, section 4.5.1.

The Study Team checked the data created by the counterpart, and explained the errors present in their work, possible causes of the errors, and how to correct them. However, correction itself was done by the counterpart.

A basic manual concerning structuralization was created and distributed to the counterpart.

Figure 6.2.12 presents a sample of error correction.   In this error, polygon data has failed to form a polygon since line data that constitute the polygon are not closed.

Since the software used in the work (ArcInfo Workstation) has the function to automatically indicate such an error with a mark, it is easy to identify and correct these errors.

Before correction   After correction
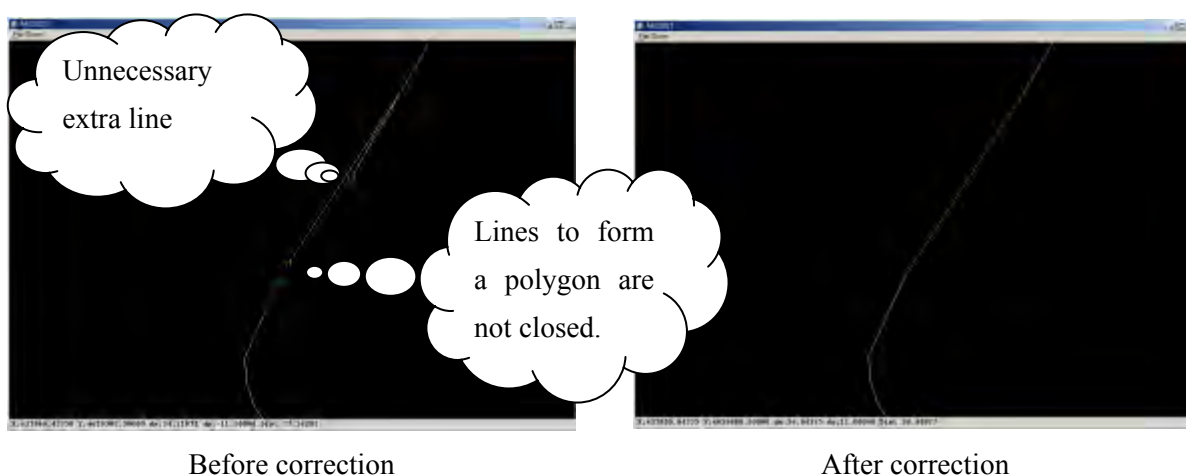
Figure 6.2.12   Sample of error correction

(3) Phase-3

File format of GIS database was shifted from ArcInfo coverage to ESRI Geodatabase by the counterpart's request. The reasons were; 1) Trend of recent data format on ArcGIS, 2) Easiness of work, and 3) Relation to time period for OJT and understanding ability of the counterpart.

Geodatabase was generated on ArcMap and ArcCatalog as GUI interface not ArcInfo workstation as CUI interface.

OJT was carried out with the sample data again because the words used and the data structure were difference between Geodatabase and ArcInfo coverage though the concept of data generation is similar.

The included contents of OJT were below.

- Difference of data structure between Geodatabase and ArcInfo
- Explanation of technical terms in Geodatabse
- How to export from CAD data to Geodatabse
- How to set topological rules on Geodatabase

T38_6418.mdb
- Boundary
  - Admin
- Building
  - Building_pnt
  - Building_pol
- Landform
  - Contour
  - Contour_pol
  - Control_pnt
- Object
  - Object_lin
  - Object_pnt
- Plottage
  - Site_lin
  - Site_pnt
  - Site_pol
  - Vegetation
- Transportaion
  - Rail_lin
  - Rail_pnt
  - Road_lin
  - Road_pol
  - Trans_lin
  - Trans_pnt
- Water_System
  - Hydro_lin
  - Hydro_pnt
  - Hydro_pol

L6418
- bldg_pnt
- bldg_pol
- contour
- control
- hydr_lin
- hydr_pnt
- hydr_pol
- obj_lin
- obj_pnt
- rail_lin
- rail_pnt
- road
- site_lin
- site_pnt
- site_pol
- tic_cov
- trns_lin
- trns_pnt
- trns_pol
- vgt

Data structure on Geodatabase   Data structure on ArcInfo coverage

Figure 6.2.13   Difference of data structure between Geodatabase and ArcInfo coverage

Table 6.2.3   List of topological rule for polygon feature

Feature	Topology rule	Examples
		(quote from ArcMap help)
Polygon	Must Be Larger Than Cluster Tolerance	
	Must Not Overlap	
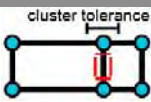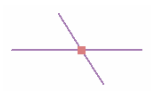
Must Not Have Gaps

Must Not Overlap With

Must Be Covered By Feature Class Of

Must Cover Each Other

Must Be Covered By

Boundary Must Be Covered By

Area Boundary Must Be Covered By Boundary Of

Contains Point

Table 6.2.4   List of topological rule for line feature

Feature	Topology rule	Examples (quote from ArcMap help)
Line	Must Be Larger Than Cluster Tolerance	
	Must Not Overlap	
	Must Not Intersect	

