2. OUTLINE OF THE STUDY

2. OUTLINE OF THE STUDY

2-1. Study Objectives

This study aimed;

- To prepare digital Topographic maps, 1:100,000 and 1:25,000 for their application,
- To prepare the basic data for GIS to the Integrated Development Master Plan and future map data usage by other concerned organization and data users, and
- To transfer the latest technology of digital mapping and related technology for the creation of GIS basic data to the counterpart organization, SSGC.
- To secure transferred technology for digital map production.

In the course of the Study, all works were executed for promotion of ownership in the future study and implementation.

2-2. Study Area

The Study area covered Issyk-Kul Lake watershed, located in the northeastern part of Kyrgyz Republic shown in figure 2-1.

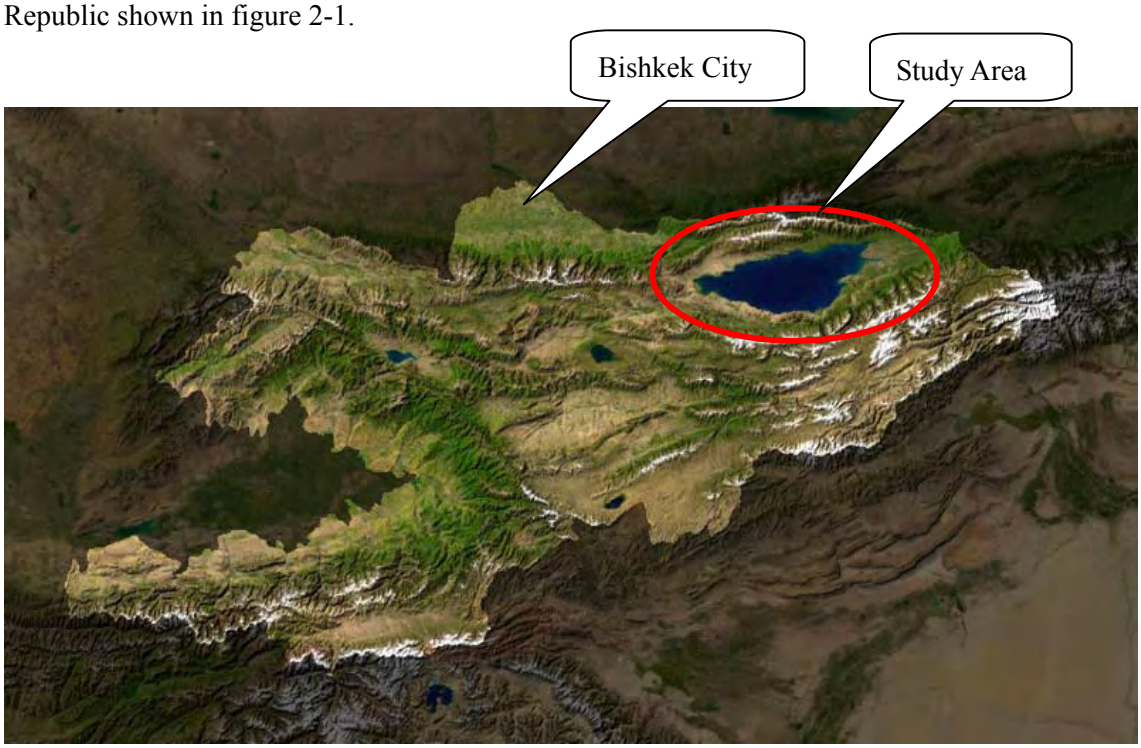


Figure 2-1. Location of Issyk-Kul Lake

The Study area is approximately 14,000km^2. Surroundings are TienSian mountain range and the altitude of more than 3,500m. The altitude of Issyk-Kul lake water surface is 1,600m. The territory of the study area was set along the international border between Kazakhstan and Kyrgyz Republic in the northern part. Project Demarcation of Eastern and Southern parts are set to the range of 1:100,000 topographic maps as shown in figure 2-2.

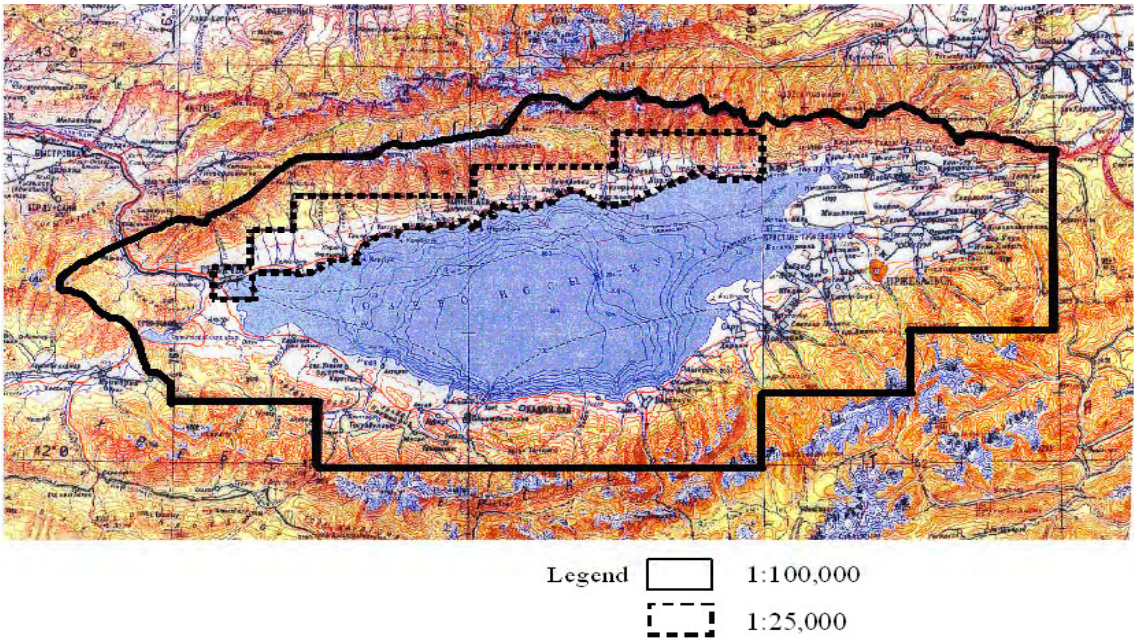


Figure 2-2. Study area

2-3. Topographic Map Production

Production of Digital Topographic mapping Data and Printed Maps corresponding to the individual scales was carried out. The list of produced topographic maps is shown in following table 2-1.

No.	Scale	Qty	Area	Sheets Number
1	1:25,000	30 sheets	2,300km^2	K43-47-v-v, K43-47-v-g, K43-47-g-v, K43-47-g-g, K43-48-v-a, K43-48-v-b, K43-48-v-v, K43-48-v-g, K43-48-g-a, K43-48-g-b, K43-48-g-v K43-48-g-g, K43-57-b-b, K43-57-b-v, K43-57-b-g, K43-57-v-b, K43-57-g-a, K43-57-g-b, K43-58-a-a, K43-58-a-b, K43-58-a-v, K43-58-a-g, K43-58-b-a, K43-58-b-b, K43-58-b-v, K43-59-a-a, K43-59-a-b, K43-59-b-a, K43-59-b-b, K43-60-a-a
2	1:100,000	19 sheets	14,000km^2	K43-45, K43-46, K43-47, K43-48, K43-56, K43-57, K43-58, K43-59, K43-60, K43-68, K43-69, K43-70, K43-71, K43-72, K44-37, K44-38, K44-49, K44-50, K44-61

Table 2-1. List of produced Topographic Map

2-4. Work Distribution

Work Distribution was done in order to carry out Technology Transfer by OJT to SSGC considering its actual condition. As the result, SSGC completed all work volume within the planned schedule. This fact gives hope that SSGC has possibility to produce Topographic maps without Study team assistance. The following table 2-2 shows work distribution of the individual Topographic mapping Work for Study team and SSGC.

No.	Work Items	Scales	Study Team	SSGC
1	Production of Map Manuscript	1:100,000		14,000km^2
		1:25,000		2,300km^2
2	Digitizing of Map Manuscript	1:100,000	13,000km^2	1,000km^2
		1:25,000	2,100km^2	200km^2
3	Digital Compilation and Data Structuralization	1:100,000	13,000km^2	1,000km^2
		1:25,000	2,100km^2	200km^2
4	Symbolization	1:100,000	13,000km^2	1,000km^2
		1:25,000	2,100km^2	200km^2

Table 2-2. Work Distribution

2-5. Satellite Image Digital Mapping

The study enabled Kyrgyz Republic to develop new geographic data for other priority areas of Republic by using new satellite image data and the latest technology. This can be achieved through technology transfer and supply of relevant equipment to the Kyrgyz Republic. New map information could be generated for other areas in short period.

2-6. Work Stages

Topographic mapping work was carried out within three Phases of Study and executed in accordance with the following table 2-3.

Stage	From	To
First Phase	November 2003	March 2004
Second Phase	April 2004	March 2005
Third Phase	April 2005	February 2006

Table 2-3. Work Stages

The entire program for the execution of the Study is shown in the following figure 2-3, Work Schedule is shown in figure 2-4 and Assignment of Study Team member is shown in figure 2-5.

