Republic of Togo
Directorate General of Cartography

The Study on Establishment of Topographic Database in Togo

Final Report (Summary)

September 2013

JAPAN INTERNATIOAL COOPERATION AGENCY

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Abbreviations

2D	2 Dimension
3D	3 Dimension (Stereo)
ALOS	Advanced Land Observing Satellite
CAD	Computer Aided Design
CPU	Central Processing Unit
DEM	Digital Elevation Model
DF/R	Draft Final Report
DGC	Directorate General of Cartography
DTP	Desktop prepress
GCP	Ground Control Point
GIS	Geographic Information System
GNSS	Global Navigation Satellite System(s)
GPS	Global Positioning System
GRS80	Geodetic Reference System 1980
GSD	Ground Sample Distance
IC/R	Inception Report
IGN	Institut Geographique National
IGS	International GNSS Service
ITRF	International Terrestrial Reference Frame
IT/R	Interim Report
JICA	Japan International Cooperation Agency
MM	Minutes of Meeting
OJT	On the Job Training
PDF	Portable Document Format
RTK	Real Time Kinematic
RPC	Rational Polynomial Coefficient
SHP	Shapefile
SPOT	Satellite Pour l'Observation de la Terre
TIFF	Tagged Image File Format
UPS	Uninterruptible Power Supply
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

Chapter 1 Outline of Study

The necessity for the development and upgrade of a geographic information system (GIS) as an essential tool for "infrastructure development for economic development" is mentioned in the Poverty Reduction Strategy Paper (PRSP) of the Republic of Togo (hereinafter referred to as "Togo") for the period between 2009 and 2011.

However, the most recent topographic maps which Togo has analog topographic maps created between 1964 and 1987 and Togo does not have original plates for printing of those maps. Therefore, it is not always possible to provide topographic maps to their users in various administrative institutions in Togo. This situation has been a great obstacle to the utilization of topographic maps in the country.

Against this background, the decision to implement this Study was made for the development of topographic map database in Togo.

1-1. Objectives

The objectives of the Study are as follows:

(1) 1/50,000-scale digital topographic maps of the entire national land area of approximately 56,000km^2 of the Republic of Togo (hereinafter referred to as "Togo") shall be developed.

(2) Technology for developing digital topographic maps shall be transferred to the Directorate General of Cartography (hereinafter referred to as "DGC") as the counterpart agency of Togo.

a. The capacity of staff members of DGC shall be developed so that they can create topographic maps by themselves after the completion of the Project.

b. The capacity of staff members of DGC shall be developed so that they can update topographic maps by themselves after the completion of the Project.

c. The capacity of staff members of DGC shall be developed so that they can promote the utilization of topographic maps by themselves after the completion of the Project.

1-2. Problems in Achieving the Purposes and Strategies and Achievement in the Study

The Study Team conducted a study on the status of DGC before the commencement of the Study and the capacities to be developed for the achievement of the purposes of the Study with the Report on the Detailed Planning Survey for the Establishment of Topographic Database in Togo (draft) and the information obtained independently by the team.

The team established the activities and basic strategies to improve various capacities required by DGC during the Study on the basis of the result of the above-mentioned study and implemented the Study in accordance with the basic strategies. The table below shows the subjects, methods

and basic strategies of the capacity development and the criteria for the implementation of the Project and achievement of the purposes.

Table 1 Problems in achieving the purposes and strategies and achievement in the Study

