

3. Considerations and Recommendations

3.1 Use of Ground Control Points

In this Study, 44 new ground control points were established. The ground control points that had been established in Mali so far in the past were only the astronomic points installed for producing the existing 1/200,000 topographic maps and the traversing points installed in the 12th parallel survey implemented late in the 1960's. Under these circumstances, the ground control points installed with high accuracy using the GPS in this Study will form the foundation of the ground control point network to be established in Mali in the future. Thus, it is expected that further efforts will be made to expand the survey network conducted independently by Mali itself using the GPS survey technology transferred in this Study.

3.2 Use of Mapping Data

In this Study, also, the topographic mapping data to ensure the output of the 1/50,000 topographic maps by plotter were created. This data can be output in the format to ensure it to be imported into the usual GIS software. In Mali, currently, the projects to digitize the geographic information that the map-user agencies possess individually and to build the GIS combined with maps are being promoted, and the World Bank and some assisting organizations in Europe and the U.S.A. are also positively considering similar projects. Thus, the application of these topographic maps will be increased and expanded in the future. The mapping data created in this Study covered only 48 map sheets of about 2000 map sheets that can cover the entire national land in terms of the 1/50,000 topographic map. However, the mapping data is expected to be positively used not only for the planned development programs in the Kita area but also for the spatial analysis in the development of the surrounding areas in an integrated form with the data created by this Study.

3.3 Use of Supplied Equipment

In this Study, the following equipment was supplied to Mali:

(1) Work vehicles

TOYOTA Land Cruiser 4 units

(2) GPS sets and accessories

Leica GPS Survey Set 4 sets

(3) Digital mapping system

The digital mapping system introduced in this Study consists of the following major equipment and the software to operate it:

Server (PC)	1 unit
Client (PC)	3 units
Laser printer (B/W)	1 unit
Digitizer	2 units
Image scanner (B/W)	1 unit
UPS	1 unit
Transformer	1 unit

In the case that similar surveys to this Study are planned and implemented in the future, the GPS survey sets will effectively be used for installation of ground control points and acquisition of initial data. The digital plotting and compilation system will be very useful for data editing and production of study products. It is, therefore, expected that the equipment supplied in this Study will greatly contribute to the future socioeconomic development of Mali.

3.4 Technology Transfer and Future Response of IGM

In this Study, the transfer of technology in all the processes involved in the topographic mapping should have been conducted, but it was thought to be advisable that the process of securing equipment and materials necessary for topographic mapping and the processes requiring high costs of maintenance and management, such as aerial photography, aerial triangulation, data acquisition by plotter and printing, should be implemented on a contract basis. Thus, these processes were excluded from the items of technology transfer, but the technology transfer in all other processes was conducted. In this scope, the transfer of technology in all the processes from the receipt of documents and materials for production of topographic maps to producing topographic maps was implemented.