Must Not Have Dangles

Must Not Have Pseudonodes

Must Not Intersect Or Touch Interior

Must Not Overlap With

Must Be Covered By Feature Class Of

Must Be Covered By Boundary Of

Endpoint Must Be Covered By

Must Not Self Overlap

Must Not Self Intersect

Must Be Single Part

Table 6.2.5   List of topological rule for point feature

Feature	Topology rule	Examples (quote from ArcMap help)
Point	Must Be Covered By Boundary Of	
	Must Be Properly Inside Polygons	

Must Be Covered By Endpoint Of

Must Be Covered By Line

6.2.6. OJT for Creation and Use of GIS Model Systems

(1) OJT for Creation of GIS Model Systems

Regarding the creation of these GIS layers, the Study Team tried to transfer as much technology as possible to the counterpart personnel and members of the taskforce. During the creation of GIS database for the Models, the counterpart personnel were assigned with jobs for which they would work together in the GIS groups. All together, three (3) OJT (On-the-Job Training) sessions have been conducted regarding GIS Model Systems. Their summaries are presented in the following Table 6.2.6.

Table 6.2.6   Summary of OJTs Conducted Regarding the Creation of GIS Models

OJTs	Duration	Involved Organizations	Main Activities	Outputs
OJT1	2005	6 organizations involved in the Coordinating Committee	Data collection. Discussion on theme determination	Basic information on the existing thematic maps
OJT2	Aug. – Sep. 2006	➢ GCGS staff ➢ Taskforce members: ⇒ Department of Forest Management ⇒ Department of Cultural Heritage ⇒ Department of Policy making and Strategy Development	➢ Input of existing geographic as well as related attribute data into GIS	➢ Various kinds of GIS data such as: ⇒ Land use of Tbilisi, ⇒ Forest of Zestaphoni and Kutaisi, ⇒ Soil data of Mtskheta, ⇒ Touristic Information of Borjomi/Bakuriani ⇒ Others.

OJT3	Jan. – Feb. 2007	Continuation of OJT2	Correction of existing data and compilation of the categories	⇒ Historical sites information of Borjomi/Bakuriani ⇒ Forest information of Zestaphoni and Kutaisi ⇒ Others.

All the GIS layers such as forest data of Zestaphoni and Kutaisi, soil data of Mtskheta, and others were created in cooperation with the counterpart personnel. The following figures present moments of working together between the Study Team and the counterpart.

Similarly, members of the taskforces were involved during the operations wherever possible. This not only facilitated discussion on the details regarding the included GIS layers but also transferred the procedural know-how to them. The photo on the right shows a scene from the discussion with members of the Forestry Department regarding the items and procedures of entering the forest boundaries and attribute data of Zestaphoni and Kutaisi forest areas.

Figure 6.2.14 shows the description of a monument after checked and approved by the personnel from the Department of Cultural Heritage.

Name of the monument: *Gogia's Fortress*
City: *Borjomi*

The name of the monument is Gogia's fortress (Gogia is a name of a Man). The fortress is located to the west from Borjomi, on the high mountain, on the left side of the river Mtkvari. It is built of cut-stone with cobble. On the north side, there is a square-shaped military tower.

The entrance is from the south. Now all floors are smashed. Walls have loop-holes, fireplaces and windows.

The dimensions of the tower - 4.3 X 5m. The dimensions of inside territory of the fortress - 25 X 12m. The wall is 1.4m in width.

Figure 6.2.14   Description of a Historical Site

(2)   OJT for the use of GIS Model Systems

All the created six (6) GIS Model Systems were presented to the Task force members along with detail explanation of all the included steps.   During this following points

were emphasized:

✧ Types of geographic data included in each GIS Model System.
✧ The concept of spatial analysis of geographic data, such as overlaying of two layers.
✧ Evaluation of result outputted from the spatial analysis.

Operating manual including detail for displaying these models was provided to Task force members. They practiced the displaying of these Models. This provided them opportunity to go through about the steps of the Model systems more closely and further to understand their significance in promoting use of geographic information including newly produced Topographic maps under this Project.

Also, discussions were held regarding the possible use of these models in future, whereupon their feedback remained as these products being first of this kind in Georgia, are very useful for practical purposes. The photo presented below shows a scene of such discussion.

6.2.7. OJT for Map symbolization

(1) Methods and engineers (the counterpart personnel)

Since the staff of the former DGC were gone due to the reorganization implemented by the Georgian government 1st year, the technology transfer concerning symbolization was again provided based on the series of work procedures, in accordance with the map symbolization discussed and agreed with the counterpart during the 1st year. The training was scheduled twice from August 15th to September 22nd, 2006 and from January 23rd to March 5th, 2007.