Purpose	Problem in achieving the purpose		Required capacity	Activity	Basic strategy	Achievement
Creation of digital topographic maps	Problem regarding quality	Updated survey standards or specifications have not been established	Establishment of survey standards Establishment of the specifications for the quality of topographic maps	Various types of discussions Quality control	Implementation of the work in accordance with the Survey International Specifications Establishment of updated survey standards. Creation of high-quality topographic map data	1/50,000-scale topographic maps of sufficient quality have been successfully created.
Technology transfer in the creation of digital topographic maps	Technical Problem	Technologies are to be transferred to staff members without experience in them.	Survey technology	Technology transfer in the control point survey	Technology transfer focused on basic technologies Technology transfer with OJT Clarification of problems with preparation of the technology transfer evaluation sheet	Technologies at the basic level have been successfully transferred.
			Technology to create (compile) topographic map data	Field identification/ field completion Aerial triangulation Digital plotting/ compilation Map symbolization		
			Technology to analyze topographic map data	Technology transfer in the data structurization and GIS analysis		
			Quality control technology	Inspection and preparation of the quality control tables	Implementation of technology transfer in the quality control	Inspection of accuracy of outputs and preparation of the quality control tables have been successfully implemented at each stage of the work.
			PC technology	To be included in the technology transfer in each subject	Technology transfer focused on basic technologies	Technologies at the basic level have been successfully transferred.
	Organizational problem	DGC does not have sufficient equipment for the creation and printing of topographic maps	Acquisition of required hardware and software	Provision of equipment		All the equipment to be procured have been procures.

Technology transfer in the update of digital topographic maps	Technical Problem	Technologies are to be transferred to staff members without experience in them.	Technology to modify maps for changes over time	Modification of maps for changes over time using the materials provided by donors and satellite imagery	Implementation of the technology transfer in the partial modification	The technology to modify changes over time expected in future, except for large-scale ones, has been successfully transferred.
	Organizational problem	DGC does not have sufficient human resource for the update of topographic maps	Reinforcement of personnel Sharing of technologies and knowledge and technology transfer within the organization	To be included in the technology transfer in each subject		It is necessary to reinforce the organizational structure for the update of maps for large-scale changes.
		DGC does not have sufficient financial resource to continue to update the maps	Securing of a financial resource for the continuous update in future	Transfer of cost-efficient technologies	A recommendation is to be made on the cost for the update.	It is necessary to have a separate budget for the purchase of satellite imagery and field works as the need for them may arise.
Technology transfer in the promotion of data utilization	Technical Problem	DGC does not have sufficient knowledge on promotion of the use of digital data	Transfer of technologies for promotion of the use of digital data	Creation of data which can be used in GIS and technology transfer in the creation of such data	A recommendation is to be made on the utilization of digital data.	It is necessary to create GIS models which satisfy a large number of requirements of organizations concerned.
	Organizational problem	DGC does not have a sufficient organizational structure to promote utilization of digital data	Reinforcement of personnel Sharing of technologies and knowledge and technology transfer within the organization Development of laws on the promotion of the utilization of digital data	An opportunity for cooperation between DGC and relevant organizations is to be provided during the Study Holding of seminars	A recommendation is to be made on the utilization of digital data and an organizational structure to be developed for the utilization.	It is necessary to develop an organizational structure both physically and technically for the promotion of the utilization of digital data.
		DGC does not have sufficient budget for the facilitation of the promotion of digital data	Securing the budget required for the promotion of the utilization	Various types of discussions	A recommendation is to be made on sales of topographic maps and an organizational structure to be developed for the sales.	It is recommended that decision should be made on the sales prices of topographic maps and that the cost required for the promotion of their utilization should be estimated.

1-3. Study Area

Figure 1 shows the area for the development of topographic map data. The Study originally began with a plan to create digital topographic maps of an area of approximately 22,000 km^2 in the southern part of Togo (the area south of latitude 8°N). However, the Togolese and Japanese sides came to share the understanding that priority should be given to the preparation of a master plan for the development of an economic corridor from the Port of Lomé to the northern frontier in the discussions between the two sides after the commencement of the Study. On the basis of this shared understanding, the area for the development of topographic maps was expanded to cover the entire territory of Togo (an area of approximately 56,000 km^2) including the Northern Area.

