

**State Authority for Geodetic Works  
The Former Yugoslav Republic of Macedonia**

**THE STUDY FOR  
ESTABLISHMENT OF STATE BASE MAPS FOR GIS  
IN THE FORMER YUGOSLAV  
REPUBLIC OF MACEDONIA**

**Final Report  
(Main)**

**December 2006**

**JAPAN INTERNATIONAL COOPERATION AGENCY  
KOKUSAI KOGYO, CO., LTD.**

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## PREFACE

In response to a request from the Government of Macedonia, the Government of Japan decided to conduct a study on The Study for Establishment of State Base Maps for GIS in the Republic of Macedonia and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr.Akira NISHIMURA of KOKUSAI KOGYO Co., LTD. and consists of KOKUSAI KOGYO Co., LTD. between March, 2004 and December, 2006.

The team held discussions with the officials concerned of the Government of Macedonia and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Macedonia for their close cooperation extended to the study.

December 2006

Kazuhisa MATSUOKA,  
Deputy Vice President  
Japan International Cooperation Agency

## LETTER OF TRANSMITTAL

Kazuhisa Matsuoka  
Deputy Vice President  
Japan International Cooperation Agency

It is an honor to submit herewith the report of the Study for Establishment of State Base Maps for GIS in the Republic of Macedonia. This report was prepared, incorporating the suggestions and advices received from the Japan International Cooperation Agency (JICA) and concerned authorities, as well as the agencies affiliated with the Government of Macedonia including the State Authority for Geodetic Works.

During the study, a spatial data infrastructure on a scale level 1:25,000 was established as a part of National Spatial Data Infrastructure for the Macedonia, and printed topographic maps were created on the same scale. In the meantime, techniques relating to this work (GPS survey, digital leveling, digitization of aerial photo film, digital triangulation, digital mapping/editing, GIS, printing data) were transferred to the State Authority for Geodetic Works of the Government of Macedonia. Furthermore, various activities related to the dissemination of geographic information (environmental map exhibition, forum, and press release etc.) were conducted.

In the final chapter of this report, specific recommendations are made based on the results of the study. From the perspective of maintaining and developing the results of the study, I hope that these recommendations will be promptly implemented by the agencies affiliated with the Government of Macedonia.

On behalf of the team, I would like to express my sincere gratitude to JICA, the Ministry of Foreign Affairs, the Ministry of Land, Infrastructure and Transport, and the affiliated agencies, for the valuable advice and cooperation they provided us with during the implementation of this study. I would also like to express my deep appreciation to the agencies affiliated with the Government of Macedonia, including the State Authority for Geodetic Works, for their generous assistance and cooperation during our stay in Macedonia.

December 2006

Akira Nishimura  
Team Leader  
The Study for Establishment of State Base Maps for  
GIS in the Republic of Macedonia

# Location Map of the Study for Establishment of State Base



**Former Yugoslav Republic of Macedonia**



# Photograph

(1/11)



Scenery of Skopje



Local Scenery of Macedonia



SAGW Office (Skopje)



Sign of SAGW (Skopje)



First Order Triangulation Point



Observation Tower of Triangulation Point



# Photograph

(2/11)



Installing Photo Signal  
(Photo Control Point Survey)



Observation  
(Photo Control Point Survey)



Levelling (Photo Control Point Survey)



Levelling (Photo Control Point Survey)



Field Identification (Preparation)



Field Identification (Field)

# Photograph

(3/11)



Supplementary Field Identification  
(Preparation)



Supplementary Field Identification  
(Field)



Field Identification for Land use DB  
(Field)



Field Identification for Land use DB  
(Arrangement of Results)



Technology Transfer (GPS Survey)



Technology Transfer (GPS Analysis)



# Photograph

(4/11)



Technology Transfer (Levelling)



Technology Transfer (Levelling)



Technology Transfer (Photogrammetry)



Technology Transfer (Photogrammetry)



Technology Transfer (Photogrammetry)



Technology Transfer (Photogrammetry)

# Photograph

(5/11)



Technology Transfer (Field Identification)



Technology Transfer (Field Identification)



Technology Transfer  
(Supplementary Field Identification)



Technology Transfer  
(Supplementary Field Identification)



Technology Transfer (GIS)



Technology Transfer (GIS)