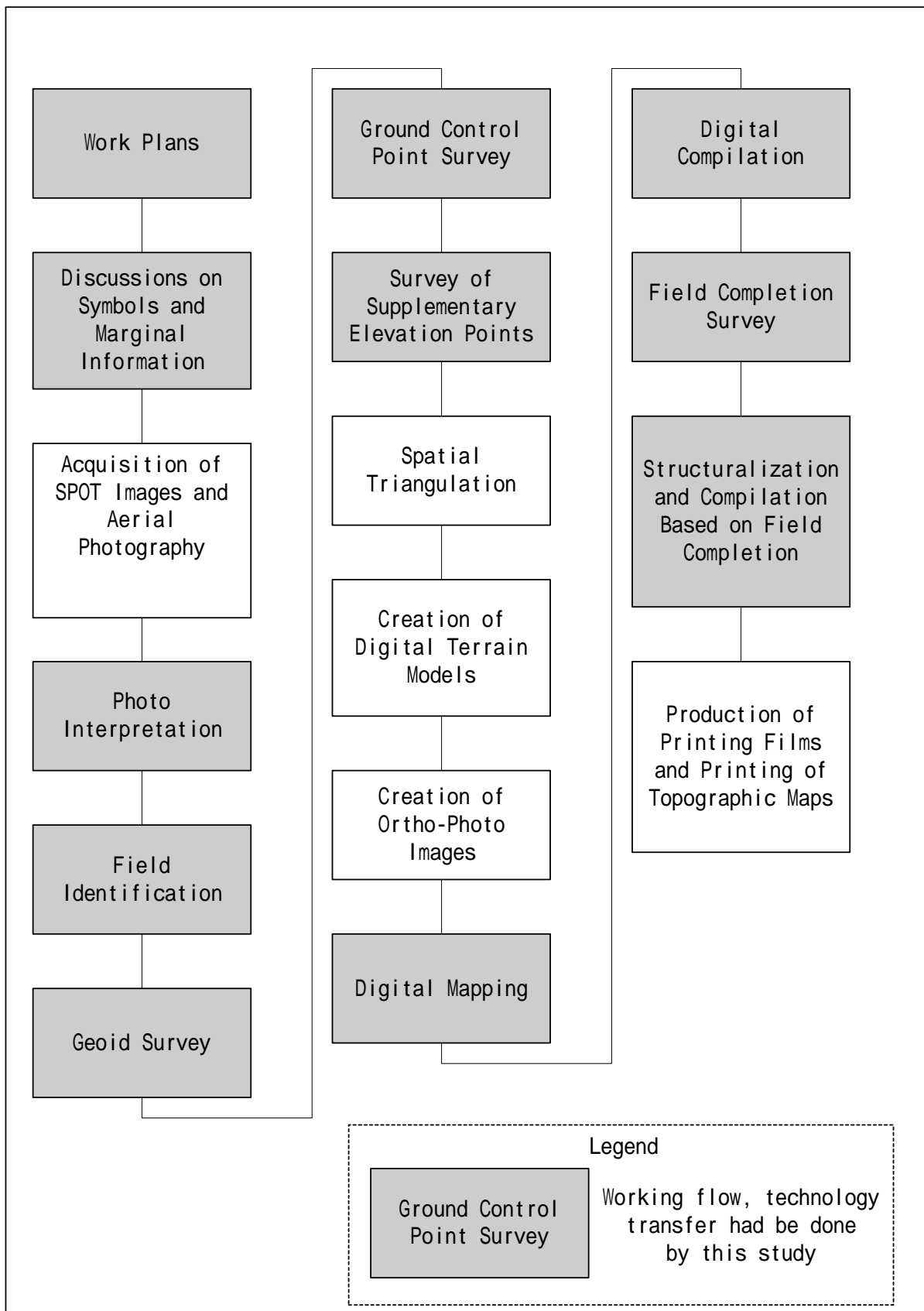


Fig. 3. 4.1 Working flow, technology transfer had be done by this study

(1) Computer literacy

Computers have been used as OA equipment in IGM, but it is difficult to say they have been generally used in the mapping and survey fields so far. In the technology transfer in this Study, computers were used in many processes. Many of counterparts had slight knowledge of computers. In fact, much time was spared for basic matters such as computer operation and data management through time should have originally been used for operation of topographic mapping software programs. In addition, as the arrival of the supplied equipment was delayed, alternative equipment was used for training, so that the technology transfer took much time. It is expected, therefore, that the environment to enhance the computer literacy (basic knowledge) will be created in IGM.

(2) Survey manual

The survey manual was prepared in the form of a booklet prior to the technology transfer. Some corrections were added to the manual after actual survey work was carried out. Owing to the efforts of the counterparts to check the French terminology and provide practical expressions, the survey manual will serve as a handy dictionary in future. It is expected that this manual will be used in future work and that any discrepancies that arise will be corrected and additional items included in a revised version

The contents of survey manual are as follows:.

Contents of Manual

- GPS SYSTEMS
- DIGITAL LEVEL
- AERIAL PHOTOGRAPHY
- MANUAL ON PHOTO INTERPRETATION
- FIELD IDENTIFICATION
- FIELD COMPLETION
- COMPUTER OPERATION
- CLASSIFICATION OF TOPOGRAPHIC MAPS
- BASIC CONDITION OF TOPOGRAPHIC MAPPING
- MERIT AND DEMERIT OF DIGITAL TOPOGRAPHIC MAPPING
- PREPARATORY WORK FOR DIGITAL TOPOGRAPHIC MAPPING
- DATA FILES FOR DIGITAL TOPOGRAPHIC MAPPING
- ACQUISITION OF DIGITAL DATA(DIGITAIZING)
- SUPPLEMENTARY FIELD SURVEY
- DIGITAL COMPILATION
- STRUCTURIZATION

- CREATION OF PLOTTING DATA FILE
- FINAL CHECK AND CORRECTION
- UPDATING OF DIGITAL TOPOGRAPHIC MAPS
- FLOWCHART OF DIGITAL MAPPING

(3) Additional technology transfer

Technology transfer using the procured equipment could not be implemented within the third year of the study period because installation was delayed until the last month of the third year. Nor could training be given in operation of the peripheral equipment such as the scanner, digitizer or plotter required for creating and checking the initial data. Two engineers were therefore dispatched to Mali before the start of the fourth year of the study to carry out additional technology transfer for one month.

The software installed for this study was limited to basic tools for producing topographic maps. In the fourth year, software such as Illustrator for displaying topographic mapping data, Photoshop for displaying ortho-photos, and Office for use in data and manual preparation and study presentation was provided to the counterpart agency. It is expected that this software will be used not only for data creation but also for demonstrations, training and promotion activities.

3-5 Present Status of IGM

DTGC was renamed IGM in January 2001. The new name was intended to: define IGM as an agency dedicated to services related to topographic maps, and enable it to raise funds independently as an independent corporate entity.

Based on this view, IGM plans to be a pioneer in the GIS field in Mali, including production of digital basic maps, creation of GIS data for other ministries and agencies, support for GIS construction and training of GIS engineers. For this purpose, IGM is making efforts to fortify its position domestically, based on its mapping department, and strengthen its cooperative relationship with other ministries and agencies.