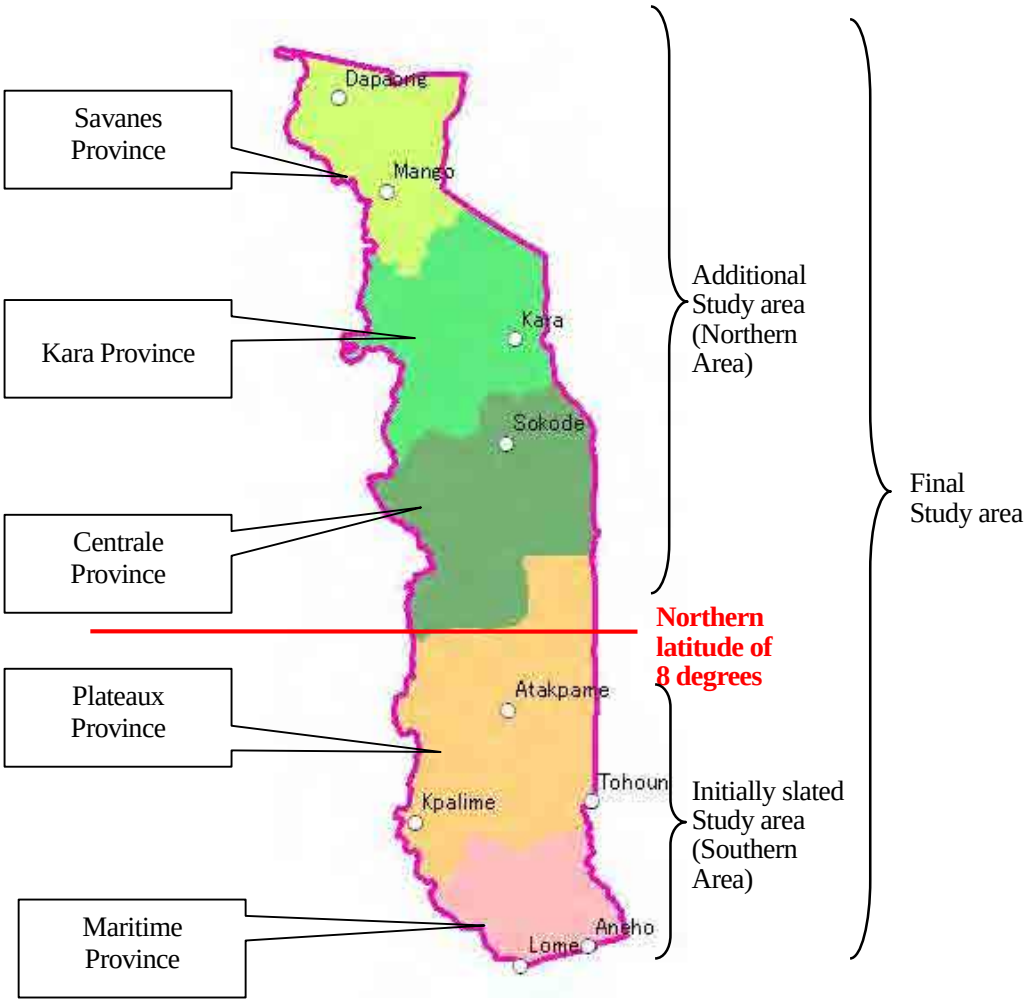


Figure 1 Study Area for Digital Topographic Map Development

1-4. Details and Workload of Study

The following table shows details and workload of this Study.

Table 2 Details and Workload of Study

Work		Workload		Work category
Control point survey	South	2 points	Control point origin	Work in Togo Technology transfer (OJT)
		32points	Control points	
	North	3 points	Control point origin	
		29 points	Control points	
Leveling (New simple leveling)	South	20 points	at control points	Work in Togo Technology transfer (OJT)
	North	11 points	at control points	
Satellite image acquisition	South	148 images (37× front, orthotropic, back views, AVNIR)	ALOS images	Work in Japan
		13 Scenes	SPOT images	
		Approx. 1,280 km^2	WorldView-2 satellite images	
	North	248 images (62 × front, orthotropic, back, AVNIR)	ALOS images	
		5 Scenes	SPOT images	
Aerial triangulation	North South	294 Scenes	ALOS satellite images	Work in Japan Technology transfer
Field identification	South	37 Sheets (Approx. 22,000km^2)	Existing data collection/organization Interview survey Field reconnaissance	Work in Togo Technology transfer (OJT)
	North	61 Sheets (Approx. 34,000km^2)		