# Photograph

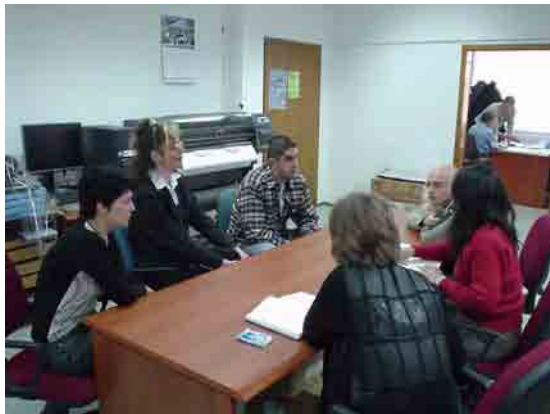
(6/11)



Technology Transfer (GIS)



Technology Transfer (GIS)



Technology Transfer (Printing Data)



Technology Transfer (Printing Data)



Technology Transfer (Printing Data)



Technology Transfer (Printing Data)



# Photograph

(7/11)



Dissemination of Geographic Information  
(Environmental Map Contest)



Dissemination of Geographic Information  
(Environmental Map Contest)



Dissemination of Geographic Information  
(Environmental Map Contest)



Dissemination of Geographic Information  
(Environmental Map Contest)



Visit to Neighboring Country (Czech)



Visit to Neighboring Country (Czech)

# Photograph

(8/11)



Visit to Neighboring Country (Hungary)



Visit to Neighboring Country (Hungary)



Visit to Neighboring Country (Slovenia)



Visit to Neighboring Country (Slovenia)



Dissemination of Geographic Information (Forum)



Dissemination of Geographic Information (Forum)



# Photograph

(9/11)



Dissemination of Geographic Information  
(Forum)



Dissemination of Geographic Information  
(Forum)



Dissemination of Geographic Information  
(Forum)



Dissemination of Geographic Information  
(Forum)



Dissemination of Geographic Information  
(Forum)



Dissemination of Geographic Information  
(Forum)

# Photograph

(10/11)



Work Shop



Work Shop



Seminar



Seminar



Press conference



Press conference

# Photograph

(11/11)



Equipment for Technology Transfer  
(Scanner)



Equipment for Technology Transfer  
(Plotter)



Equipment for Technology Transfer  
(Compiler)



Equipment for Technology Transfer  
(Macintosh)



Equipment for Technology Transfer  
(GPS receiver)



Equipment for Technology Transfer  
(Electric Level)

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## Chapter 1 Overview of the Study

### 1.1 Objectives of the Study

The objectives of the Study were as follows:

- ◆ **Production of national base maps (Establishment of spatial data infrastructure)**
- ◆ **Technology transfer**
- ◆ **Dissemination of geographic information**

#### 1.1.1 Production of National Base Maps (Establishment of Spatial Data Infrastructure)

The aim of the establishment of spatial data infrastructure was to generate the following products:

- ◆ Digital National Base Maps (1/25,000) (including the production of printed maps)
- ◆ GIS topographic map database

#### 1.1.2 Technology Transfer

The following technology transfers were conducted so that SAGW would be able to establish and utilize similar products independently after completion of the Study.

##### (1) Techniques for the establishment of spatial data infrastructure

Technology transfer for the establishment of spatial data infrastructure by the following land surveys and digital photogrammetric techniques was planned.

- a. Installation of aerial photo signals (including pricking)
- b. Photo control point survey (GPS survey, leveling)
- c. Field identification
- d. Aerial triangulation (digital method)
- e. Digital plotting
- f. Digital compilation
- g. Supplementary field identification
- h. Production of topographic map data
- i. Construction of topographic map database for GIS
- j. Production of data for printing

This technology transfer included methods for the planning, process control and quality control of the establishment of spatial data infrastructure.

## (2) GIS techniques

The technology transfer for GIS techniques included the following:

- a. Basics of GIS software
- b. Database construction
- c. Use of spatial data infrastructure in GIS
- d. GIS applications

### 1.1.3 Dissemination of geographic information

In order to disseminate geographic information to government agencies and the general public, the following activities were planned to be implemented.