(1) Budget and personnel

IGM's annual budget for the past five years increased substantially in 1998 and 1999 as shown in Table 3.5.1. Personnel shows a slight decrease after 1997, but remains virtually unchanged. It can be assumed, therefore, that the project costs increased. The organization chart of IGM is shown in Fig. 3.5.2. As there is no evident increase in personnel, the transfer of personnel to the new computer mapping department is expected to meet the change in IGM's role.

Table 3.5.1 Budget and personnel by year

Year	Budget Amount	Personnel
1997	217 million Fcfa	145
1998	250 million Fcfa	135
1999	350 million Fcfa	134
2000	471 million Fcfa	133
2001	501 million Fcfa	132

Source: IGM

(2) IGM's revenue sources

IGM obtains its income from the sale of resources such as maps and data in its possession, and technical services for surveying and mapping, as shown in Table 3-5-2. As can be seen from the table, map sales are high and mapping and survey services are the main external source of income.

Table 3.5.2 Main IGM revenue sources

Revenue source	Average income amount
Sale of maps	28.5 million Fcfa
Sale of geodetic survey results	0.1 million Fcfa
Sale of data	2.0 million Fcfa
Sale of photographs	2.4 million Fcfa
Survey services	90.0 million Fcfa
Mapping work	300 million Fcfa

Source: IGM

(3) Equipment owned by IGM

IGM possesses equipment for use in its survey, photography and mapping operations. As shown in Table 3-5-4, it is an extremely poor range of equipment for undertaking mapping work.

Table 3.5.3 Equipment possessed by IGM

Department	Equipment	Quantity
Geodetic survey department	Level	5
	Theodolite	12
	Range finder	2
	Plane table	2
	GPS	3
Photogrammetry department	Plotter	1
Mapping department (GIS)	Personal computer	4
	Digitizer	2
	Drawing board	2
Photograph processing department	Rectifier	1
	Photo copier	1
	Contact camera	2
	Blueprinted	5

Source: IGM

(4) Projects undertaken by IGM

IGM is engaged in the following projects at present:

1) Sadiola area 1/50,000 topographic mapping project

This project was implemented with the aim of developing and mapping the national territory from 1995 to 1996. Mapping work was carried out using digital photogrammetry, and Arc/View GIS software digitizers, scanners and printers were introduced.

2) Project for the return of Mali national maps owned by France

This project is being implemented from 1996 to 2002. 136 topographic maps of Mali on a scale of 1/200,000, geodetic survey results and aerial photos in the possession of France were returned to Mali. Following this, a system capable of digitizing, storing and printing the topographic maps was introduced. The system consisting of a micro-station, geomedia, printer and scanner was installed in August 2000.

3) National border fixing project

The territory of Mali is bordered by 7 countries with which Mali is working to fix the borders. The survey is being conducted using GPS.

4) Cadastral survey

A cadastral survey on a scale of 1:5,000 of an area of 66,000 km² including the cities of Bamako and Kati is in progress. 200 ground control points were established by GPS survey to implement this project.

5) Decentralization project

To promote decentralization, a database was created including administrative boundaries and public facilities, based on existing materials. The database is stored on a CD-ROM.

6) Other projects

In addition the following projects are planned:

- 1/50,000 topographic map of Nielle area (8 map sheets)
- 1/50,000 topographic map of Sikasso cotton plantation area (40,000 km²)
- 1/50,000 topographic map of Kossanto area (5 map sheets)
- Tourist map of Dogon plateau
- Revision of 1/2,000,000 general maps of Mali
- Revision of 1/20,000 tourist maps of Bamako city

3.6 Recommendations to IGM

(1) Effective use of equipment procured by JICA

The vehicles, GPS units, map compilation system and other survey equipment introduced into Mali for this study will certainly be put to effective use to meet growing expansion in the survey and mapping field in Mali which only has very poor equipment. It is expected that IGM will make effective use of the procured equipment and transferred technology to promote the projects mentioned above.

(2) Building a LAN within IGM

Building an intra-agency LAN to connect the system procured by JICA with IGM's existing system will promote joint use of data and peripheral equipment and make effective use of resources owned by IGM.

(3) Promotion of GIS

A Central Geographic Information Committee has been established in Mali to promote smooth exchange of GIS-related information among ministries and agencies. It is recommended that IGM plays a central role in this committee to promote various activities such as monitoring the need for GIS data by other agencies and creating data on high priority areas.

More precisely, it is fervently hoped that IGM will play a leading role in planning the creation of a spatial database in areas where there is great demand for GIS, such as around the capital of Bamako, using the materials and manual prepared in this survey, and will take advantage of the technology transfer undertaken in this project to strengthen the system for aggressively updating and digitalizing maps. The effects of the technological transfer will take root in throughout IGM as a result, and become firmly established.

In addition, IGM should undertake the training of GIS engineers and encourage especially those engineers trained in this and previous studies to pursue higher technology,.

(4) Publicizing of IGM's activities

Since IGM is the agency responsible for surveys and maps, it is recommended to spread its knowledge to public users through display of mapping processes, samples of various products and equipment used for surveying and mapping.