Figure 2-3 Workflow of Topographic Mapping

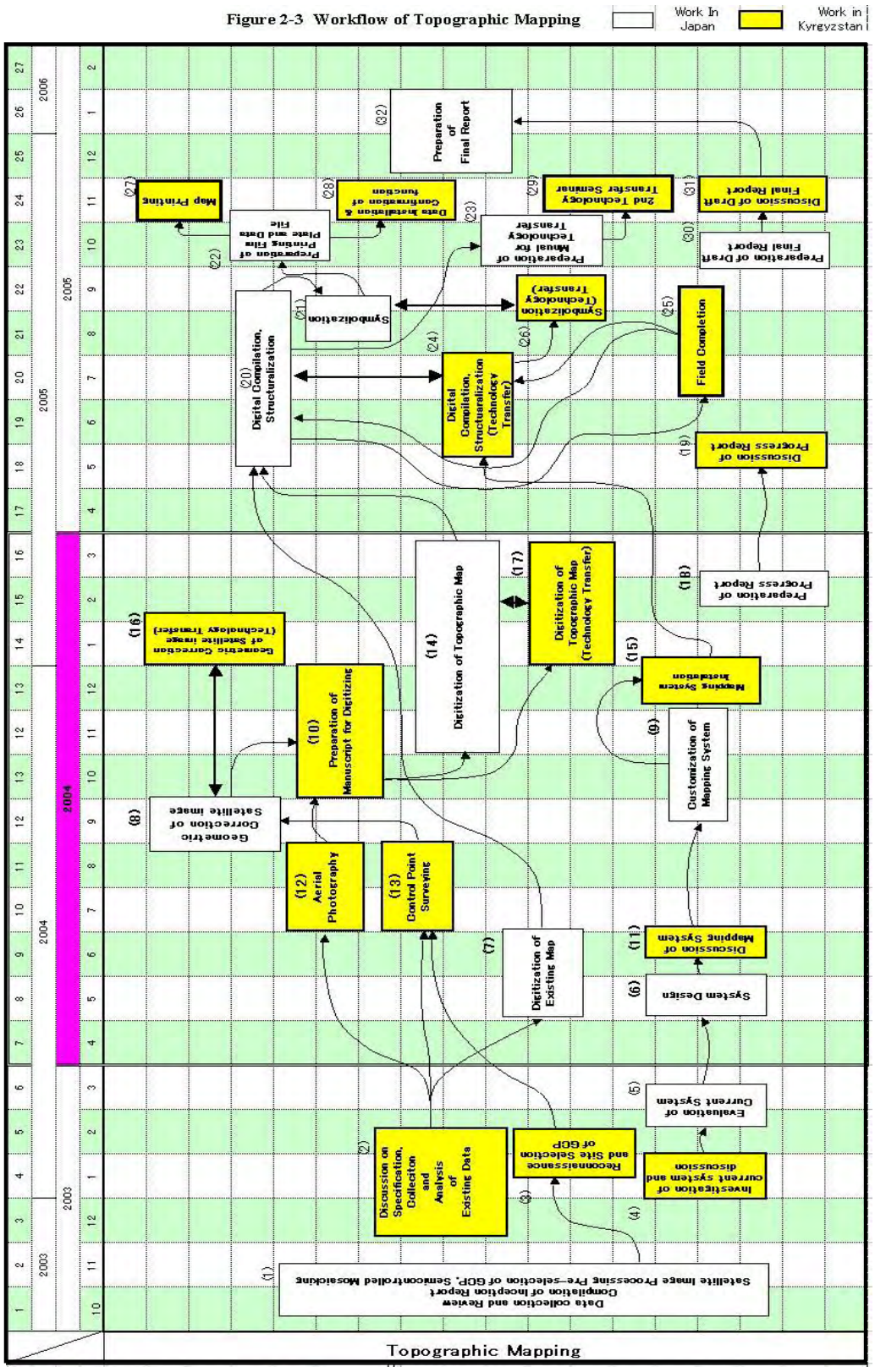


Figure 2-4 Work Schedule

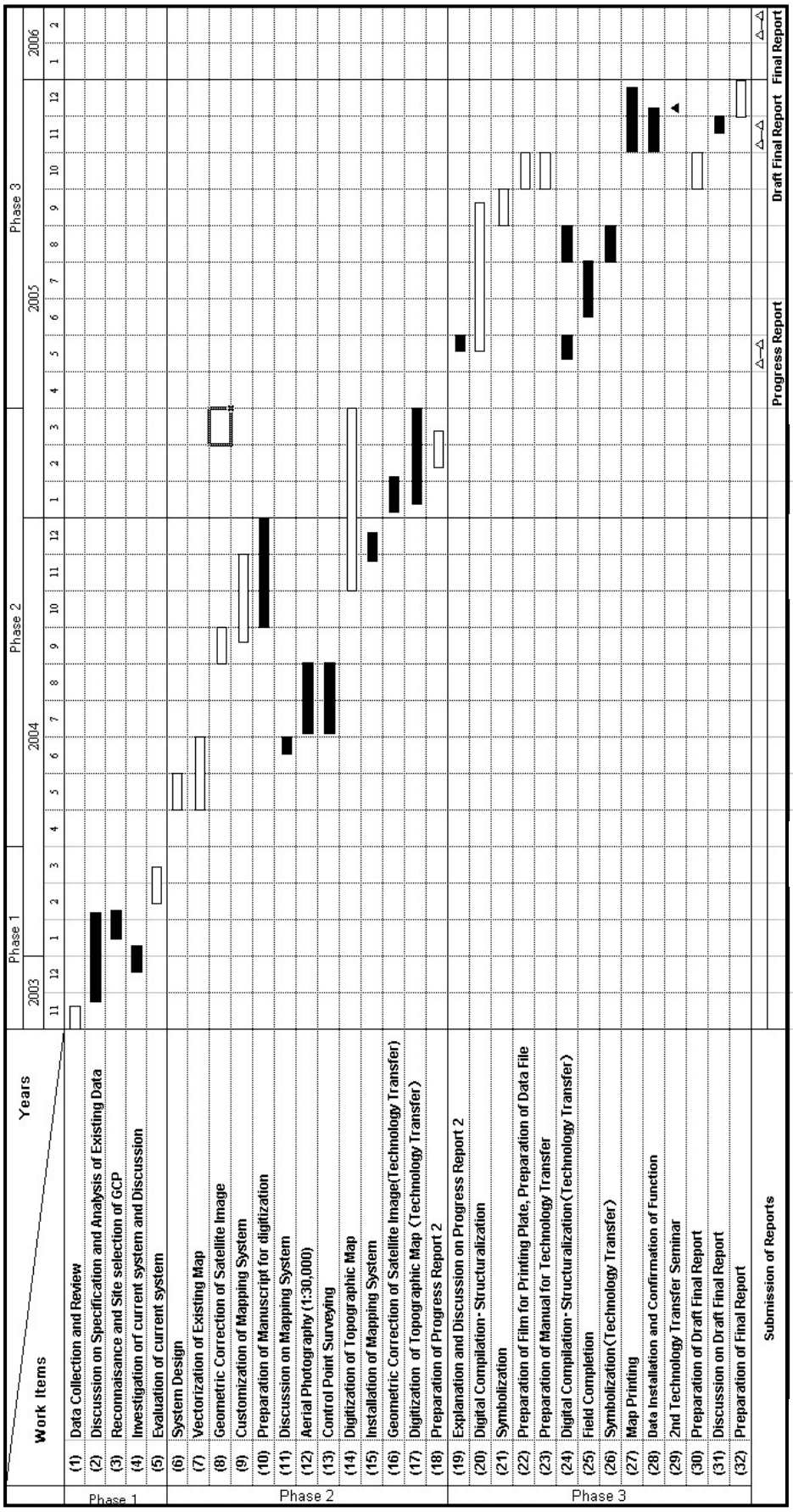
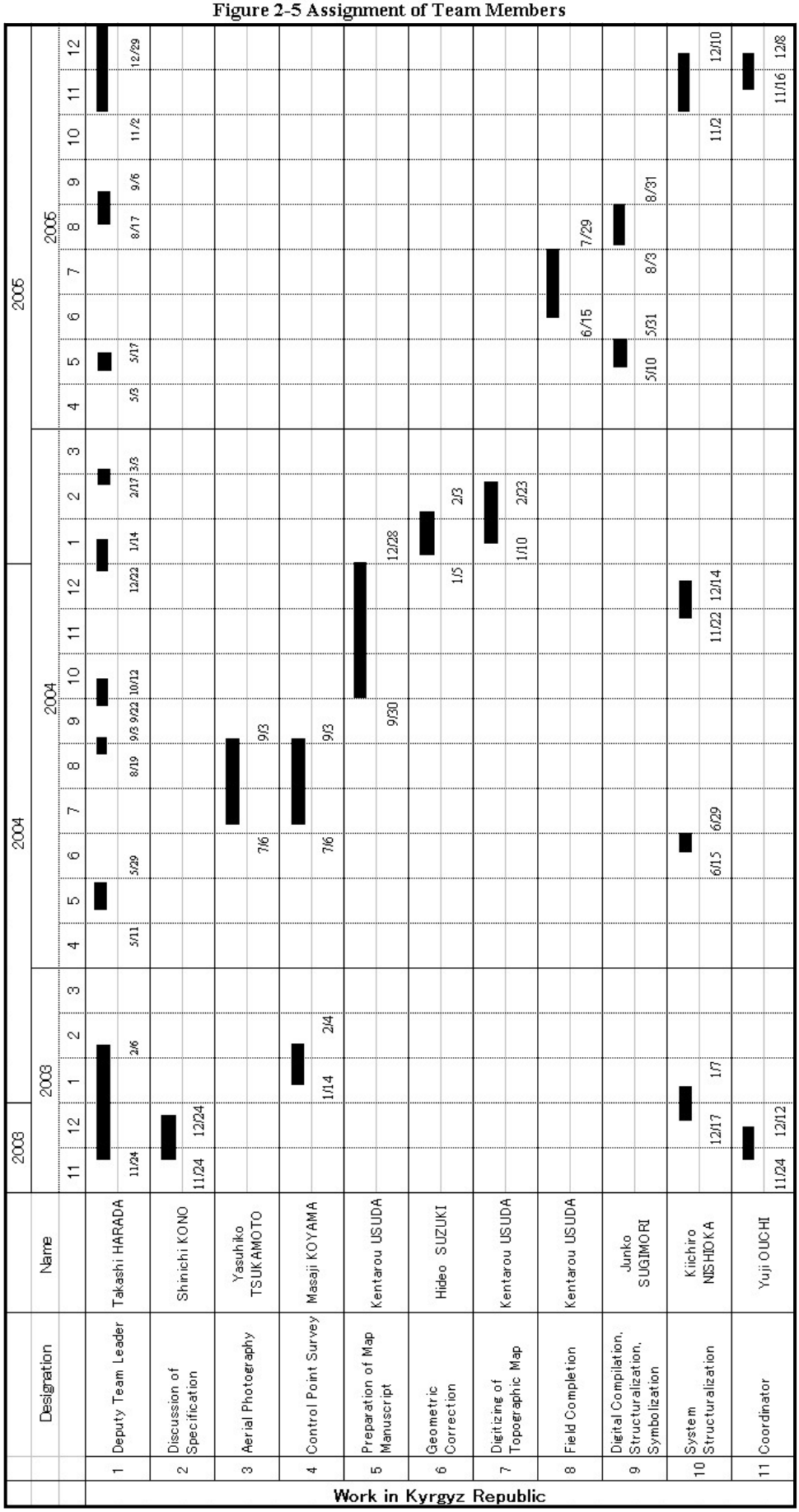


Figure 2-5 Assignment of Team Members



3. FINAL PRODUCT

3. FINAL PRODUCT

Final products to be delivered is shown in the table 3-1.

1) Aerial Photography	
Negative film	1 set
Contact print	1set for 1:100,000 scale mapping area (for GOK)
	1set for 1:25,000 scale mapping area (for GOK)
2) Digital Mapping Data	
Digital Topographic map data file	2 sets (CD-ROM) for GOK
DEM data file	2 sets (CD-ROM) for GOK
3) Topographic map	
Printing film for offset prints	1 set (for GOK)
Printed Map	503 sets of each Topographic map (500 sets for GOK, 3 sets for GOJ)
Printed Maps by inkjet printer	2 sets (for GOK)
4) Final Report & Summary	1 set
5) * Working Manual	1 set

Table 3-1. Final Product

* Working manual includes the following work items.