The actual technology transfer was implemented through training in the form of exercise in which the trainees symbolize per layer, such as roads, rivers and other

linear objects, buildings, symbols, vegetation, contour lines, etc. with concurrently acquiring the commands for operating the application used.   Adobe Illustrator CS2 (Ver.12) was used in the training.

The following five officials participated in the technology transfer for symbolization.

＜OJT staff＞

Mr. Shalva Rukhadze

Ms. Kahthna Alasania

Mr. Irakli Gotsadze

Mr. Tedo Gorgodze

Mr. Giorgi Peradze
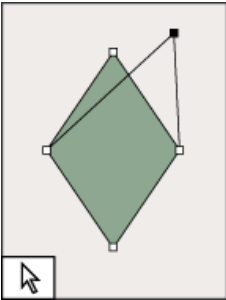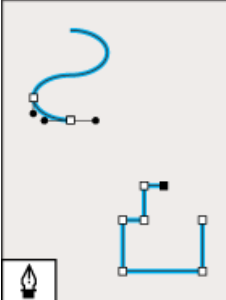
(2)   Major contents of the training

i)   How to operate

Aiming at learning of basic operations of the application, exercise was performed particularly focusing on the functions necessary for map symbolization.   The major topics of the exercise are as follows.

- Setting of preferences and documents
- Menus and respective functions
- Functions of the tools
- Drawing using the tools
- Object management using layers
- How to adjust colors and line gauges
- Copying and editing of objects

Table 6.2.7   Functions of the Tools

	The direct-selection tool ⬉ allows you to select individual anchor points or segments on a path. All direction lines then appear on that part of the path for adjusting. When the direct-selection tool is on an unselected path or object, it changes to ⬉▪. When it is on the anchor point of a selected path or object, it changes to ⬉□.
	1. Select the **pen tool** ✑. 2. Position the tip of the pen point where you want a straight segment to begin, and click to define the first anchor point (do not drag). The anchor point remains selected (solid) until you add the next point.
	1. Select the **type tool** T or the vertical type tool ⊥T. The pointer changes to an I-beam within a dotted box. 2. Click where you want the type to begin. 3. Enter the type you want. Press Enter or Return to begin a new line of type.

ii) How to symbolize

The exercise was intended to bring all the counterparts up to such a level that they can create all the symbols on their own.   The Study Team has already explained how to create symbols using the map symbolization prepared with Adobe Illustrator, and therefore the counterpart created the following symbols in the exercise.

● Line symbols created with simple functions (Figure 6.2.15)
● Line symbols created with complex functions
● Donut-shaped polygon symbols (Figure 6.2.16)
● Point symbols using the brush (Figure 6.2.17)
● Map editing including displacement of symbol and discontinuity of featuring lines
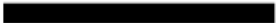● Input of annotation

Draw line → set line weight 1.4mm and color k=100%	Copy → paste in front → set line weight 1.0mm and color Orange 100%	Copy → paste in front → set line weight 0.12mm and color k=100%

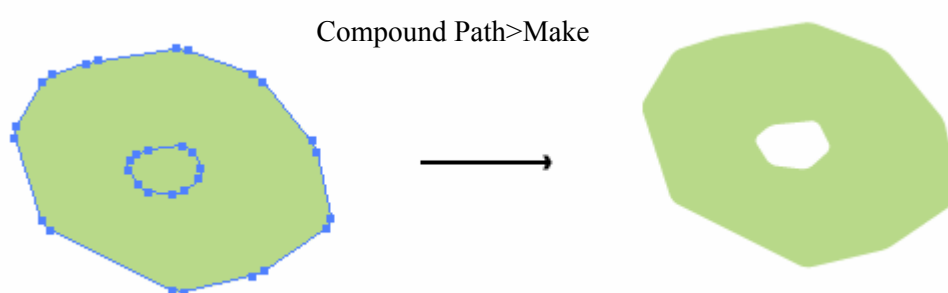**Figure 6.2.15   Line Symbols Created with Simple Functions**