Digital plotting	South	37 Sheets (Approx. 22,000km^2)	Data acquisition from ALOS, SPOT, WorldView-2 and the results of field identification	Work in Japan Technology transfer
	North	61 Sheets (Approx. 34,000km^2)		
Digital compilation	South	37 Sheets (Approx. 22,000km^2)	Proofreading, inspection for logical errors and correction of logical errors in the plotted data	Work in Japan Technology transfer
	North	61 Sheets (Approx. 34,000km^2)		
Field completion	South	37 Sheets (Approx. 22,000km^2)	Field identification of ambiguities identified in the plotting	Work in Togo Technology transfer (OJT)
	North	61 Sheets (Approx. 34,000km^2)		
Digital compilation after field completion	South	37 Sheets (Approx. 22,000km^2)	Compilation of plotted data into which the results of field completion have been imported	Work in Japan Technology transfer
	North	61 Sheets (Approx. 34,000km^2)		
Map symbolization	South	37 Sheets (Approx. 22,000km^2)	Symbolization of data created in the digital compilation after field completion	Work in Japan Technology transfer
	North	61 Sheets (Approx. 34,000km^2)		
Digital data structurization	South	37 Sheets (Approx. 22,000km^2)	Structurization of data created in the digital compilation after field completion	Work in Japan Technology transfer
	North	61 Sheets (Approx. 34,000km^2)		