- Geometric Correction
- Production of Map Manuscript
- Digital Mapping (includes Digitizing of Map Manuscript, Digital compilation, Symbolization and Data structuralization)

All the intermediate materials acquired in the study process as satellite images, control points survey result and etc, were donated to the SSGC, Kyrgyz Republic. Figure 3-1 and 3-2 shows the Topographic Maps of each scale for final result.

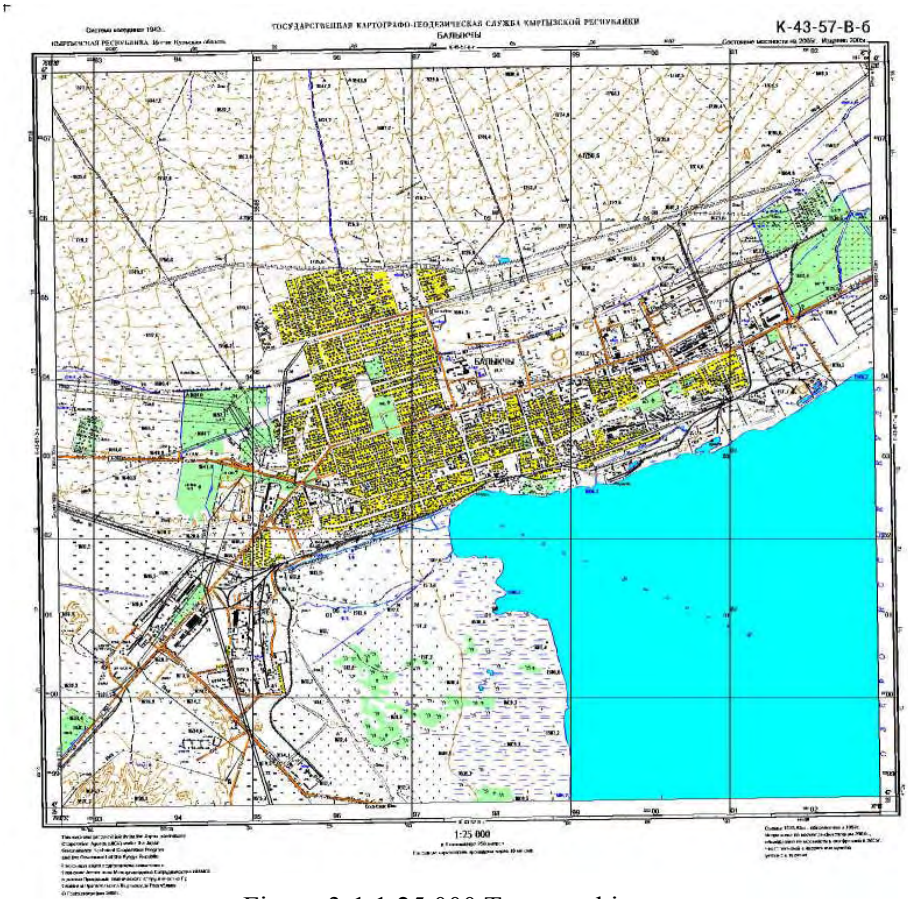


Figure 3-1 1:25,000 Topographic map

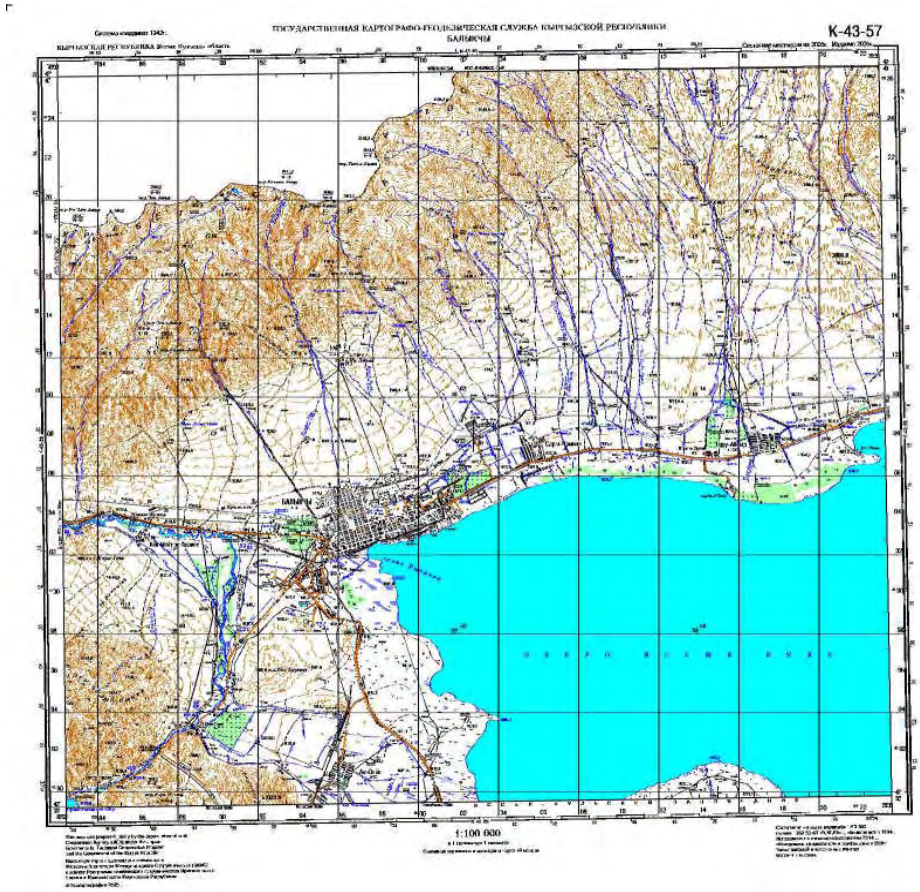


Figure 3-2 1:100,000 Topographic map

4. DONATED INSTRUMENT & SOFTWARE

4. DONATED EQUIPMENT & SOFTWARE

Equipment and software were donated in first and second stage respectively. Donated equipment and software to SSGC are shown in following table 4-1.

No.	Items	QTY	Unit	Production & Remarks
1	Personal Computer	1	set	MicroSoft Office XP-Professional
2	Transceiver	5	sets	GPS survey, Alinco
3	Generator	5	sets	GPS survey, SUZUKI
4	Uninterruptible Power Supply	1	sets	For Personal Computer
5	CAD software	1	set	MicroStation J, Bentley
6	GIS software	1	set	ArcView 8.3, ESRI
7	Image Processing software	1	set	Satellite Image, PCI
8	Car Battery	5	sets	For GPS Surveying

Table 4-1. Donated equipment and software

5. TECHNOLOGY TRANSFER

5. TECHNOLOGY TRANSFER

Technology transfer was carried out during study implementation by OJT thorough actual works. The evaluation of Technology transfer can be made through results of seminars and production of trekking map. Additional technology transfer was carried out on counter part training program in Japan.

5-1. Comparison of Result of Technology Transfer of SSGC

SSGC estimates the results of Technology transfer for individual related works as following table 5-1.

	Old technology	New technology	Advantage of new technology
1	There was no system of coding of objects of a map and corresponding to it library of symbols. Each time the operator should adjust style, thickness and color of a line for each new map object.	There is a special system of coding of objects of a map and library of symbols corresponding to it. For digitizing a new map object it is necessary to choose only a code of a map object.	Process of digitizing of a map is accelerated dramatically. The greater convenience of work.
2	As a result of digitizing it is necessary to prepare 2 files manually: File for a printing of a map on a Plotter (PLOT-file); File for GIS	It is created only 1 DGN-file. Preparation of a file for a printing of a map (PLT-file) and file for GIS is carried out automatically in the process of symbolization and structuralization accordingly.	Process of digitizing of a map accelerates dramatically. The greater convenience of work.
3	The initial original of a map had no codes	The initial original of a map (manuscript) has codes.	Process of digitizing of a map accelerates dramatically. Process of digitizing becomes simpler. Operators of lower qualification can carry out digitizing.
4	30-40 days were required for digitizing 1 map sheet	25 days are required for digitizing 1 map sheet.	Productivity of digitizing has increased minimum 1.5 times.

Table 5-1. Result of Technology Transfer

5-2. Geometric Correction of Satellite Image

OJT on orientation and geometric correction of satellite images was held in SSGC in Kyrgyz Republic. Training was conducted with the use of soft-and-hardware supplied by JICA.
Transferred technology includes:

- Basic knowledge of satellite imagery
- Acquisition of satellite image data
- Import of data into systems
- Geometric correction of satellite imagery
- Mosaicking
- Image processing

Technology transfer by OJT was carried out with the processing manual prepared beforehand. After explaining the whole practical process with SPOT5 data, the counterpart agency processed orthogonal correction without assistance of the Study Team. The result of orthogonal correction was within one pixel size of SPOT5 image, and it was sufficiently accurate for the purpose of topographic mapping data acquisition.
The SSGC was familiar with digital aerial orthogonal photo correction and knew basics of digital image processing. This experience made understanding of satellite image processing easier and faster.

5-3. Digitization of Topographic Map

Based on the result of digitization work of Topographic maps in Japan, technology transfer of the preparation of digital mapping data was carried out through OJT. The detail of work procedure and key points are mentioned in paragraph of Digitization of Topographic map, Chapter 3. The work volume of the SSGC is in the following table 5-2.

No.	Map scale	No. of sheets	Sheet number	Area (sq. km approx.) (w/o water Part)
1	1:100,000	1 sheets	K-43-57 (Balykchi)	1,000
				Total 1,000k2
2	1:25,000	3 sheets	K-43-57-G-a	25
			K-43-58-B-a	83
			K-43-57-B-g	94
				Total 202km2

Table 5-2. Digitization Work volume of SSGC under technology transfer program

Outline of work process and main points of the work were as follows:

- Basic knowledge of customized MicroStation
- Operation of customized MicroStation
- Structure of MicroStation system file
- Acquisition of digital vector data from the raster data of Topographic map manuscript
- Conversion of MicroStation data for the GIS basic data

5-4. Digital Compilation and Structuralization

Technology transfer on the digital compilation and structuralization was carried out by OJT. Outline of the process is as follows:

- Consideration of the data (objects) for Structuralization
- Connection of line features, closing polygon feature
- Method of transformation of structuralized data to prescribed data format

5-5. Symbolization

Technology transfer on the symbolization was done by OJT. Outline of the process is as follows:

- Preparation of marginal information
- Preparation of marginal information files at each map sheet
- Compilation of structuralized data (first step compilation)
- Transformation of vector data to raster data
- Plotting of each map sheet
- Visual checking
- Transformation of symbolized data for prescribed data format and arrangement at each map sheet unit

5-6. Counterpart Training in Japan

To confirm the transferred technology to the SSGC, SSGC Director, Mr. Tzurkov Valery Egorovich, in the period from 26th September to 5th October and SSGC Deputy Director, Mr. Obidenko Vladimir Ivanovich, in the period from 26th September to 18th October, visited Japan as trainees. Training classes were related to the Study work. Questionnaires were submitted in advance by trainees. Training schedule is shown on the following table 4-2. Digital Mapping,

Symbolization and Data Structuralization with customized program. were the main issues of training.