Figure 6.2.16   Donut-shaped Polygon Symbol
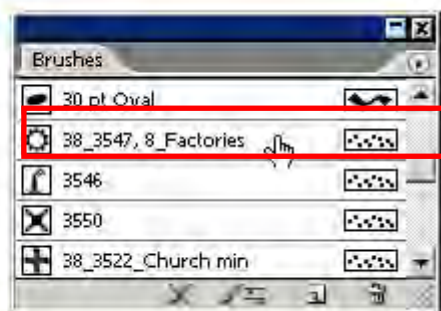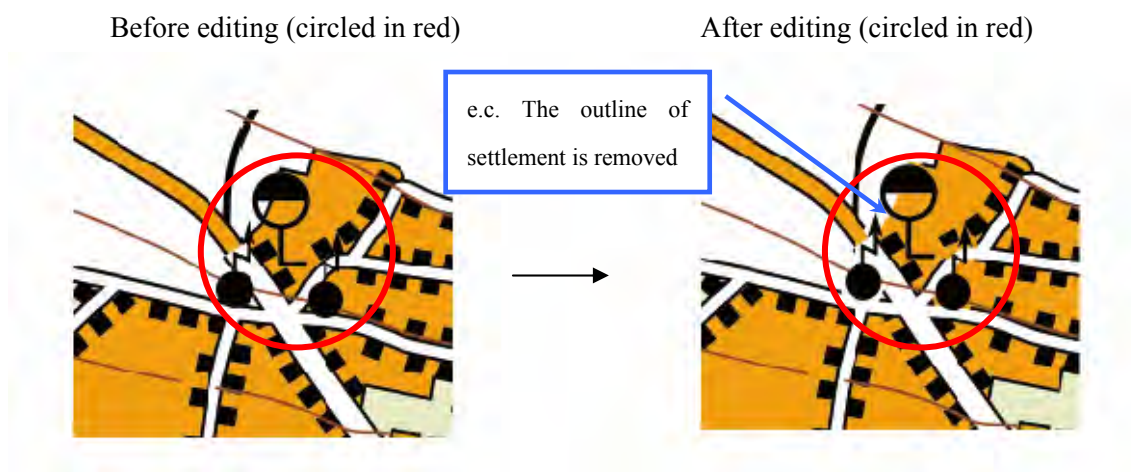

Figure 6.2.17   Point Symbol Using the Brush

iii) Map editing

Because of overlapping of ground features with each other and symbols or annotation, a map after symbolization looks complicated and difficult as it is.

Guidance on map editing (Figure 6.2.18) was provided, for the purpose of creating easy-to-see maps by displacing symbols or separating ground features from each other.

Before editing (circled in red)   After editing (circled in red)

e.c. The outline of settlement is removed

Figure 6.2.18   Map Editing

iv) Input of annotation

The language for annotation was changed from Russian to Georgian (Figure 6.2.19). Therefore, the font had to be newly selected.   Moreover, since annotation was to be entered based on the existing paper maps, it was important to judge the type, which could be guided as part of training.

Russian   Georgian

ТБИЛИСИ   თბილისი

Figure 6.2.19   A sample of annotation for "Tbilisi"

In addition, the manual prepared by the Study Team and used in this technology transfer training is attached hereto for reference.

v) Matters concerning printing

The second half of the technology transfer（between January and March 2007）focused on color check, conversion into EPS (Encapsulated Post Script), and inspection of the positive for each edition (using actual positives).

vi) Creation of symbols

Technology transfer was given on how to create building symbols (factory, church, etc.) and object symbols (monument, radio tower, smokestack, etc.), using actual digital compilation data.

In addition, the manual prepared by the Study Team and used in this technology transfer training is attached hereto for reference.

6.3.   Training in Japan

6.3.1. Digitization of existing maps

(1)   Contents of lectures and exercises

Table 6.3.1   Training items and technology transfer intended

Contents of lecture	Exercise details	Technology transfer intended
Relationship between scanning resolutions and their data sizes in scanning existing maps	How to calculate the data size of an existing paper map scanned at a particular resolution	Estimating a data size in advance smoothens preparatory works (by ascertaining a disk capacity required.)
Georeferencing of scanned images	Exercise on the georeferencing method using ArcGIS	Overlaying map image data and GIS/geographic data on the display for vectorizing existing map data.
Head-up digitizing method using ArcGIS	Appropriate display scale when digitizing Items to be considered when acquiring geographical features (snapping, how to create duplicate data, etc.) How to enter the code numbers for GIS data	Generating a dataset with an accuracy or a consistency suited to a certain purpose.

(2)   Outcomes of training

On the last day in the series of lectures, the trainees were asked to operate the software

on PC to carry out the above works on their own, in order to assess the level of their understanding of the technologies.   Although they took somewhile, they were able to complete the works without any help.   Therefore, it seemed that they have built up the basic knowledge sufficient for carrying out the work on their own in Georgia.

6.3.2. Generation of annotation data

(1) Contents of lectures and exercises

Generation of annotation data was originally excluded from the training in Japan for this year since the former DGC counterparts were to share the work within the country. However, since it was desirable for the former DGC side to start the preparatory works as soon as possible, the work methods necessary for the following items were lectured during the training.

- Explanation on how to operate the Illustrator and the commands thereof (in relation to entering annotations)
- Explanation on data to be entered as annotations
- Explanations on items to be considered when entering annotations
- Exercise on entry work

(2) Outcomes of training

Mr. Tedo was quick to pick up on the contents and soon became acquainted with the entry work; therefore was assessed as to have acquired sufficient skills for carrying out the work in Georgia.   As for Ms. Sedae, the training focused rather on a review of operations taught in Georgia; it still contributed as a reminder of the commands and methods.   It was anticipated that the technologies transferred in the training was effectively leveraged, in and after the year ahead, on an occasion of using the Illustrator for map symbolization or entering geographic names and other annotations to compilation data for printing.