- a. Dissemination and publicity activities for geographic information
- b. Improvement of the system for providing geographic information

## 1.2 Basic Policies of the Study

### 1.2.1 Basic policies of the study

The basic policies for implementation of the study based on the above objectives and scope of the study were as follows:

- (1) Basic policies for the production of national base maps (establishment of spatial data infrastructure)

Adoption of technical specifications that meet user needs

Establishment of spatial data infrastructure for general use

- (2) Basic policies for technology transfer

Transfer of digital techniques for establishing spatial data infrastructure

Transfer of techniques for using spatial data infrastructure in GIS

- (3) Basic policies for the dissemination of geographic information

Opening of geographic information to the public

Promotion of the use of geographic information

## **1.3 Target Area of the Study**

### **1.3.1 Target area for the production of national base maps**

The target area of this work was as follows:

a. Target area for the acquisition of aerial photo image data

The target area for the acquisition of aerial photo image data was the entire country, which has an area of approximately 25,713 km<sup>2</sup>. (Refer to Figure 1-1).

b. Target area for the production of national base maps (establishment of spatial data infrastructure)

The target area for the production of national base maps was approximately 14,145 km<sup>2</sup> of the national territory by 105 sheets (scale: 1/25,000). (Refer to Figure 1-2).

The target area for the OJT of the technology transfer was seven of the 105 sheets.

c. Scope of land use database construction

This work targeted approximately 3,556km<sup>2</sup> including the area of the Lake Ohrid conservation project in 30 sheets (1/25,000 sheets) (Refer to Figure 1-2).

d. Scope of environmental conservation database construction

As with the scope of land use database construction, this work targeted approximately 3,556 km<sup>2</sup> in 30 sheets (1/25,000 sheets) (Refer to Figure 1-2).

### **1.3.2 Target area for technology transfer**

The technology transfer was conducted for personnel from the various sections of SAGW.

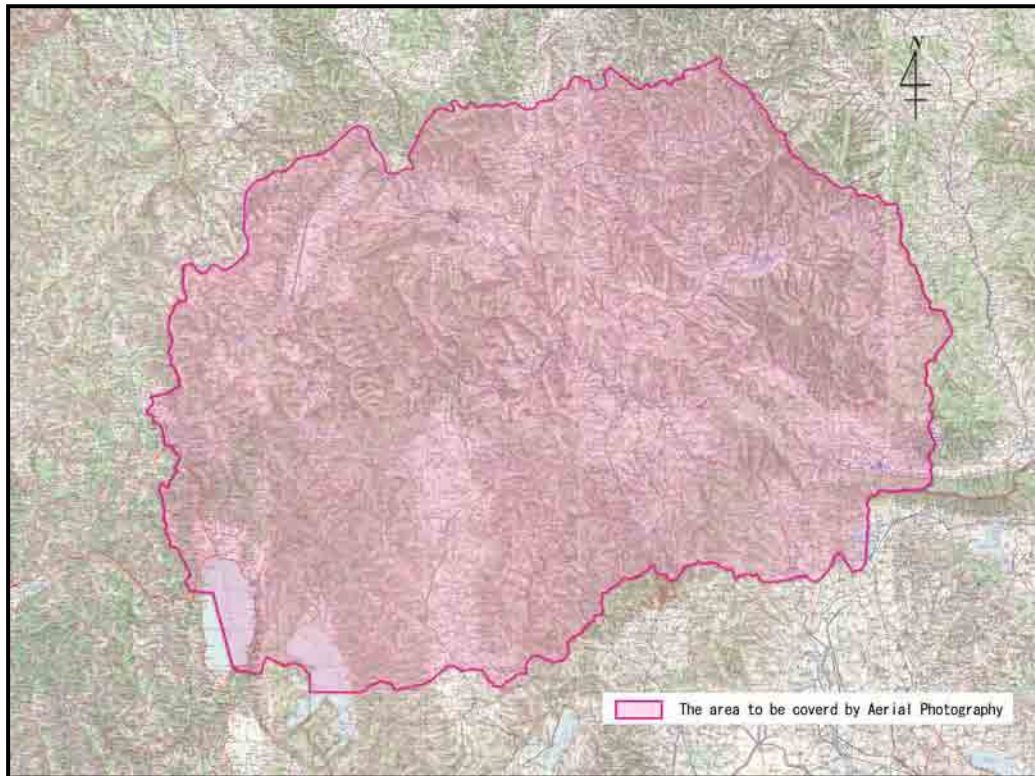


Figure 1-1 Target Area of Aerial Photo Image Data Acquisition (Target Area of Aerial Photography)