5-7. Disclosure of Topographic Maps and Data

SSGC will disclose and transfer printed Topographic Maps and digital data to the organizations which activities are related to the development of Issyk-Kul zone and the local government, depending on their needs and free of charge. But in case of data conversion necessity, the corresponding work will be charged accordingly.

5-8. Distribution of Topographic Maps

SSGC will distribute printed Topographic Map to the organizations related to the development of Issyk-Kul zone. The produced maps will be distributed to concerned organization and companies through SSGC.

5-9. 2nd Technology Transfer Seminar

The second technology transfer seminar was held to present the result of this project at the end of the 3rd stage. Invitation was announced to the officials of authorities and organizations, personnel and so on, concerning to the Study. Presentation of the Study was carried out by SSGC with the support of Study team

(1) Objective of Seminar

The objectives of Seminar were;

- To explain the necessity of sharing data and information among governmental organizations and research institutes.
- To show the final result of the Study and how to use map data in various field especially GIS basic data.
- To confirm the result of Technology transfer through the seminar.
- To make contents and significance of the Study for SSGC clear to the concerned personnel and other staff who didn't participate in this Study.

(2) Agenda of the Seminar

The Agenda of Seminar was following.

I. Registration: 9:30 – 10:00

II. Honorable Speeches

2-1	Opening speech:	A.ZH. ZHOLDOSHEV Director of the State Agency on Registration of Rights to Immovable Property (Gosregistr) under the Government of the Kyrgyz Republic	10:05 – 10:10
2-2	VIP-guest's salutation:	KASAI TATSUHIKO Charge d'affaires ad interim of Japan Embassy of Japan in Kyrgyz Republic	10:10 – 10:15
2-3	Guest of honor's Salutation:	NAKANO SATOSHI Resident Representative, Kyrgyz Republic Office Japan International Cooperation Agency (JICA)	10:15 – 10:20
2-4	Salutation:	TSURKOV V.E. Director of the State Service of Geodesy and Cartography (Goscartography) under Gosregistr of the Kyrgyz Republic	10:20 – 10:25

III. Technical Speech A

3-1	Outline of Project	V.I. OBIDENKO Deputy director of the State Service of Geodesy and Cartography (Goscartography) under Gosregistr of the Kyrgyz Republic	10:30 – 10:40
3-2	Topographic Mapping • Mapping Work Procedure • Creation of Satellite Orthophoto image • Technology Transfer • Results of Study Question and Answer		10:40 – 11:10 11:15 – 11:30

IV. Technical Speech B

4-1	Application of Topographic map Data in GIS ALEXANDR BOBROVSKY Head of GIS Department, The State Service of Geodesy and Cartography (Goscartography)	11:45 – 12:15
4-2	Demonstration of GIS Application Fly Through in Issyk-Kul area	12:15 – 12:30
	Question and Answer	12:30 – 12:45

(3) Participants to the Seminar

Number of Participants attended to the Seminar was 119 approximately from around 44 authorities, organizations and media.

(4) Distribution of JICA_Net CD_ROM

By the courtesy of JICA Kyrgyz Republic office, JICA_Net CD_ROM were distributed to the organizations participated in the seminar. The content was created in order to promote Remote sensing and GIS for the sustainable development of natural resources and environment in developing countries.

5-10. Trekking Map

SSGC prepared Trekking map at the south vicinity of Karakul city with the help of transferred technology as the one of the topographic data application. SSGC worked on the most of data collection and processing work. Deserving special mention is that SSGC produced digital data of 1/3 of data shortage part by themselves. Study team did nothing except other than provision of three dimensioned shadow data of that area. SSGC expects this technology will help further mapping mission in their future. The detail is mentioned in paragraph **5. Recommendation.**

6. RECOMMENDATION

6. RECOMMENDATION

6-1. Recommendation Related to Topographic Map Production

To develop the technology of topographic map production of SSGC, Study team recommends the followings.

(1) Technical matters

1) Training of System Engineer

Nowadays computer technology is being continuously improved. (day by day on a global mass scale). At the same time the technology of spatial data processing is being developed quickly too by mapping firms. During the project implementation the Study team has revealed that SSGC needs more specific (concrete) knowledge and technology for system development to process mapping data. Topographic mapping can be done by the standard function of MicroStation but to accelerate work progress and to save expenses of mapping production, higher-level system development is needed. Otherwise the transferred technology from Study team to SSGC on the development of spatial data for mapping won't be effective in future.

Training of System engineers for SSGC can be carried out by .their participation in training programs of foreign governmental organizations. But the training period should be more than half year depending on the course and ability of participant.

Another way is to invite foreign expert on the technical assistance program. The expert will give the opportunity to learn system development in trainees situations (circumstances) and a number of trainees can participate at the same time.

2) Operators for digitization

Operators for map digitizing should have knowledge of photogrammetry and cartography, such as photograph interpretation and understand symbols specification, at least. The speed of digitizing is very important to consume work quantity. Operator's knowledge will help to reach high productivity of mapping work.

(2) Administrative matters

1) Disclosure of Topographic maps and data

Before completion of map production, Study team addressed to the counterpart, SSGC, to provide the approval of disclosure of Topographic maps for the future wide usage of map data. The Kyrgyz government officially took action on this request and sent the official letter to the Study team through JICA Kyrgyz Republic office.
However publishing of topographic map was approved only for maps of 1:25,000 and 1:100,000 scale. Study team requested SSGC to continue work on production of new topographic map data in future for other parts of Kyrgyz Republic to assist the development and improvement of social economy in the Kyrgyz Republic.

As a result of above mentioned matters, it is considered important for SSGC to apply effort for laying down laws, regulations and standards of survey and map production that SSGC carried out, and to prepare the standards based on transferred technology, such as symbol specification for digitizing, working manual and so on.

2) Maintenance Budget

Taking into consideration the governmental budget for the management and maintenance of SSGC, it is not clear whether the maintenance and running cost of SSGC are sufficient or not. However, to develop additional production aids such as computer, plotter and other peripheral devices and software, to make more income, is necessary. SSGC is producing several map products such as city map, trekking map, tourism map and so on. But SSGC has to manage more their own income taking into consideration established (lay down) laws and regulations.

(3) Future production of Topographic map data

JICA Study team recommended SSGC to continue map-revising. Nowadays, digital mapping data is more convenient for the use and easy for processing, updating and handling. SSGC is the only one organization that has a right and power to create the National base map in Kyrgyz Republic. JICA Study team expects that in future SSGC can produce or revise mapping data applying transferred technology.

SSGC commented as following to recommendation of JICA Study team.

- Due to the development of computer technology mapping works are improving and work progress can be achieved promptly comparing to the conventional

method. But hardware and software required for this technology are quite expensive.

- SSGC meets lack of budget to apply their skill to the latest technology.
- Transferred technology might be efficient for the next 5 or 6 years. SSGC is expecting to have further cooperation to update the technology again on other areas of Kyrgyz Republic (paragraph 4).

(4) Future plan of SSGC

SSGC is planning to produce maps for tourism development in other areas of Kyrgyz Republic applying the same technology in future. The map scale should be 1:50,000 because of multi purpose mapping.

The targeting area of future project is shown in the following figure 6-1. Priority is shown as a number with circle. Taking into consideration this fact, JICA study team recommends to send Japanese experts to Kyrgyz Republic to ensure further mapping technology for production necessary mapping data.

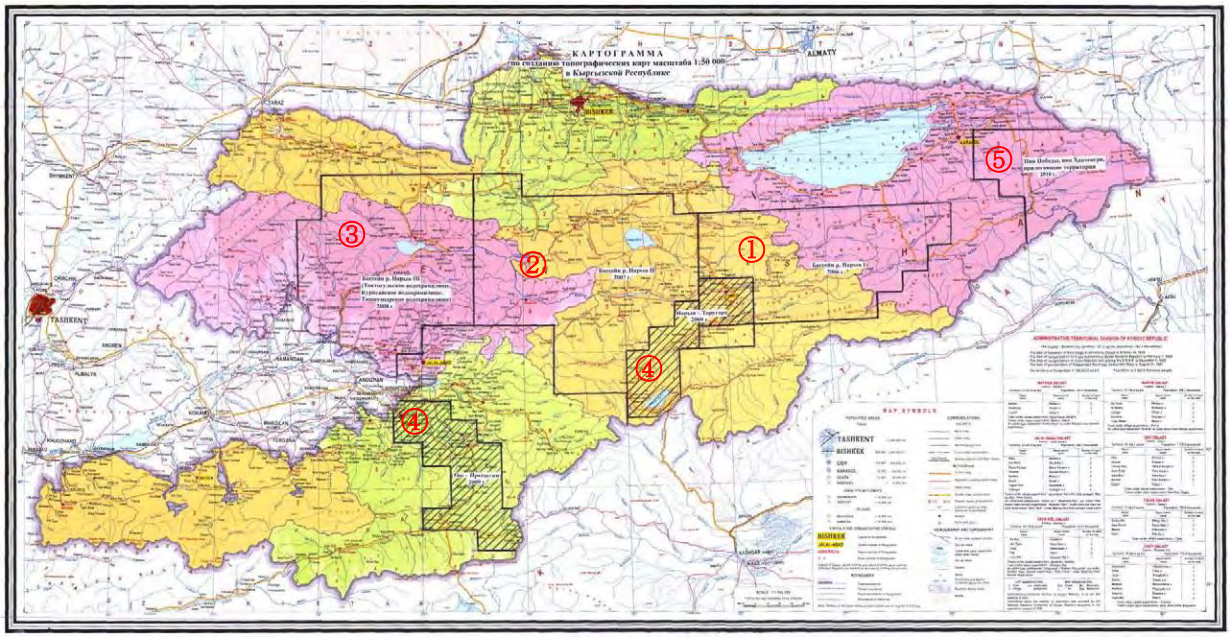


Figure 6-1. Expected Area of Future Project

(5) Application of Topographic map

Study team proposed SSGC to produce following products as the examples of application of topographic map.

1) Trekking Map

Towards the active utilization of digital map data, the Study team examined the method and organization for the arrangement, utilization and updating of map data. Study team proposed SSGC to produce trekking map as an example of map data application. The target place for trekking map production was Karakol city, the eastern part of Issyk-Kul area. Study team made field reconnaissance to collect landmark information for the Trekking map during Phase 2 study. Trekking map was displayed and distributed to the attendants of 2nd technology transfer seminar. At the same time, as the example of topographic map data use, Study team created simple GIS at the Karakol city with the same purpose of trekker usage. This GIS application was disclosed in seminar held at the end of 3rd stage of the project.