However, the combined exercise time in Georgia and Japan was yet insufficient. Retraining on the next OJT occasion was highly expected.   By so doing, the counterparts were necessarily able to raise the level of their understanding and establishing the technologies in the country.

Figure 6.3.1   Exercise on the operation of the Illustrator using existing map image data

6.3.3. Aerial triangulation

(1) Contents of lectures and exercises

Training on digital aerial triangulation was conducted for five days from December 1st to 7th, 2005, using scanned images of aerial photos taken over the northern part of Tbilisi city during the Study.   Table 6.3.2 summarizes the data, software, etc. that were used in the training, whereas Figure 6.3.2 is an index map of the aerial photos used in the training.

Table 6.3.2   Data used, etc.

Scanned image of aerial photos	15 images from 3 courses in total. Resolution: 20μm
Camera principal points	Same as aerial photos
Camera file	In compliance with "Camera Calibration Rmk-Top 15 SN-141 306"
Tie-Point pattern	3×3 pattern
GCP	5 points: No. 1, 2, 3, 4 and 28.
Aerial triangulation program	MTS of the Socet Set software
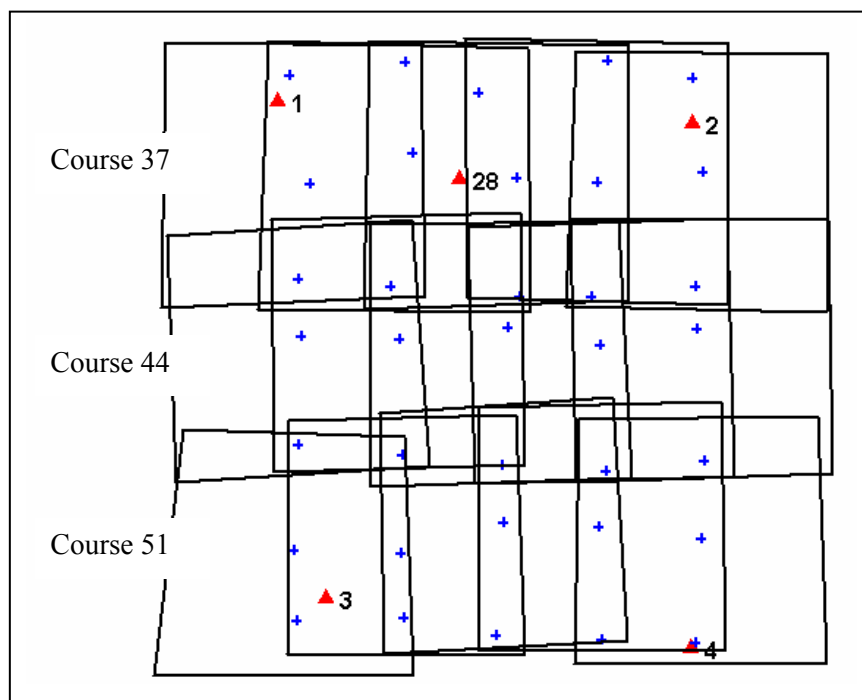
Figure 6.3.2 **Index map of aerial photos used (▲ indicates control points and + tie points)**

Table 6.3.3 describes major contents and methods of the training.

Table 6.3.3 **Training items and technology transfers intended**

Contents of lecture	Exercise details	Technology transfer intended
Importing of aerial photos	Importing the scanned aerial photo image data into the aerial triangulation software. Camera file and camera principal point data were also imported, along with an explanation on what these data are used for.	
Interior orientation	Manual interior orientation of a few photos. Automatic computation for the remaining photos.	Understanding of the significance and purpose of interior orientation. Accurate judgment on the

		results.
Observation of control points	Repeated exercise to recognize the precise position of a point on the photo using one point of aerial signal and four points extracted for this training for stereoscopic observation.	(Refer to Figure 6.3.3)
Observation of tie points	Manual observation of 35 ties points using the 3 × 3 pattern.	
Calculation for adjustment, analysis of the results, and correction	Reobservation of 2 or 3 points with the RMS error above 1.	Interpretation of the result of adjustment calculation and understanding of the significance and necessity of reobservation
Creation, display and correction of digital elevation model (DEM)	Extraction of DEM from stereo pairs. Multiple DEM datasets were generated according to different locations of extraction and different grid intervals and were compared. As for correction, the time constraint only allowed an explanation on the method.	
Generation of orthophotographs	Exercise on generating ortho images from multiple photos. Mosaicking.	
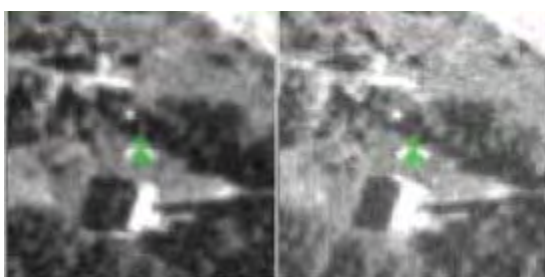
Control points on a stereo pair   Aerial signal set up in Georgia

Figure 6.3.3   **Control points and Aerial signal**

(2) Outcomes of training

Although it seemed the first time for the trainees to engage in an aerial triangulation work, they seemingly had mastered the basic operations of and obtained the philosophy in the work, as a result of active and dedicated participation in each step of the work. By manual observation of tie points, which is inevitable for orientation of the model, they seemed to have learned the underlying theory as well. They first took a long time to complete the work and made some mistakes, but, as they repeated the exercise, they became accustomed and able to operate quickly.