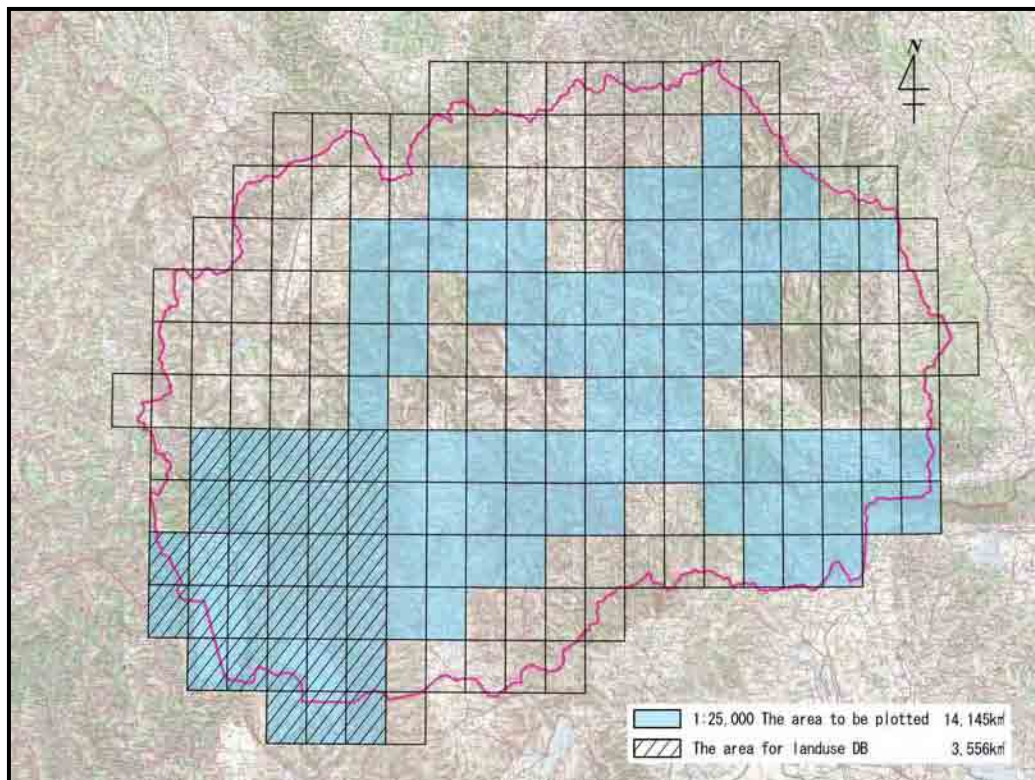


Figure 1-2 Target Area of National Base Map Production



### 1.3.3 Target for dissemination of geographic information

The target groups, other than SAGW, for the dissemination of geographic information were as follows.

- ◆ Government agencies and their concerned persons
- ◆ International institutions (Including donors from various countries)
- ◆ General public

## 1.4 Contents of the Study

### 1.4.1 Contents and volume of work

In order to achieve the objectives of the Study, the work was divided into the following three categories.

Category 1: Production of national base maps (establishment of spatial data infrastructure, construction of GIS database)

Category 2: Technology transfer

Category 3: Dissemination of geographic information

(1) Production of national base maps (establishment of spatial data infrastructure, construction of GIS database)

The contents and volume of this work are summarized in Table 1-1.

Table 1-1 Content and Volume of Work for the Production of National Base Maps

Work item	Description	Volume
Preparatory work in Japan	Making of various preparations required for implementation of the Study.	1 set
Survey of existing data and conditions related to geographic information	Survey and confirmation of various types of existing data related to topographic maps.	1 set
Discussions on specifications for spatial data infrastructure	Discussion and determination of specifications for the production of national base maps with the counterpart agency.	1 set
Reconnaissance of control points and selection of photo control points	Survey of the conditions of existing control points and selection of the positions of photo control points.	Photo control points: approx. 53
Installation of aerial photo signals	Installation of signals at the selected photo control points, the carrying out of pricking when necessary.	Approx. 53 points