1-5. Final Products of the Study

The following table shows final products of the study.

Table 3 Final Products of the Study

Items		Quantity	
(1)Study Report	Inception Report (IC/R)	French	15 copies
		English	15 copies
	Interim Report (IT/R)	French	15 copies
		English	15 copies
	Progress Report(PR/R)	French	15 copies
		English	15 copies
	Draft Final Report (DF/R)		
	Main Report	French	15 copies
		English	15 copies
	Summary Report	French	15 copies
		English	15 copies
	Manuals	French	15 copies
		English	15 copies
	Final Report (F/R)		
	Main Report	French	15 copies
		English	15 copies
	Summary Report	French	15 copies
		English	15 copies
	Manuals	French	15 copies
		English	15 copies
(2)Study Result	1) Satellite Imagery		
	Satellite Imagery	1 set	
	2) Results of Field Survey	1 set	
	3) Results of Aerial Triangulation	1 set	
	4) Ortho Photo	1 set	
	5) Digital data		
	1/50,000 Mapping Data	1 set	
	1/50,000 GIS data base	1 set	
	Final Report	1 set	
	6) Report for Quality Control	1 set	

1-6. Workflow

The table below shows an outline of the workflow in this Study.

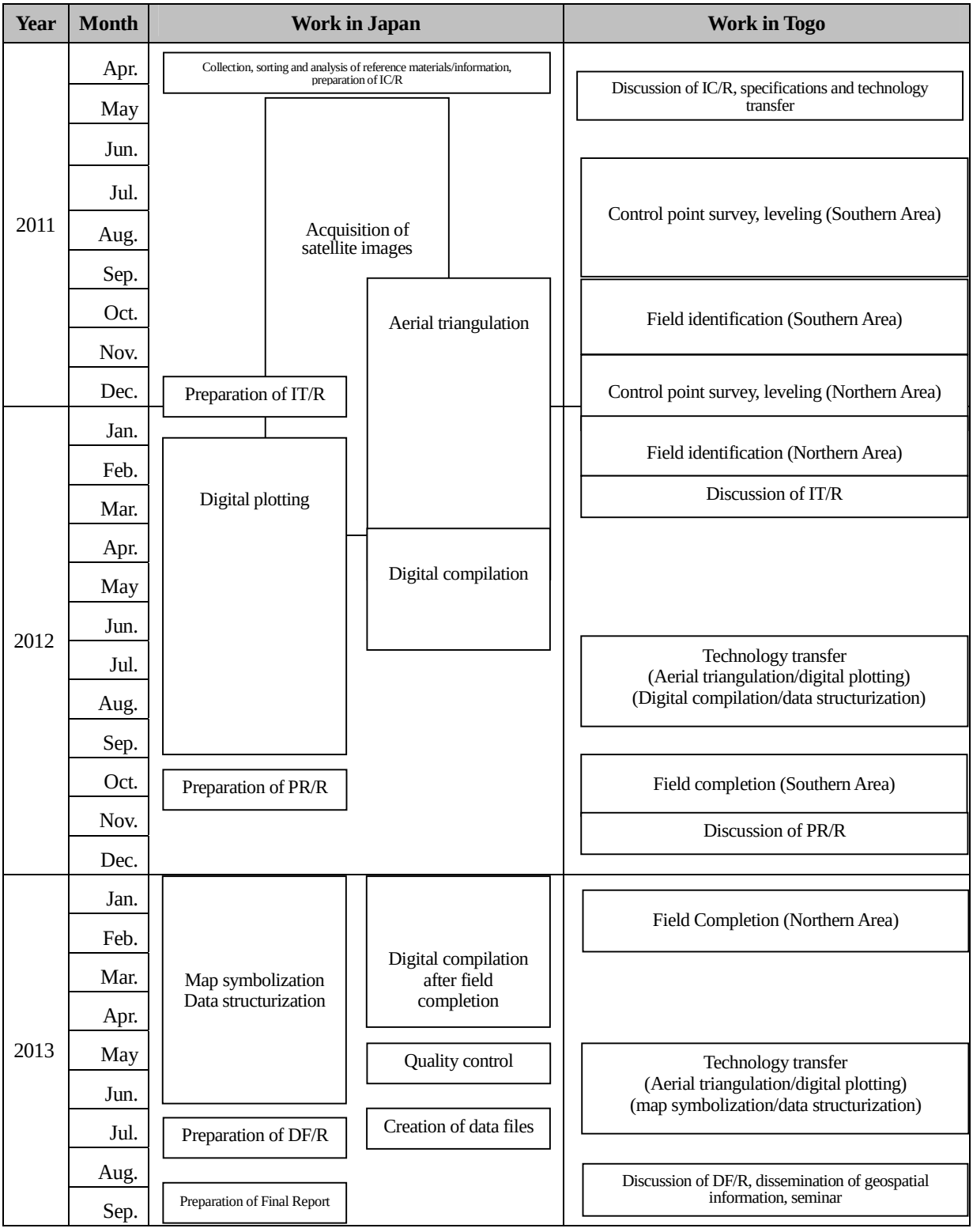


Figure 2 Workflow of the Study

1-6-1. Organizational Structure for Implementation of the Study

The diagram below shows the organizational structure for the implementation of this Study by the Togolese and Japanese sides.