At the beginning, it seemed difficult for them to ascertain the relationship between DEM and ortho images created in the generation of orthophotographs. Yet, since they had a good understanding of the effectiveness of orthophotos, they were interested in and eager for learning the technology.

6.3.4. Introduction to GIS

(1) Contents of lectures and exercises

A session on an introduction to GIS was held on December 8th, in response to the strong request from the senior officials of DGC and the trainees, though this topic was not included in the training in Japan for this year.

- Explanation on an outline of GIS and basic operation of GIS software
- Exercise on operation using sample data
- Generation of bird's-eye views from the DEM data and orthophotographs used in the aerial triangulation training

Using ArcGIS ArcInfo as the GIS software, the training mainly covered ArcCatalog, ArcMap, ArcScene, DEM generation and 3D & Spatial extension. The details of respective exercises are given below.

i) ArcCatalog

The basic functions and operation procedures of ArcCatalog were explained using sample data. Following that, the trainees exercised actual operation based on the manual provided for their quick acquisition of operation. The training mainly covered the followings:

- Copy, paste, delete, operation with icons, folder connection, zoom, pan, display of attribute values, etc.
- How to display metadata.

ii) ArcMap

The basic function and operation procedures of ArcMap were explained using sample data.   Following that, the trainees exercised simple spatial analysis and encoding of data for printing based on the manual.   It seemed that the actual outputs gave them a sense of accomplishment.   The training mainly covered the followings:

● How to display data and how to use the tool bar

● How to change the method of depicting data

● How to search data

● How to display labels

● How to use map layouts (Refer to Figure 6.3.4 "Example of map layout".）

● How to store map data (How to generate .mxd files.）
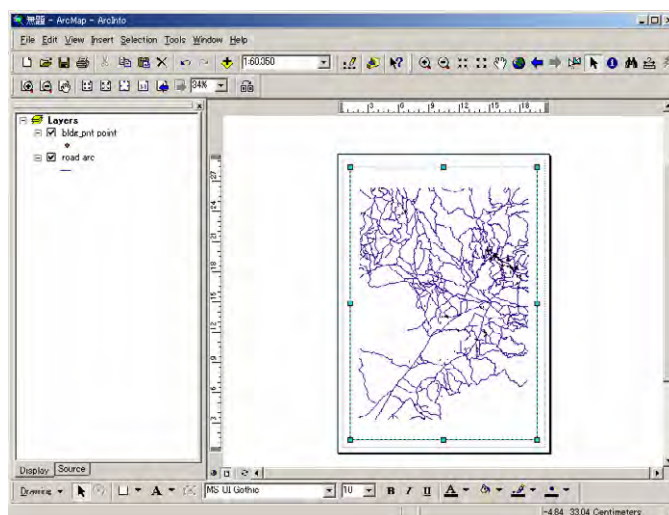
Figure 6.3.4   Example of map layout

iii) Generation of DEM

Exercise on generation of DEM took the following two ways.   Through the training the trainees were able to deepen their understanding of DEM by comparing the results of products generated for different target areas and different grid intervals.

● Importing of DEM data created in the aerial triangulation training

● Creation of DEM data from the contours of existing maps using the TOPOGRID command

iv) 3D & Spatial extension

The functions and operation procedures of 3D extension and spatial extension were explained using the DEM data created in the training.   Following that, the trainees