#### 1.4 Contents of the Study

Work item	Description	Volume
Shooting of aerial photographs	Taking of aerial photographs at a scale of 1/40,000.	Approx. 25,712 km <sup>2</sup>
Photo control point survey	Carrying out of a photo control point survey, mainly by the GPS survey method.	Photo control points: 53
Field identification	Collection in the field, using the photographs taken, of the various types of information (place names, annotations, etc.) that could not be obtained through photo interpretation.	Approx. 14,145 km <sup>2</sup>
Aerial triangulation	Computation of the elements of orientation required for digital plotting using the results of the photo control point survey.	Approx. 1,625 models
Digital plotting	Carrying out of digital plotting at a level of 25,000, using the results of the aerial triangulation and the field identification.	Approx. 14,145 km <sup>2</sup>
Digital compilation	Carrying out of digital compilation in accordance with the symbols regulations, using the digitally plotted data.	Approx. 14,145 km <sup>2</sup>
Supplementary field identification	Confirmation in the field of any uncertainties that arose during the digital plotting and compilation.	Approx. 14,145 km <sup>2</sup>
Supplementary digital compilation	Compilation of the digital data based on the results of the supplementary field identification.	Approx. 14,145 km <sup>2</sup>
Establishment of topographic map data	Production of topographic map data per map sheet from the compiled data.	Approx. 105 sheets
Construction of topographic map database for GIS	Construction of a topographic map database that can be operated in GIS from the topographic map data.	Approx. 14,145 km <sup>2</sup>
Discussions on specifications for printed maps	Discussion and determination of the specifications for printed maps.	1 set
Production of data for printing	Compilation of the topographic map data produced per map sheet into data suitable for producing printed maps.	Approx. 105 sheets
Production of printed maps	Printing of maps after making of reproduction film and aluminum plates from the data for printing.	500 sets
Design of basin environment GIS	Discussion and determination of the specifications for data items necessary for the construction of an environmental GIS database, and collection of the concerned information.	1 set
Construction of land use database	Survey of land use in the field according to the land use items of the land use database.	Approx. 3,556km <sup>2</sup>
Construction of environmental conservation database	The environmental conservation database was constructed based on the design of the basin environment GIS	Approx. 3,556km <sup>2</sup>

## (2) Technology transfer

The items and its outline targeted in the technology transfer are summarized in Table 1-2.

Table 1-2 Techniques transferred

Field	Technique transferred	Outline
Land survey	Installation of aerial photo signals	Photographic scale and signal size Installation method
	GPS survey	Planning method Observation method Analysis method (baseline analysis, net adjustment) Coordinate conversion method
	Field identification (including supplementary field identification)	Planning method Implementation method Method of arranging the results
Digital photogrammetry	Aerial triangulation (digital)	Planning method Implementation method Method of evaluating the results
	Digital plotting	Operation of digital plotter Digital plotting Manipulation of plotted data
	Digital compilation	Setting of symbols Digital compilation Manipulation of compiled data
	Establishment of topographic map data	Data format and method for establishing data Manipulation of topographic map data
	Construction of topographic map database for GIS	Technique for constructing a GIS database from the topographic maps data
Production of printed maps	Production of data for printing	Production of marginal information and legend Production of data for printing
Use of spatial data infrastructure	Basics of GIS software	Mastering in the basic functions of GIS software, Training using the sample data
	GIS database construction	Method for construction of GIS database based on specification
	Spatial data infrastructure in GIS	Management and maintenance of spatial data infrastructure
	GIS applications	Presentation of some examples of GIS applications

(3) Dissemination of geographic information

The activities concerned with this work are summarized in Table 1-3.

Table 1-3 Outline of activities for the dissemination of geographic information

Activity	Outline
Discussions on the dissemination of geographic information	Discussions will be held with SAGW and other relevant organizations on how to widely disseminate geographic information.
Dissemination activities for geographic information	Various means for disseminating geographic information such as through the media, websites, pamphlets, newsletters, and exhibits will be selected, and multiple campaigns will be conducted taking into consideration the cost and impact within the country. Education on geographic information will also be carried out at primary educational institutions.
Workshops	Specific examples of how geographic information is used will be demonstrated to SAGW so that they can appreciate its usefulness and convenience.
Technology transfer seminar	The progress and results of the Study will be announced and the development/expansion of the products will be encouraged. The results of the technology transfer will also be reviewed.

(4) Flowchart

The flowchart of the overall study is shown on the following page.