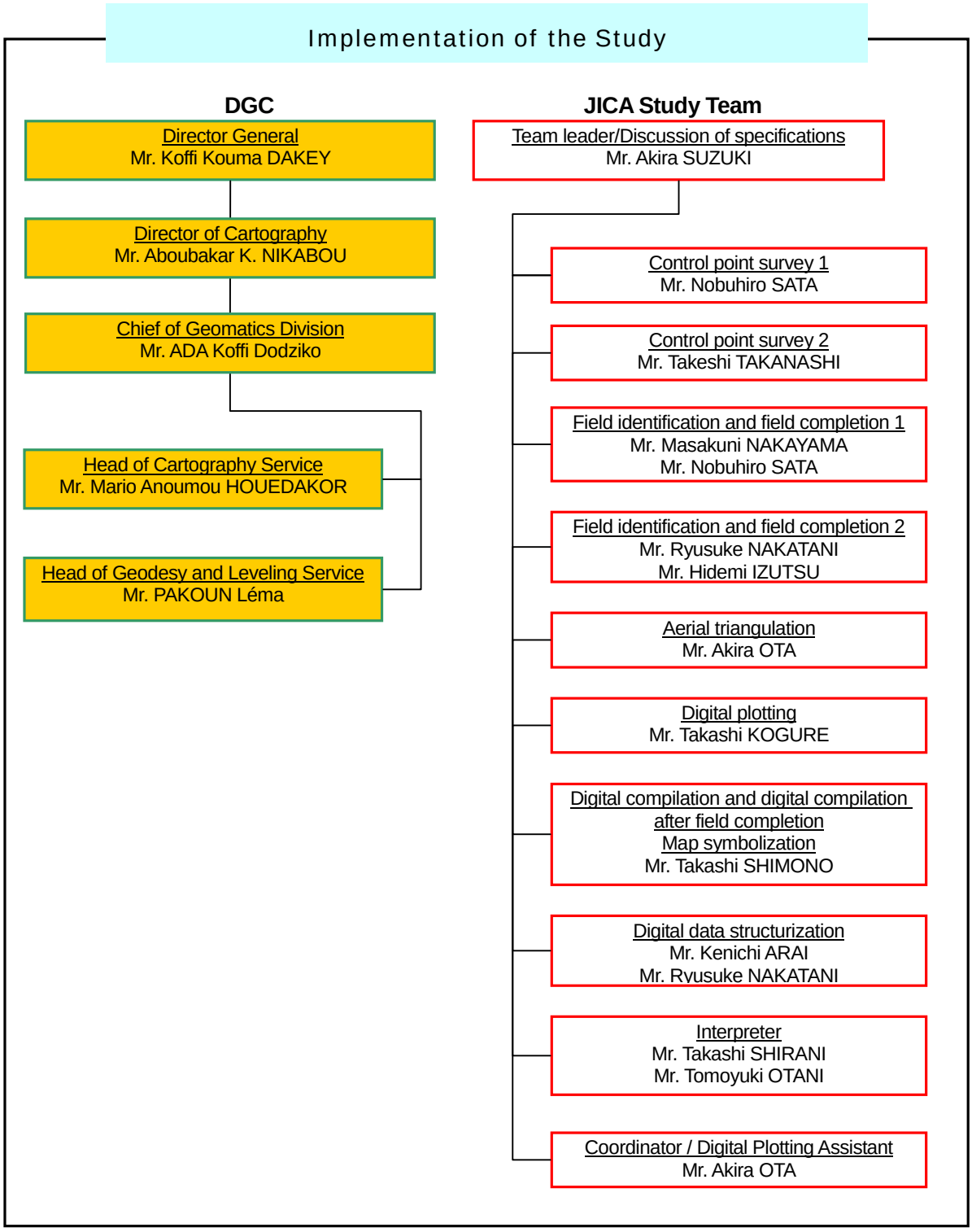


Figure 3 Organizational Structure for Implementation of the Study

Chapter 2 Outputs of the Study, Impact of the Outputs and Recommendations

Import of data accumulated independently by government ministries and offices, local governments, international aid organizations and private companies involved in Togo into the topographic map data to be developed in this Study is expected to generate use of such data in a wide variety of areas. In addition, the control points established for the development of topographic maps in this Study can be used as the control points for positional coordinates in a wide variety of areas, including cadastral surveys, as they are provided with highly accurate positional coordinates.

Following recommendations were summarized about the dissemination of utilization in this chapter.

- Introduction of case examples and users for mapping data
- Organizational, Personnel, Finance of Togo Government or DGC for distribution and update of mapping data
- Problems Related to Utilization of the Outputs

2-1. Cases of Utilization of the Topographic Map Data

As the scale of the data developed in this Study is 1/50,000, map utilization can be expected in planning and implementation of projects to be implemented in the whole of Togo such as those for development of roads, public facilities and wide-area infrastructure.

For example, the outputs of this Study were used in “the Project for the Study on Togo Logistics Corridor Development” at the stages of the preparation of a plan to facilitate the use of the corridor in Togo between the Port of Lomé and the border with Burkina Faso and the outline design of roads and bridges in the process of the preparation of plans for the priority construction projects in the above-mentioned plan which could pass the loan screening of development partners. Such use of the outputs have enabled improvement in the efficiency of field works and detailing of the information of the study results in the Project.