deepened their understanding of the topic by stereoscopically observing the data and generating bird's-eye views from the data using the ArcScene software.   Figure 6.3.5 is an example of the bird's-eye views generated during the training.
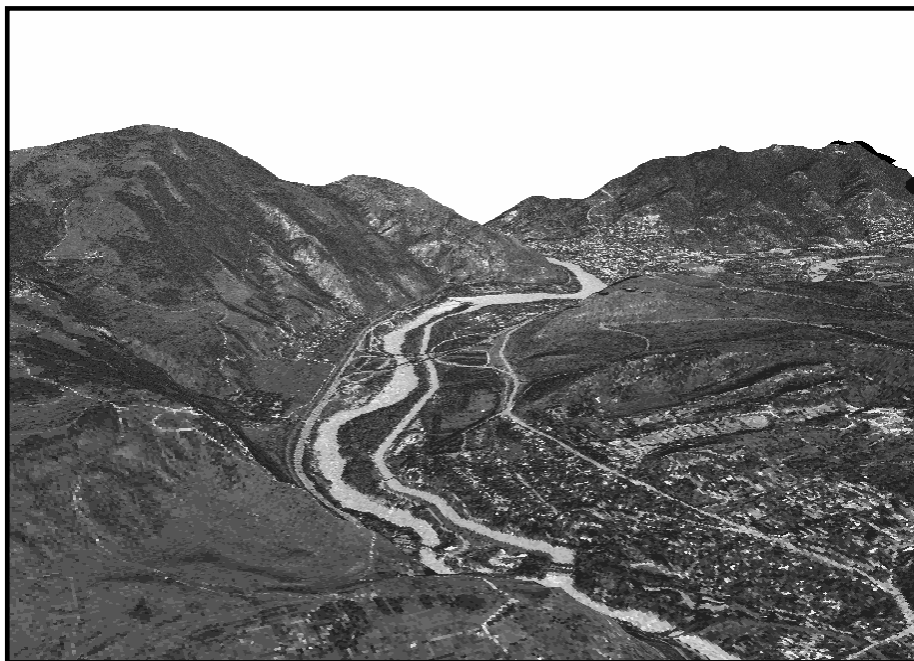
Figure 6.3.5   Bird's-eye view created in the training

6.4.   Workshop

6.4.1.   Workshop

With the purpose to demonstrate the understanding of the involved counterpart personnel, the Workshop was organized on 14th February 2008 prior to holding the Seminar.   During this, not only the staff of GCGS and Agency got chance to present their knowledge gained during this Project period, but also the members of Task force presented their experience from this Project.   All these staffs were being involved in OJTs, in other words their presentation showed the confirmation of knowledge gained during these OJTs.

The program of this Workshop was as mentioned in Table 6.4.1.

Table 6.4.1   Program of the Workshop

Time	Description		Title
10:30-10:40	Opening Speech	First Deputy Minister	Vice Minister of the Ministry of Environment Protection and Natural Resources
10:40-11:00	Project Overview	Mr. Hisashi Mori	Team leader of the JICA Study Team
Coffee break (11:00 - 11:15)			
11:15-12:30	Short Introduction for Preparation of Topographic Map	Mr. Akihiro Sugita	Member of the JICA Study Team
	Creation of Digital Topographic Data	Ms. Tamar Onashvili Mr. Otar Demetrashvili	GCGS / SIA
	Vectorization	Ms. Khatuna Alasania	GCGS
	Field Verification	Mr. Irakali Gotsadze Mr. Giorgi Peradze	SIA
	Symbolization	Mr. Shalva Rukhadze Mr. Tedo Gorgodze	GCGS / SIA
12:30-12:45	Question and Discussion		
Lunch break (12:45 - 14:00)			
14:00-15:00	GIS Database Creation	Ms. Mariam Gigauri	SIA
	GIS Application 1	Ms. Nino Khidirbegishvili	GCGS
	GIS Application 2	Ms. Maka Devidze	SIA
15:00-15:10	Question and Discussion		
Coffee break (15:10 - 15:30)			
15:30-16:20	Purpose of GIS Model Systems and Expectations	Mr. Awadh Kishor Sah	Member of the JICA Study Team
	Possible use of GIS Model Forest Management and Reforestation	Mr. George Bagaturia	Department of Forest Management
	Possible use of GIS Model for Facilitating Environmental Protection	Ms. Lika Salia	Department of Protected Areas
	Possible use of GIS Model for Enhancing the Tourism Development	Mr. Kakhaber Todua	Department of Tourism and Resorts
	Possible use of GIS Model for Optimization of Agricultural Land Use	Mr. Beso Gelitashvili	Land Management Service
	Possible use of GIS Model for Developing cultural resources in need for tourism promotion	Mr. Tengiz Kodua	Department of Cultural Heritage
16:20-16:30	Question and Discussion		
16:30	Closing Speech	Mr. Irakli Lejava	Head of GCGS

6.4.2. Seminar

Beside the workshop the seminar was successfully held with more than 70 participants from various organizations. This was attempted for rising keen public awareness of the effective uses of digital topographic data under the aims of the followings;

- Explanation of this research service
- Explanation of results
- Explanation of digital technique used by main enumeration
- Introduction of uses of made digital topographical map and GIS basic data, etc.
- Construction vision of system concerning use and spread of geographic information

Therefore, main emphasis was placed on utilization of the digital data for its applications to such as GIS analysis.

5 specialist from the members of coordinating committee were involved in making their presentations for this purpose.