During preparation of trekking map data, SSGC specialists carried out digitizing and processing of digital data for 26% of the trekking map territory (figure 6-2-1, 6-2-2) without any assistance of Study team. This fact confirmed that technology was transferred successfully.

Figure 6-2-1. Trekking Map front face

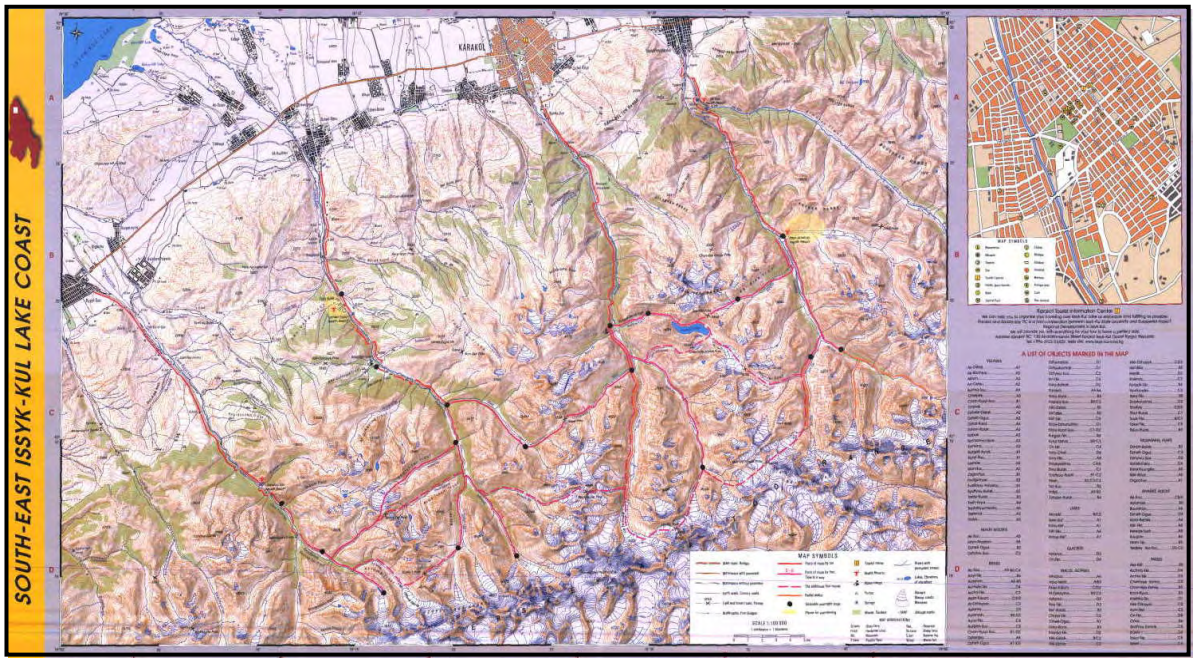


Figure 6-2-2. Trekking Map main face

2) LSG (Local Self Government) map

1:25,000 and 1:100,000 LSG maps were produced from Topographic map data as the one of the topographic map data usage. Maps were presented in the seminar. These maps can be used for local governance and development of social life. Map data is in digital format, therefore, it is easy to arrange and process data for required purposes. Updating of map is also easy and simple as suitable computers and software are available. In another case, local government can apply to SSGC to update the map or express necessary data for local government use on the LSG map. This is the typical way of profitable practical use of mapping data. Following figure 6-3 is the sample of LSG map scaled in 1:100,000.

Figure 6-3. Example of Topographic Data Application of Scale at 1:100,000 LSG Map

6-2. Recommendation on Usage of GIS data

The results of the Study are summarized as follows.

- 1:100,000 scale topographic and digital map data covering approximately 14,000km2.
- 1:25,000 scale topographic and digital map data covering approximately 2,300km2.
- Provision of personal computer with peripheral equipment
- Provision of software for digital mapping, satellite image processing, operating and mapping manuals, etc.
- Transfer of technology to the study

The 1:25,000 and 1:100,000 topographic and digital map data, covering 2,300km2, 14,000km2 around the Issyk-Kul area, can be used immediately for not only development of the area but various administrative purpose as it is a revised version of the existing 1:25,000 and 1:100,000 topographic maps respectively.

At the same time, some of ground features were structuralized to GIS basic data for individual scale topographic maps. This can provide a fundamental basis for GIS development in Issyk-Kul area, which can be used for various user interest and applications as basic spatial data.

The Study team recommends the Kyrgyz Government to create a unified database by adding necessary information to the basic data of individual scales provided by JICA Study team. This unified database should be developed for both analytical and management objectives in the next future stage. The expected GIS database for the Issyk-Kul zone is summarized in the following table 6-1.

No.	Field and Purposes	Advantages	Input data	Availability of input data
1	Water resources management Purpose: To implement appropriate water control (inlet-outlet and quality of water)	-Data are maintain in a standard format -Revision and updating are easier -Data and information are easier to search, analyze and represent -Data are more value added products -Data can be shared and exchange freely -Productivity is improved and more efficient -Time and money are saved	-River flow quantity (Average and extreme record)	yes
			-Subsurface water quality and water level	yes
			-Seasonal water quantity of irrigation and drainage	yes
			-Pollution	unknown
			-Soil classification and water permeability	unknown
2	Agricultural Land use Purpose: To evaluate and determine acceptable arable land	-do-	-Irrigation lands and rain-fed lands	yes
			-Crops, cropping pattern and production statistics	yes
			-Abandoned fields and causes	unknown
			-Land ownership	yes
3	Environment and ecology Purpose: To restore natural environment and ecology	-do-	-Land use classification	yes
			-Land cover classification	yes
			-Wildlife distribution and classification	yes
			-NOAA NVI image	yes
			-Hydrological data	yes
			-Contamination in water bodies	unknown
			-Micro-topography/detailed vegetation classification of vicinity of Issyk-Kul lake	yes
4	Social environment Purpose: To acquire and maintain minimum living standard	-do-	-Population statistics	yes
			-Social infrastructures	To be updated
			Public health	yes
			-Education	yes

Table 6-1. Expected GIS Database for Issyk-Kul Area

Study team expects that central and local government organizations, research institutions and international organizations have already acquired and studied most part of the above mentioned data.
However some data needs to be updated and oriented as geo-referenced data, other information needs to be acquired and analyzed.
To develop a Geographic Information System for the Issyk-Kul area, the following conditions should be established and observed

(1) Open classified framework data related to other agencies, experts and wide range of private users

The input data for the expected GIS database should be digitized by one central organization, for instance, State Service of Geodetic and Cartography, which is one of the major counterpart agencies in this study. The digitized data can be utilized on the framework data shared by concerning organizations. Also data updating should be managed by such organizations.

(2) Cooperation between various agencies and experts for exchanging the existing data in different fields

An interagency committee should be established to make coordination effective and the development of the inventory, analytical and management GIS application less redundant. Regular meetings should be held by experts of various fields to exchange their topics and opinions on updating input data, method of analysis, etc. For instance, in Japan, Information Exchange Organ has been established in order to facilitate information exchange.

(3) Sound user interests in GIS applications

Specific applications of GIS, such as water management, agricultural land use, environment and ecology and social environment should be demonstrated for users.

(4) Important factor for a suitable GIS

1) Data input

The cost of data input will make about 80% of the total GIS cost. More attention should be given to selection and classification of required Geo-spatial data by taking into consideration the digitizing method. To minimize the cost, detail assessment of available data should be done because it is quite expensive to develop new Geo-spatial data. We recommend to utilize satellite image data for Kyrgyz Republic for

development and updating of input data effectively. Satellite image data can cover wide area at lower cost comparing to aerial photographs.

2) Maintenance of data base

In the Kyrgyz Republic, routine maintenance of database is carried out by limited professional personnel and equipment. It is suggested to concentrate these works at one central organization.

3) Education

The GIS project should be supported not only by top managers but also by other administrative staff and engineers. Therefore, GIS education has to be extended to all members of GIS user organization.

4) Data sharing

Data sharing is one of the most important keys to minimize the total cost of data input and maximize the use of the database. Political and administrative problems should be solved to promote the data sharing for successful GIS.

7. DESCRIPTION OF WORKS

7. DESCRIPTION OF WORKS

1. First Phase

Following works were carried out in the First Phase.

1-1. Collection, Review and Analysis of Related Materials

The Study team collected, arranged and analyzed the existing data and material to understand well the actual situation of SSGC and the condition of Study area. Following materials were prepared based on the analysis:

- Plan of Study
- Draft of Specification
- Draft of Inception Report

1-2. Discussion and Preparation of Specification for Topographic Mapping

The SSGC possesses the unified map symbols used by CIS countries. However, SSGC did not possess any specification for digital mapping. Study team discussed with SSGC and prepared a specification of digital Topographic mapping. The specification contained following items:

- Map symbol and marginal information
- Digital Topographic map data structure as GIS basic data
- Survey standard

Survey stanrdard is as follows.

1. Reference Ellipsoid	:	Krassovsky 1940
Semi-Major Axis	:	6378245.00m
Flattening	:	1/298.26
2. Projection	:	Gauss-Kruger conformal projection
3. Coordinate System	:	CK1942 Zone13(Central meridian E 75 degree) Zone14(Central meridian E 81 degree)
4. Scale Factor	:	l.000 on the central meridian
5. Elevation	:	from 1/25,000 and 1/100,000 existing topographic map's elevations, those were derived from Baltic Mean Sea Level

6. Contour Interval : 10 meter for 1/25,000
40 meter for 1/100,000
7. Unit : Meter

1-3. Processing and Mosaicking of Satellite Image

The Spot satellite image was processed and simple mosaic images of 1:500,000 scale were printed for the study to hold the condition of Study area.

1-4. Pre-selection of Control Point

Using the 1:200,000 topographic maps and mosaic satellite image of 1:500,000 scale, suitable point for the ground control points were selected. High-resolution SPOT images of Study area were printed for GCP-GPS selection.

(1) Selection of GCP – GPS and GCP - MAP

Selected points of GCP-GPS and GCP-MAP are shown in the following table 7-1.

No.	Type of Points	Quantity of Selected Points
1	GCP – GPS	29 points
2	GCP – MAP	23 points

Table 7-1. Selected GCP-GPS and GCP-MAP

(2) Preparation of Point description

Point description was prepared for 29 selected points of GCP – GPS before implementation of field work in Japan.

(3) Surveying plan and schedule

Reconnaissance plan in Kyrgyz Republic was prepared and submitted to SSGC before fieldwork assignment for preparatory work such as instrument and transportation to Issyk-Kul area.

1-5. Evaluation of Actual Condition of SSGC

On the basis of the examination and discussion of system maintenance of SSGC, the result was that suitable mapping system was to be introduced to the mapping system of SSGC. Promotion of streamlining of mapping work was considered and added SSGC system to make data

management easier with the requirement of following several additional functions and extension.