2-1-1. Concept of Data Utilization

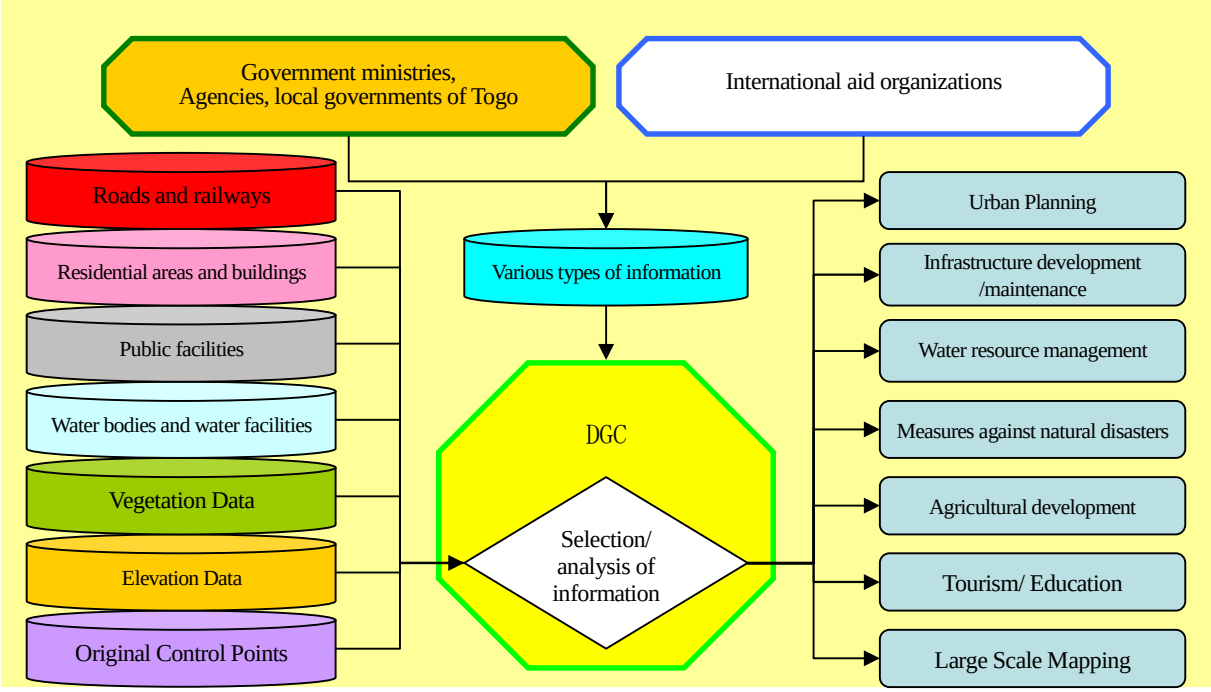


Figure 4 Conceptual Diagram of Data Utilization

Table 4 Cases of Utilization

Field	Contents
Urban planning	Equitable development of the national land and promotion of public welfare may be realized by utilization of the topographic map data as basic maps in projects for development of city areas, port districts and land transport.
Development and maintenance of infrastructure	Quick delivery of services to citizens may be realized by utilization of the topographic map data as background maps for data on maintenance of urban facilities above and below the ground (*e.g.* power transmission lines) and as basic maps in urban infrastructure development projects.
Water resource management	Improvement in services to citizens concerning water resources, an important lifeline, may be realized by utilization of the topographic map data as basic maps for maintenance of water towers, water sources and water-supply and sewage aqueducts and wells.
Measures against natural disasters	Utilization of the topographic map data will enable development of a disaster prevention plan against flooding caused by rainfall, which has become frequent in recent years, taking into consideration the scale of flooding, priority in protection of structures, urgency of projects and impact of projects.
Agricultural development	Utilization of the topographic map data as basic maps for a master plan for the development of farmland will lead to an increase in agricultural potential through development of the domestic road network and improvement in the competitiveness of Togo's agricultural products on international and domestic markets.
Tourism	Services to domestic and foreign tourists may be improved by utilization of the topographic map data as basic maps for registration, maintenance and search of tourism resources. The data may also be utilized in the preparation and implementation of a national tourism plan.
Education	The topographic map data may be used as teaching materials on interpretation of maps and topography and GIS in school education.

2-1-2. Potential User Organizations

The team conducted individual interviews with organizations which owned data that could be utilized as reference materials in the development of topographic maps. In addition, the team invited staff members from those organizations to participate in the technology transfer and exchanged views on the subject with them.