Table 6.4.2   Program of the Seminar

Program

Time	Title	Speaker	Affiliation
9:30-9:40	Opening Address	Mr. Zaal Gamtsemlidze	Minister of the Ministry of Environment Protection and Natural Resources
9:40- 9:50	Acknowledgement	Mr. Mitsuhiro Kohno	First Secretary, The Embassy of Japan in Azerbaijan
9:50-10:20	Project Overview and Outputs	Mr. Hisashi Mori	Team leader of the JICA Study Team
Coffee break (10:20 - 10:40)			
Part-1: Presentation of the Results of the Study			
10:40-10:55	Preparation of Topographic Maps	Mr. Akihiro Sugita	Member of the JICA Study Team
10:55-11:10	Creation of GIS database	Mr. Akihiro Sugita	Ditto
11:10-11:30	Skills learned through the technology transfer	Ms. Maka Devidze Ms. Tamar Onashvili	GCGS / SIA
11:30-11:50	GIS Model Systems for demonstrating the effective use of digital topographic data	Mr. Awadh Kishor Sah	Member of the JICA Study Team
11:50-12:00	Question and Answer		
Lunch break (12：00 - 13:30)			
Part-2 Application and Recommendations on Dissemination of Spatial Data			

13:30-13:45	Promising uses of digital topographic data with the use of GIS Model Systems	Mr. Awadh Kishor Sah	Member of the JICA Study Team
13:45-14:00	Appraisal of effectiveness in practical use of the GIS Model System - Useful information to approach the designation of cultural tourism	Mr. Tengiz Kodua	Department of Cultural Heritage, Ministry of Culture, Monument Protection and Sports
14:00-14:10	Appraisal of effectiveness in practical use of the GIS Model System - Useful information to develop natural resources for promoting tourism	Mr. Kakhaber Todua	Department. of Tourism and Resorts, Ministry of Economic Development
14:10-14:20	Appraisal of effectiveness in practical use of the GIS Model System - Possibilities to contribute to demarcation of Protected Area	Ms. Lika Salia	Department of Protected Areas, Ministry of Environment Protection and Natural Resources
14:30-14:40	Appraisal of effectiveness in practical use of the GIS Model System - Possibilities to contribute to allocating agricultural lands	Mr. Beso Gelitashvili	Land Management Service, Ministry of Environment Protection and Natural Resources
14:40-14:50	Appraisal of effectiveness in practical use of the GIS Model System - Possibilities to contribute to planning reforestation	Mr. George Bagaturia	Department of Forest Management, Ministry of Environment Protection and Natural Resources
Coffee break (14:50 - 15:10)			
15:10-15:25	Some Useful Suggestions for Dissemination of Spatial Data	Mr. Hisashi Mori	Team leader of the JICA Study Team
15:25-15:30	Vision of GCGS in Promoting Spatial Data	Mr. Irakli Lejava	Head of GCGS, Ministry of Environment Protection and Natural Resources
15:30-15:40	Question and Discussion		
15:40	Closing Remarks	Mr. Michio Kanda	Special Advisor, JICA

Figure 6.4.1   Presentation by the Study Team   Figure 6.4.2   Participants attended the Seminar

6.5. Overall evaluation on the Technology Transfer

The counterpart personnel, who had not been sufficiently familiar with the field work, data creation, updating and so on in the beginning of this project, have acquired fundamental techniques for the creation of topographic map and GIS data processing through the OJT.

It is however necessary for them to acquire further application techniques in order to satisfy the demands for higher level of data services though they have attained a certain level of ability for ordinary data service.

The current situations after technology transfer and issues to be considered in future on each OJT item are as below.

A.   To complete the remaining updating of the map sheets, the counterpart acquired basic skills to carry out this work by themselves.

B.   However more elaborate practice will be needed in terms of improving knowledge and skills of geographic features acquisition by skillful photo interpretations so that they can produce reliable topographic maps.

C.   The possibility of self-production of new maps is limited in the method by updating at this moment.   It is mainly because of that their skills and knowledge do not reach a sufficient level so as to challenge the professional process through the photogrammetric operation and 3 dimensional plotting(stereo scopic feature capturing) for new map creation.

D.   For the purpose of realization in the above, the counterpart should accomplish a reinforcement of staff who are familiar with these expertise skills, and also the current staff should be trained for longer period than at least 5 years.   Just for the reference, it takes more than 10 years in order to acquire sufficient skills for this work even in Japan.

For the rest of evaluation on their efforts, the following issues can be pointed out.

Table 6.5.1   OJT for Ground Control Point Survey

Current situation after technology transfer	Future tasks	Remarks
The number of staff by which the technology transfer was carried	・ Reinforcement of persons who are familiar with this item.	

out is a little because of reorganization from DGC to SGC	・ New engineer should be trained.	

Table 6.5.2   OJT for Field Verification and Completion

Current situation after technology transfer	Future tasks	Remarks
The number of staff by which the technology transfer was carried out is a little because of reorganization from DGC to SGC	・ Reinforcement of persons who are familiar with this item. ・ New engineer should be trained.	

Table 6.5.3   Map Symbolization

Current situation after technology transfer	Future tasks	Remarks
The SGC acquired skills to carry out this item by itself.	・ Improving knowledge and skills of symbol adjustment in various cases ・ Improving knowledge and skills of utilizing various functions of software used.	