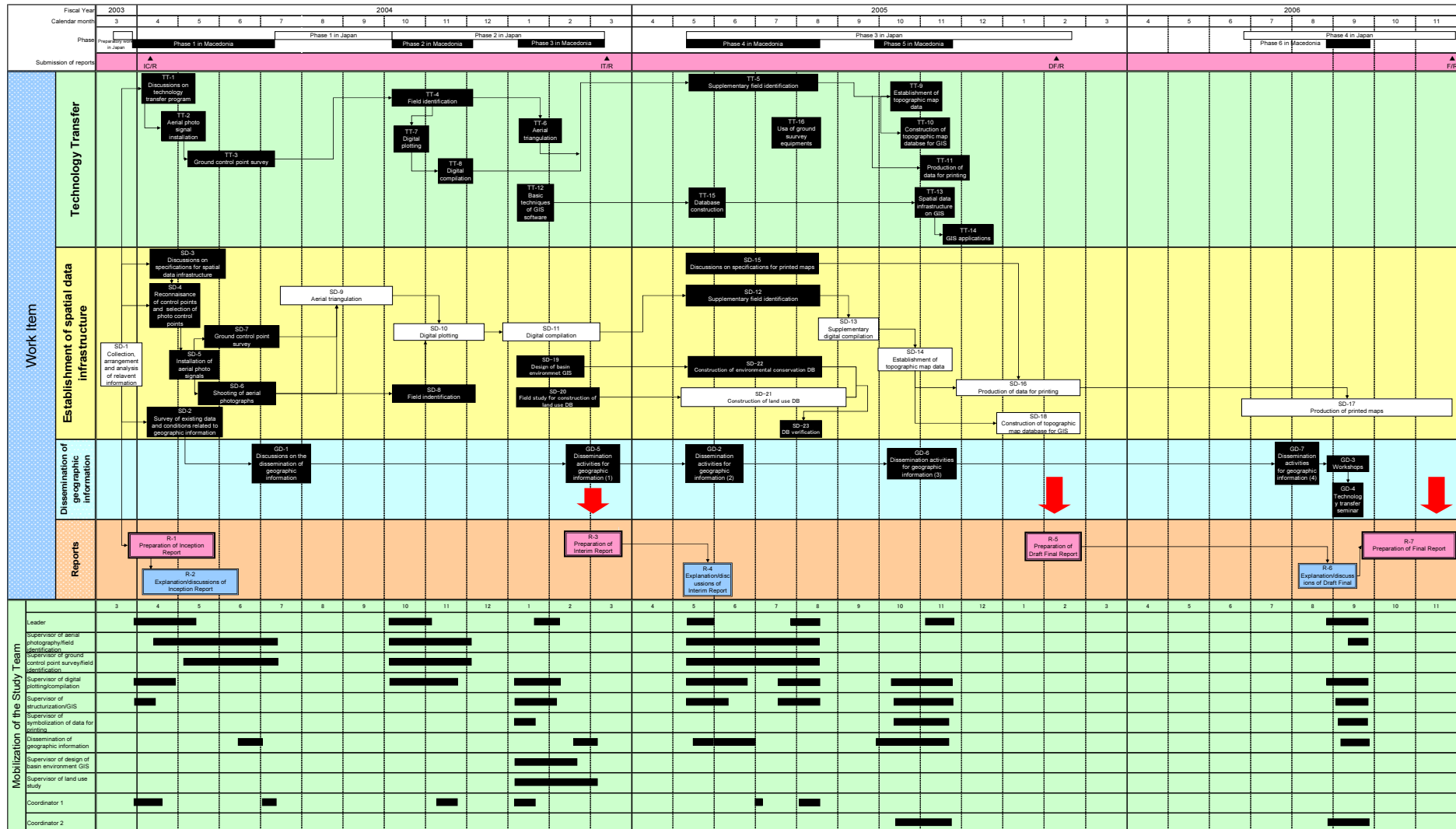
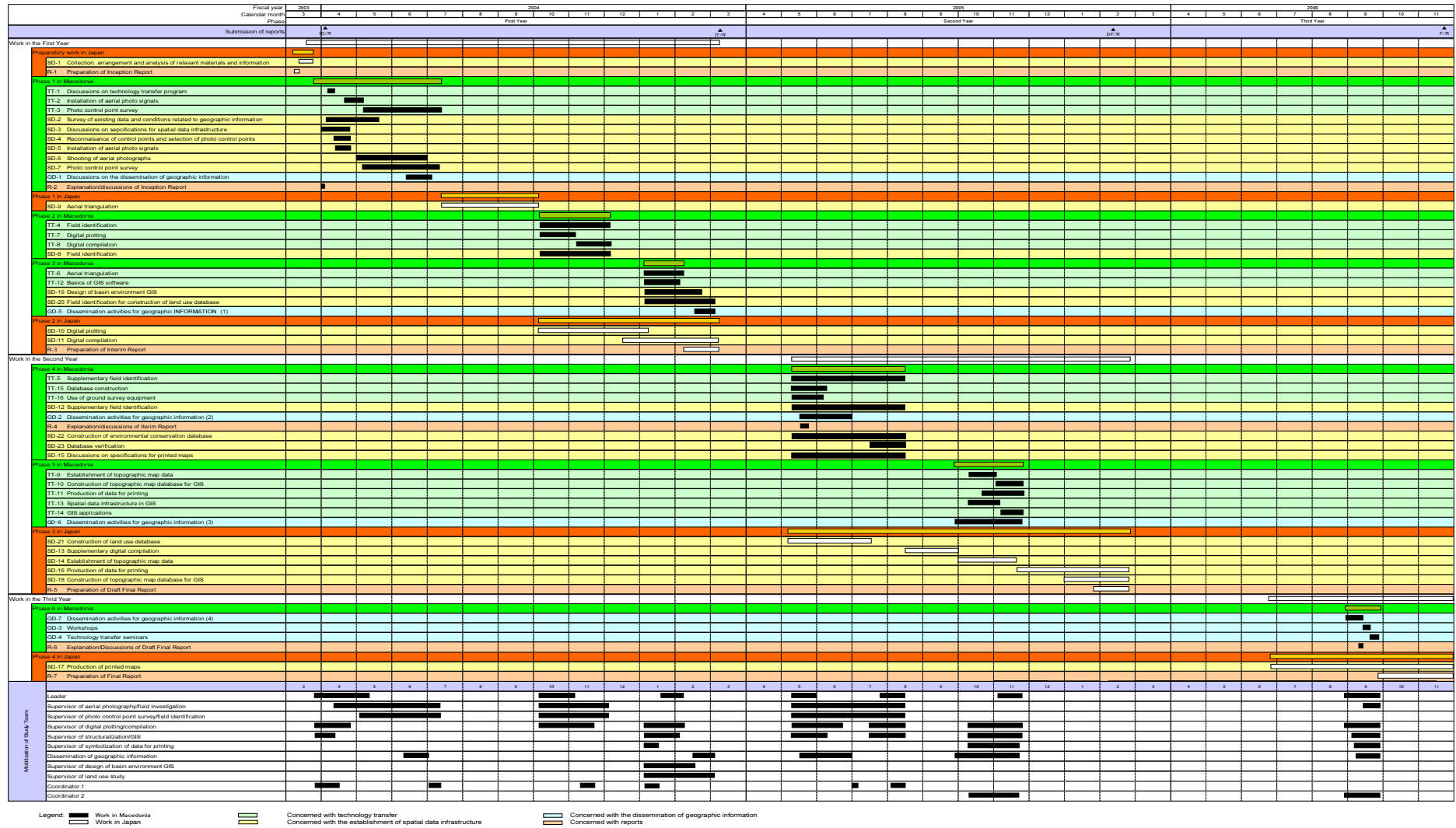


Figure 1-3 Flowchart





Table 1-4 Work Schedule



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## 1.6 Results of the Study

### (1) Reports

The following reports were prepared and submitted during the course of the Study.

a. Inception Report	20 copies
b. Interim Report	20 copies
c. Draft Final Report	
Main Report	20 copies
Summary	20 copies
d. Final Report	
Main Report	20 copies
Summary	20 copies

### (2) Products

The following products were produced and submitted during the course of the Study.

a. Aerial photography	
◆ Negative film	1 set
◆ Diapositive film	1 set
◆ Contact prints of aerial photos	2 sets
◆ Photo index map	1 set
◆ Digital data of aerial photographs	2 sets
b. Results of photo control point survey	2 sets
c. Results of aerial triangulation	2 sets
d. 1/25,000 topographic maps	
◆ 1/25,000 topographic maps (film for printing)	1 set
◆ 1/25,000 topographic maps (Printed maps)	500 sets
◆ 25,000 level topographic map data	5 sets
◆ 25,000 level topographic map database	5 sets
e. Databases	
◆ Land use database	5sets
◆ Environmental conservation database	5 sets