- Additional function to input menu (Ex. Tracing of existing line)
- Additional function to Symbolization program. (Ex. Generate symbols at the corner of segment)
- Special input tool taking into account the function after the symbolization (Ex. housing block along the street, culvert or so)
- Application of Donut cognition method to the system as Donuts polygon element.

1-6. Acquisition of Existing Data and Materials

The work categories of acquisition of existing data and materials are as follows.

a) Collected data and materials

The Study team collected existing data from SSGC. Due to the remarkable change of geographical names after the independence, the latest data were needed for map updating work.

Following data and materials were collected from SSGC.

- Administration boundary
- Geographical name
- Contour line data

b) Preparation of duplicated original existing maps

Duplicated original of 1:25,000 and 1:100,000 Topographic maps were prepared for the acquisition of contour line and annotation.

1-7. Scanning Work of Existing Map for Digitization

At the beginning of the study, raster data of existing 1:50,000 and 1:200,000 maps was acquired by SSGC. The Study team supervised the scanning work to maintain required quality. The scanned maps are in shown in the following table 7-2.

Area	Map, scanned	Number of sheets
1:25,000 mapping area	1:50,000 Topographic map	Approx. 28 sheets
1:100,000 mapping area	1: 200,000 Topographic map	Approx. 7 sheets

Table 7-2. Number of scanned topographic maps

1-8. Field Reconnaissance and Selection of Control Point

Based on the pre-selected location of control points in Japan, reconnaissance of existing triangulation station and new GCP were carried out as follows.

(1) Preliminarily discussion

Study team had preliminary meeting with SSGC regarding the following work items.

- Plan of checking survey of existing triangulation points
- Observation plan and work execution
- Quality control

(2) Field reconnaissance

Study team visited the Study area to make field reconnaissance of the existing control points with the guide of SSGC. The purpose of site visit was checking control points as well as accommodation of field surveying parties, communication and condition of electric supply.

(3) Accuracy checking of existing triangulation points by GPS observation

1) Observation plan

Observation plan was made taking into account the existing triangulation stations being used for checking survey surrounding of Issyk-Kul Lake.

2) Result of Checking survey

As a result, discrepancy of distance between GPS surveying result and existing triangulation points was 0.68m in minimum and 1.91m in maximum. Therefore the accuracy of existing triangulation point was evaluated as sufficient for map production of 1:25,000 and 1:100,000.

3) Transformation Parameter

Study team and SSGC discussed Transformation parameter between WGS84 and SK42 for carrying out GCP-GPS observation..

4) Specification of GPS Observation

Specification of GPS observation is given in the following table 7-3.

No.	Items	Specification
1	GPS Instrument	LEICA SR520
2	Data acquisition	30 sec
3	Session No.	1
4	Logging time	1 hour < less than 50km
		2 hours < more than 50km

Table 7-3. Specification of GPS Observation

5) Tolerate accuracy of GPS observation

Tolerate accuracy of GPS observation is shown in the following table 7-4.

No.	Description	Accuracy
1	Closure of each base line vector element	45mm$\sqrt{}$N : number of side
2	Closure of duplicated each base line vector element	45mm

Table 7-4. Tolerate Accuracy of GPS Observation

6) Description of GCP-GPS

Filed checking of GCP-GPS was based on descriptions prepared in Japan in January 2004. Fieldwork was limited along the coastline of Issyk-Kul Lake due to the snow coverage in the project area. As a result five (5) points were selected and confirmed for GCP-GPS.

1-9. Setting of the Goal of the Project and Confirmation of Evaluation Method and Index

This Study was carried out with mutual cooperation between the Study team and SSGC. At the beginning of the Study, the goal of project was discussed and set up between both parties. The method and index for evaluation were decided. The goal of the project was to lead that SSGC can produce map data in future. Project evaluation was done based on the Seminar as colligation of technology transfer. SSGC should take into action all work criteria of the transferred technology and understanding the project by themselves. JICA Study team expects that Technology transfer was carried out properly in this project as long as created data was delivered and examined by Study team.

1-10. Examination and Discussion on Actual Condition of SSGC Related to the Computer Mapping

At he beginning of this project, Study team planed to apply actual computer mapping system to SSGC mapping system for the middle scale topographic mapping. But it was clear that the system level of SSGC was more than Study team expected when Study team checked a sample of 1:100,000 Topographic map data. It was therefore important that inspection of existing system and method of data production of SSGC had to be done carefully to direct the technology transfer and to find the equality between SSGC and Study team system. Following items are the result of examination.

(1) Digitizing Work in SSGC

Digitizing work in SSGC is carried out in GIS center and Photogrammetric section. SSGC produced only one sample of digitized 1:100,000 topographic map data. Study team examined and discussed with SSGC sample data.

(2) System Structure

Study team investigated and examined SSGC digitizing work system.

(3) Data Management in SSGC

Three licensed Russian Input menus were installed to existing system in SSGC but only for 1:500, 1:1,000, 1:2,500, 1:5,000 scale maps due to the symbol size determination at the side of input menu. In this case input menu denies the bigger input scale value.

Based on the result of examination, the Study team explained the content of technology transfer plan and system design to SSGC. Technology transfer plan and system design were discussed by Study team and SSGC to accept the final technology transfer plan, system design and customization plan.

2. Second Phase

Following works were carried out in the Second Phase.

2-1. System Design

Based on the system design and customize plan, new mapping system was designed with the account of the existing mapping system of SSGC. Principal composition of hardware and software are as follows:

Hardware

- Desktop computer
- Scanner (SSGC possesses already)
- Printer (SSGC possesses already)
- UPS

software

- Network Server
- Operation system
- CAD (MicroStation)
- Graphic software

2-2. Discussion of Mapping System

Based on the draft of mapping system design prepared in Japan, the Study team discussed with SSGC to prepare the final design of digital mapping system.

2-3. Vectorization of Existing Map

All information related to the elevation including contour lines were digitized in Japan based on scanned data of original existing maps.

2-4. Aerial Photography

Aerial Photography was achieved by the selected subcontractor through international tender. As a result, Aerial Photography Company of Republic of Kazakhstan, KAZAVIASPAS sub-contracted aerial photography works.

(1) Specification of Aerial Photography

The purpose of aerial photography was to supplement the identification and interpretation of features at mapping scales of 1:25,000 and 1:100,000 which could not be interpreted on satellite images due to their limited spatial resolution. B/W aerial photography coverage about 14,000km^2 which constitutes the whole study territory. The photography was completed in July and August 2004 the season of maximum vegetation cover.

- Aerial Camera : TAFA-10, Precision Photogrammetric Camera

Lens	: Ortogon-5A
Focal length	: 100,6943mm
Image format	: 18 x 18cm

- Platform : AN-30 Survey Aircraft

Serial Number of aircraft	: N30038
Navigation Method	: Autopilot, GPS Navigation System
Cruising time	: 5 hours and 30 minutes

(2) Plan of Photography

Due to the high mountainous area, flying heights had to be changed depending upon the altitude of mountain. The overlap and side-lap were taken into account to the big height difference. The photographed area and the outline of aerial photography are follows.

No.	Items		Details
1.	Area		: 14,000km^2 (approx.)
2.	Scale		: 1:30,000 approx.
3.	Overlap (forward overlap)		: 65% (Due to the high mountainous area) approx.
4.	Sidelap (lateral overlap)		: 35% (Due to the high mountainous area) approx.
5.	Film type		: Panchromatic
6.	Angular field		: 180mm×180mm
7.	Number of flight lines		: 30 lines (general)
8.	Number of photographs		: 2,482 photographs
9.	Reproduction	Negative film	: 1 set
		Contact prints	: 2 sets

(3) Flight Line of aerial photography

Flight line is shown as following figure 7-1.

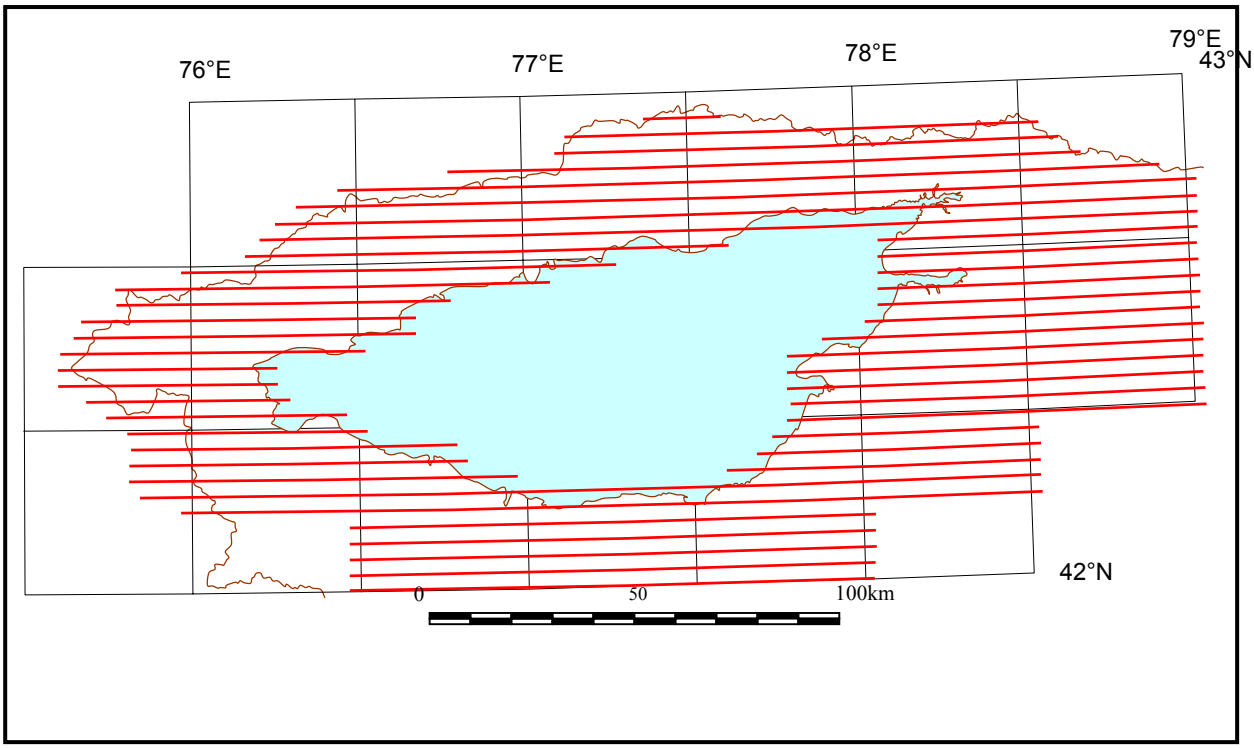


Figure 7-1. Flight Line

(4) Quality control of Aerial Photography

Photographs were checked after photographing flight immediately. In case the photographs did not meet to the required quality, re-flight was ordered to the subcontractor by the Study team. Quality Control Sheets are shown in Appendix 5.

2-5. Control Point Survey

GPS Control Point Survey was carried out to acquire the coordinates of GCP-GPS for the Geometric correction of Satellite Imagery. Technology Transfer of selection of GCP-GPS was carried out through the OJT.

(1) Work Volume

Work volume of GCP-GPS is shown in following table 7-5.

Category of points	Quantity
Ground Control Point(GCP)	: 29 points
Existing Triangulation Station (PTR)	: 12 stations
Existing Benchmarks (BM)	: 4 points
Existing Triangulation as a base station (BPTR)	: 8 stations (Used)

Table 7-5 Work Volume of GCP

Distribution of GCP and related existing control station is shown in following figure 7-2.

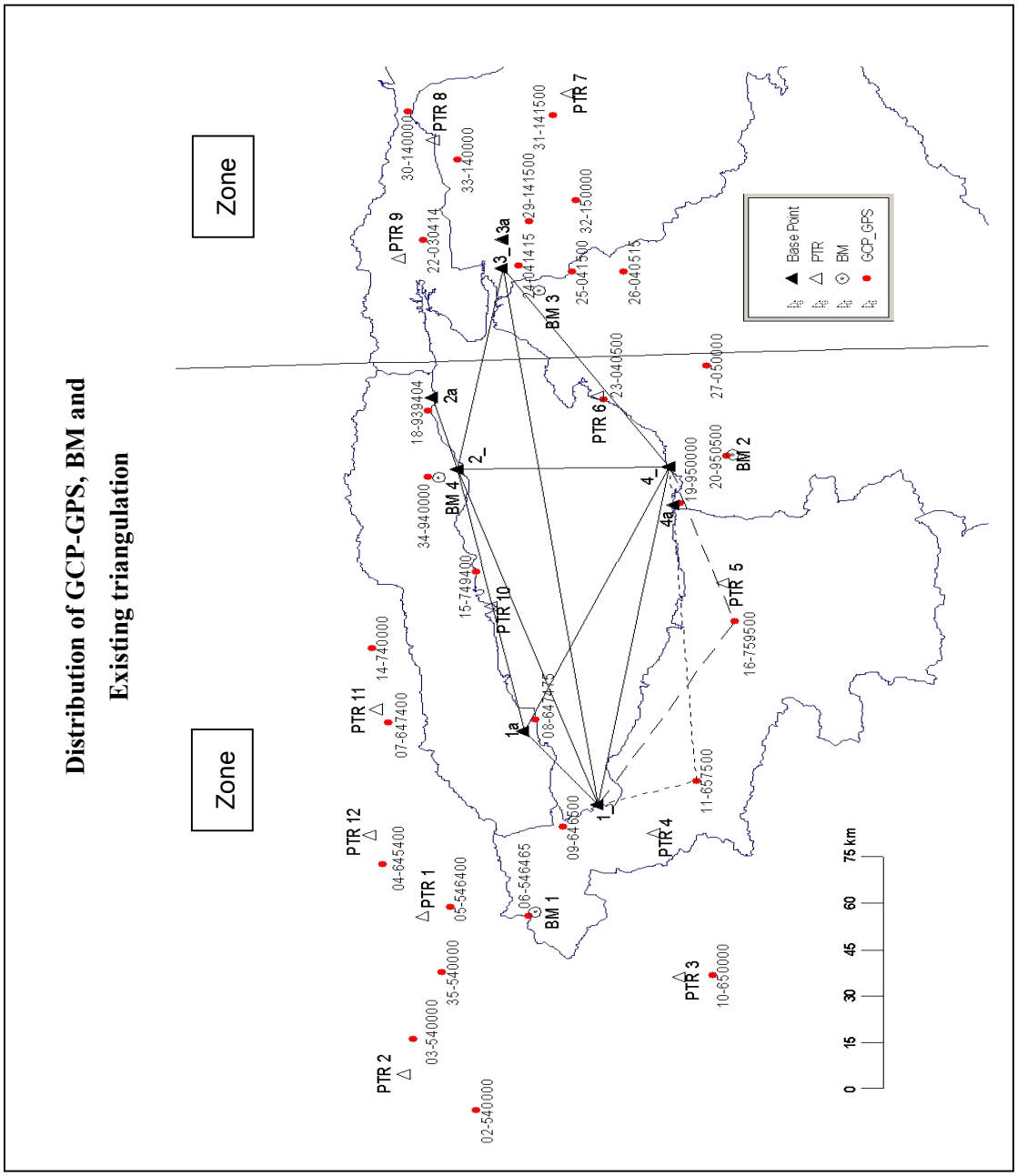


Figure 7-2. Distribution of GCP, related control points & Benchmarks

(2) Observation

GPS observation was carried out by SSGC in the period of July and August around 1.5 months with the supervision of Study team. The details of GPS survey are shown as follows.

Observation time	: GCP (New Control Point)	More than 2 hours
	: PTR (Existing Triangulation Station)	More than 3 hours
	: BM (Existing Benchmark)	More than 3 hours
Data acquisition	: EPOCH	10 second
	: Angle of elevation	More than 15 degrees
Quality Control	: 1) By Checking of closure	
	: 2) Checking Survey: 4 points	

(3) Quality Control of GPS Survey

Quality control was done with computed elevation. Confirmation of standard deviation for elevation and horizontal position was done with the quality control computation.

(4) Technology Transfer of GPS survey

The technology of GPS observation and related work of SSGC were transferred from Germany and Switzerland before this study. However the results haven't been effectively utilized, stored and evaluated as national information consistent with the work of SSGC. Therefore, Study team made technology transfer to plan and execute the GPS observation work to the SSGC.

2-6. Geometric (Orthogonal) Correction of Satellite Image

(1) Geometric (Orthogonal) Correction

Raw satellite image data contains distortion and does not coincide to Topographic map directly. Therefore, all of SPOT images were geometrically and orthogonally corrected for the production of map manuscript to be digitized. Geometric (Orthogonal) correction of SPOT5 images (15 scenes) was carried out using of GCP-GPS, GCP-MAP and DEM derived from contour line data of existing map.

For the control point reconnaissance in the field, Suitable point for the ground control points, such as shown below were selected. For this work, simply geometrically corrected and

geo-coded image was extracted from the satellite images and helped the interpretation of the control point in the field.

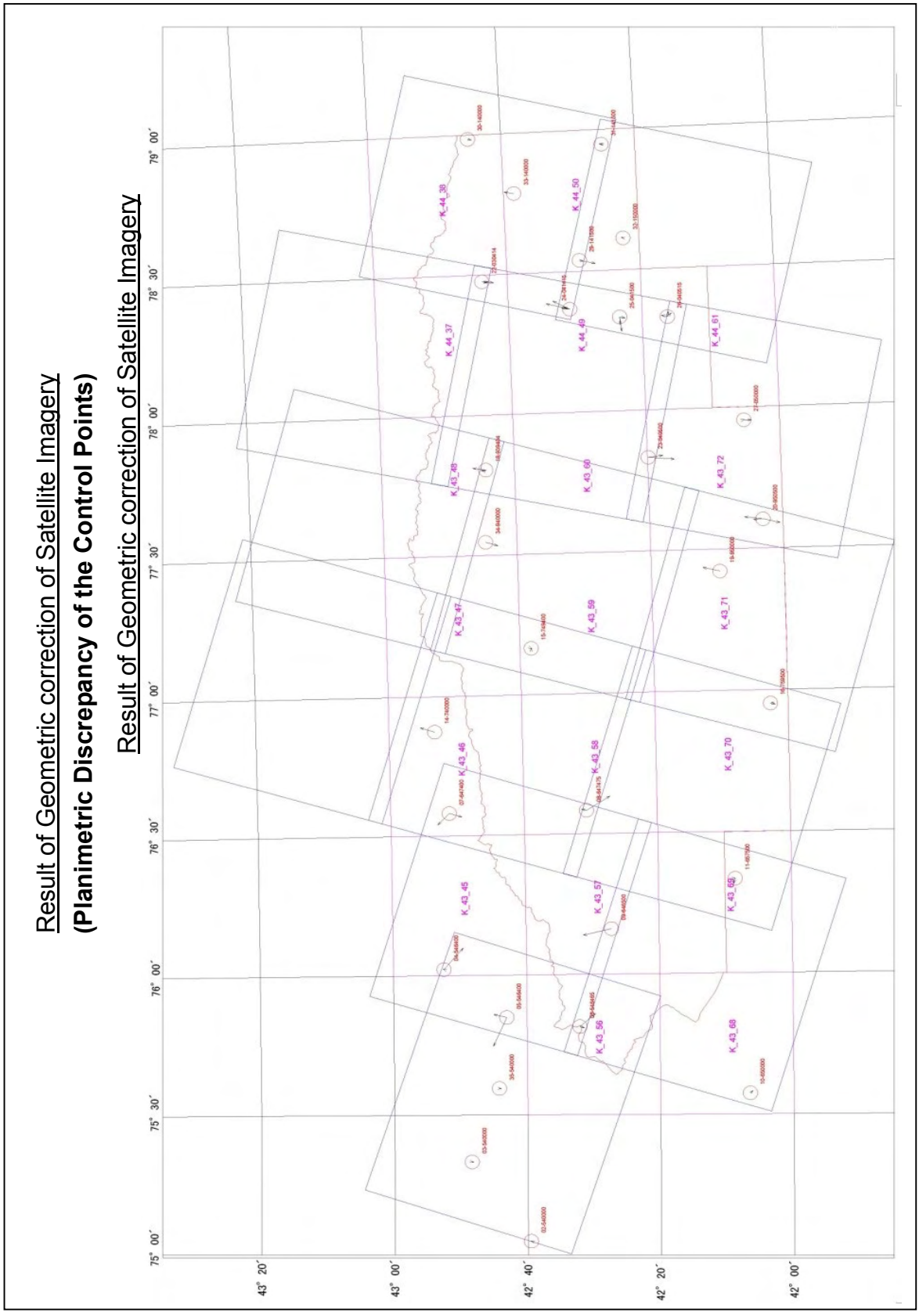
- GCP-GPS
- GCP-MAP

Geometric (Orthogonal) correction was carried out using two types of Ground Control Point, GCP_GPS and GCP_MAP and data of Digital Elevation Model.

(2) Accuracy of Geometric correction

As the project area is divided into two zones, Orthogonal correction was carried out individually. Errors in each zone are within one pixel resolution of SPOT5 image (2.5m), which is suitable to the accuracy of Geometric correction. The Planimetric deviation shown as vector line of RMS error report is shown in following figure 7-3.

Result of Geometric correction of Satellite Imagery
(Planimetric Discrepancy of the Control Points)



(3) Development of sheet-unit images (mosaicking + clipping)

Forty nine (49) frames of sheet-unit image were developed. Spatial resolution of images was maintained at 2.5m, which was equivalent to the original data. Therefore such images were used for interpretation of digital geographic data corresponding to 1:25,000 and 1:100,000 Topographic maps without problem of visibility due to pixel size.

(4) Development of Reseau marks

Numbers of Reseau marks were developed and given to corresponding Topographic map scales. Numbers of Reseau mark depend on the size of printed images for image interpretation.

(5) Printing of images for images interpretation

Sheets, enlarged 2-times for image interpretation for 1:100,000 scale, were printed based on Reseau marks. Each sheet was divided into quarters for 1:100,000.

2-7. Preparation of Manuscript for Digitizing

To prepare the current geographic information used in digital Topographic mapping, two kinds of Topographic map manuscripts at scales 1/25,000 and 1/50,000 were produced with support of geometrically corrected satellite imageries and stereo pair of aerial photographs.

(1) Work organization

This work was carried out by SSGC Aero Geodetic Complex Expedition under the supervision of the Study team.

(2) Manuscript sheets production

To transcribe map symbols and codes the following manuscript sheets were produced.

- Manuscript sheets at scale of 1/25,000 were copied on stable polyester films from their original printing plates. 30 sheets were produced.
- Manuscript sheets at scale of 1/50,000 were enlarged on stable polyester films from printing plate scale of 1/100,000. Fifty-four (54) sheets were produced.

(3) Data interpretation and transcription

An interpretation was carefully carried out comparing mosaic satellite imagery and the manuscript. The use of a set of overlapping aerial photographs was the great assistance for the interpretation of small and invisible objects on satellite image.

In accordance with classified map symbols, all of interpreted topographic features were transcribed on the manuscript with their unique code so that data could be converted as readily as possible to digital form later.

(4) Data checking and correction

After the data completion, SSGC and Study team conducted visual inspection of the data using an overlay. The following items were checked as consistency and correctness of data; (1) omission of code, (2) miss-description of code and matching of adjacent sheets. Extracted correction items were carried out. Study team also checked the result and prepared the checking list for quality control of the work.

(5) Data Scanning

After the data correction was carried out, map manuscripts were scanned in 24-bit color (TIFF) at 300dpi of resolution and rectified in RGB mode for giving an accurate geographic coordinates. Scanned image could be used as background raster data for data digitizing in MicroStation system.

2-8. Customization of Mapping System

(1) System customization

Functions of the mapping application were customized adapting to the system of SSGC. Customized functions are as follows:

- Registration of map symbol for the MicroStation application
- Support processing for structuralizing of map data
- Support processing for symbolizing of map data
- Transformation from the MicroStation format to the GIS basic data
- Registration of map symbol for graphic drawing application

(2) Preparation of System Maintenance Manual

System Maintenance Manual was prepared for Technology transfer to SSGC and for future SSGC. The manual contains the method of work and the operation of the system.

2-9. Mapping System Installation

Necessary software for digital mapping and updating of map data was set up and installed to the computer of SSGC. Installation of mapping system was done before the OJT of digital mapping work of SSGC.

2-10. Digitization of Topographic map

Digitization of Topographic maps was done with the account of the following points based on the Map Symbol Specification.

(1) Digitization of Topographic Maps

Digitalization of map categories was made with MicroStation, CAD software on the basis of satellite images with the results of image interpretation.

a. Map symbol registration and development of compilation support software

- Map symbols, agreed at the consultation of map symbols, were registered in CAD
- The data structure of line and polygon map symbols was decided in order to generate symbol parts automatically and support post-processing symbolization. Line map symbols contained data of a line and part of a symbol, which stick to a line data. Polygon map symbol is represented by area patterns filling potential surface.
- Support software recognizing digital map symbols with the account of data structure was developed
- Software for error inspection, as expression classification and data structure, was developed

b. Digital mapping

- Value unit of a coordinate is expressed in meter
- Oriented and geometrically corrected images were inspected with map features on the topographic map
- Map categories were digitized using geometrically corrected satellite images, classifying map symbols with the result of interpretation. Geometrically corrected satellite images contain location information. Interpretation results were used for obtaining information classification
- Digitized map data, including category of expression, data structure, etc. was inspected by inspection program developed in Japan

(2) Data acquisition taking into account of further Symbolization work

Data acquisition was carried out with the developed software in Japan. Following notes are examples when data was acquired.

- Buildings along the highway and street were shifted to symbolized position
- Culvert along and across the river and road were shifted its position taking into account the road symbolization.

(3) Data acquisition taking with account the Topology structure for GIS basic data.

Data acquisition of topology feature for GIS basic data was also carried out with the developed software in Japan.
Following notes are examples when data was acquired as GIS basic data.

- Building block adjacent to the street was acquired as Polygon data. .
- Data of road and street was acquired as centerline data for Network for GIS.
- Polygon data (Donuts polygon) such as vegetation, topography or other information were acquired as Duplicated polygon data.

2-11. Preparation of Progress Report

Progress report was prepared for the confirmation of work progress of the study and for the discussion on the Third Phase of the project.

3. Third Phase

Following works were carried out during the Third Phase.

3-1. Discussion of Progress Report

The second phase Progress report was discussed with SSGC. Main part of modification was the result of GCP_GPS. According to the regulation of Kyrgyz Republic, the coordinates of existing triangulation are prohibited to disclose. Study team accepted this offer and deleted the result.

3-2. Digital Compilation and Data Structuralization

Digital compilation, such as annotation, modification of digitized data, was carried out in Japan.

Digitized map data was structuralized to basic data used for GIS by application of MicroStation. Compilation of structuring data, such as connection of line feature and closing of polygon feature were carried out. Key points of Data structuralization were as follows.

- Data Structuralization was made only for the objects to be structuralized.
- Structuralized data was transformed to prescribed data format at each sheet unit and being arranged as Structuralization data file.

Classification of data as GIS basic data is shown following.

- Boundaries
- Control points
- Road network
- Railroad network
- Shorelines/rivers
- Inhabited areas
- Life-line
- Contour lines
- Annotation

3-3. Symbolization

Symbolization was made after the digital compilation work. As the map scale was small, most of ground features were expressed by map symbols.

Symbolization consisted of the following steps:

(1) Preparation of marginal information

- Common information for all sheets (Marginal Information) was prepared as graphic data by SSGC. Following note was expressed as one of the marginal information for all map sheets.

> This map was prepared jointly by the Japan International Cooperation Agency (JICA) under the Japan Governmental Technical Cooperation Program and the Government of Kyrgyz Republic.

(2) Work categories of Symbolization editing

- Compiled data was recompiled according to the results of field completion. The recompiled data was transformed for the first step compilation data, which was suitable for symbolization by using MicroStation application.
- Vector data after the first step compilation was transformed to raster data
- Map symbols, determined by discussion between Study team and SSGC were registered to the graphic processing application.
- Being the raster data as reference background, map symbols was transcribed and compiled by using graphic processing application.
- Symbolized data was combined with marginal information file.
- Combined data was plotted and checked visually.
- Checked and completed symbolized data was transformed for prescribed data format and arranged as symbolized data file..

3-4. Preparation of Film for Printing Plate and Data File

After the symbolization works were completed, output result of topographic maps were checked by JAPAN ASSOCIATION OF SURVEYORS and modified before creation of printing data.
By using of DGN file data after the modification, data was processed and converted to raster data for printing. Film for printing plate was prepared for further printing PS plates production works in the Kyrgyz Republic.

Outline of the preparation of data file was as follows:

- Structuralized vector data, symbolized data and orthogonal satellite image data were checked individually. The checked data were arranged in the data file according to the prescribed format and structure. Meta data for topographic map data was attached.
- Data files were arranged at each sheet file unit.

3-5. Preparation of Manual for Digital Mapping System

The work procedures including Geometric correction, Production of map manuscript, Digitizing works and system maintenance works were compiled as work manual in order that SSGC could produce and/or make updating of Topographic map quickly and rightly. The Manual includes preparation of work, working method, system operation method in each process and system designing.

3-6. Field Completion

Field Identification work was not carried out due to its onerous consumption of time and manpower resources and the limited amount of time available for completion of the whole study. The topographic features, which are difficult to be interpreted were investigated in the field after Digital compilation. Field completion was carried out based on the material in which the doubtful point and un-interpreted points exist. This process was carried out by SSGC under the Study team instruction and supervision. Using the results of Field completion, the corresponding part of digitized data was compiled.

3-7. Printing of Topographic map

Printing of 1:25,000 and 1:100,000 topographic maps was carried out by sub-contractor of Kyrgyz Republic with printing plates prepared in Japan. Five hundred and three (503) pieces per each sheet of a topographic map were developed by offset printing.
The quantity of printing of Topographic Map is as following table 7-6.

Topographic Map	Original Qty	Number of set	Total
♦ 1:25,000 Topographic Map	: 30 sheets	503 sets	15,090 sheets
♦ 1:100,000 Topographic Map	: 19 sheets	503 sets	9,557 sheets
Total			24,647 sheets

Table 7-6. Quantity of Printed Maps

The work was executed with German printing equipment ROLAND 700 taking into account of

following cautions and inspection procedure.
Printed maps were inspected by naked eyes visually. The inspection was performed to detect errors in contents, deviated print, color tone, dirtiness and such defects by referring to proof sheets. The number of passed maps was checked and recorded for Quality Control.

3-8. Data Installation and Confirmation of Function

Digital map data prepared by both Japanese and Kyrgyz sides were installed into the mapping system of SSGC. The function of the system was checked finally using the installed digital map data.

3-9. Preparation of Draft Final Report

Draft of final report was prepared for the discussion with SSGC before 2nd Technology Seminar.

3-10. Discussion of Draft Final Report

Draft Final Report prepared in Japan was discussed with SSGC to finalize the Final Report. Commented points of SSGC and amended parts were as follows.

a. Chapter 2. Outline of Study
   - 2-1. Objective of Study
     Add paragraph on practical technology.

b. Chapter 3. Final Results
   - Paragraph 5) Table 3-1
     Add work item to Working Manual.

c. Chapter 4. Technology Transfer
   - Add the paragraph of “Disclosure of Topographic Map Data” as 4-6.
   - 4-6. Technology Transfer
     Add explanation of data exchange between each governmental organization to the Objectives of the seminar as paragraph 4.

d. Chapter 5. Recommendation
   - Paragraph 5-1. Recommendation Related to Topographic Map Production to SSGC, Paragraph (3) Future production of Topographic map data.
     Add following explanation;

The SSGC will prepare the Topographic mapping production plan with transferred technology with utilizing of satellite image. The Study Team will provide information regarding the satellite image, including the cost and how to procure it to SSGC.

3-11. Preparation of Final Report

Final report was prepared according to the result of the discussion on Draft Final Report with SSGC.