Table 5 Contents of the Work Implemented on Extension of Data Utilization

Work	Time	Participating organizations	Contents
Inception Report Seminar	May 2011	11 organizations (See Appendix about participant)	Explanation of the Project Questions and answers Questionnaire
Interim Report Seminar	February 2012	12 organizations (See Appendix about participant)	Explanation of the Project Questions and answers Demonstration of GIS Questionnaire
Collection of reference materials during field identification/field completion	March 2012	Ministry of Home Affairs	Request for provision of reference materials
Collection of reference materials during field identification/field completion	December 2012	Benin Electricity Community Directorate of Water Source Planning and Maintenance	Request for provision of reference materials
Transfer of laboratory technologies	May 2013	General Directorate of Public Works, Ministry of Public Works	Provision of sample data for partial correction
		Ministry of Primary and Secondary Education and Literacy	Proposal of simple GIS model

Table 6 Organizations/Institutions Expected to be Potential Future Users of the Data Developed in the Study

Organization/ institution	Potential	Expected area of utilization		Highly feasible case of the utilization
General Directorate of Public Works Ministry of Public Works	The directorate maintains road data on planned national highways in analog format. It provided data for the technology transfer in the Study.	Urban planning	Use in planning development of new administrative and business districts and new roads	Update of the topographic maps with sharing of development plans prepared on the background of the outputs of this Study and the outcome of the development with DGC
Ministry of Home Affairs	The ministry provided data for the Study.	Urban planning	Sharing information with other institutions and use of the information kept by the ministry in urban planning	Information sharing with other institutions by adding more details to positional information of administrative vector data

General Directorate of Statistics	The directorate provided data for the Study.	Urban planning	Sharing information with other institutions and use of the information kept by the general directorate in urban planning	Information sharing with other institutions with addition of more detailed positional information to statistic data
Directorate for Water Source Planning and Maintenance Ministry of Water, Sanitation and Rural Water Supply	While the directorate has digitized data on water sources, it has not encoded them. It provided data for the technology transfer in the Study.	Development and maintenance of infrastructure	Improvement in the efficiency of the maintenance system and the services in the entire country	Maintenance of facilities including reservoirs and water sources using the outputs of the Study as background information and update of topographic maps with sharing of information on development plans and their outcomes with DGC
Togolese Water Supply Company	The company owns ArcGIS and uses Shape and Geodatabase for data management.	Development and maintenance of infrastructure	Improvement in the efficiency of the maintenance system and the services in the entire country	Maintenance of facilities including aqueducts using the outputs of the Study as background information and update of topographic maps with sharing of information on development plans and their outcomes with DGC
Benin Electricity Community Ministry of Mines and Energy	The community owns ArcGIS and uses Shape for data management. It is conducting a field survey on the location of domestic power transmission lines.	Development and maintenance of infrastructure	Improvement in the efficiency of the maintenance system and the services in the entire country	Maintenance of facilities including power transmission lines using the outputs of the Study as background information and update of topographic maps with sharing of information on development plans and their outcomes with DGC
Ministry of Environment and Forest Resources	The ministry maintains data on quarries, sand pits and mines in analog format.	Measures against natural disasters	Improvement in the efficiency of the maintenance system and the services in the entire country	
Directorate for Rural Development Ministry of Agriculture, Animal Breeding and Fisheries	The directorate maintains data on occupation of farmland, water channels and irrigation reservoirs in analog format	Agricultural development	The data use is expected in the agriculture sector and disaster management	
Ministry of Tourism	The ministry creates tourist maps independently.	Tourism	Improvement in the efficiency of the maintenance system and the services in the entire country	
Head Office of University Section, Ministry of Higher	These organizations have submitted a proposal for a GIS model. There are no classes using GIS.	Education	Improvement in the efficiency of the maintenance system	Improvement in the efficiency in school facility maintenance

Education and Research Ministry of Primary and Secondary Education and Literacy			and the services in the entire country	and incorporation in the study of maps and topography and practical lessons on GIS

2-2. Organizational Structure for Utilization of the Outputs and Development of Data

DGC will be the organization to manage utilization of the outputs of this Study and maintenance and updating of the data. It is important for DGC to cooperate with various government ministries and offices, the private sector and foreign aid organizations in Togo in utilization of the outputs. A view of the organizational structure required for DGC to continue to maintain and distribute the outputs of the Study is described in the following.

2-2-1. Organizational Structure and Finances of DGC

The organization of the counterpart of this Study, DGC, is following. This organization has 23 members under the Director General.

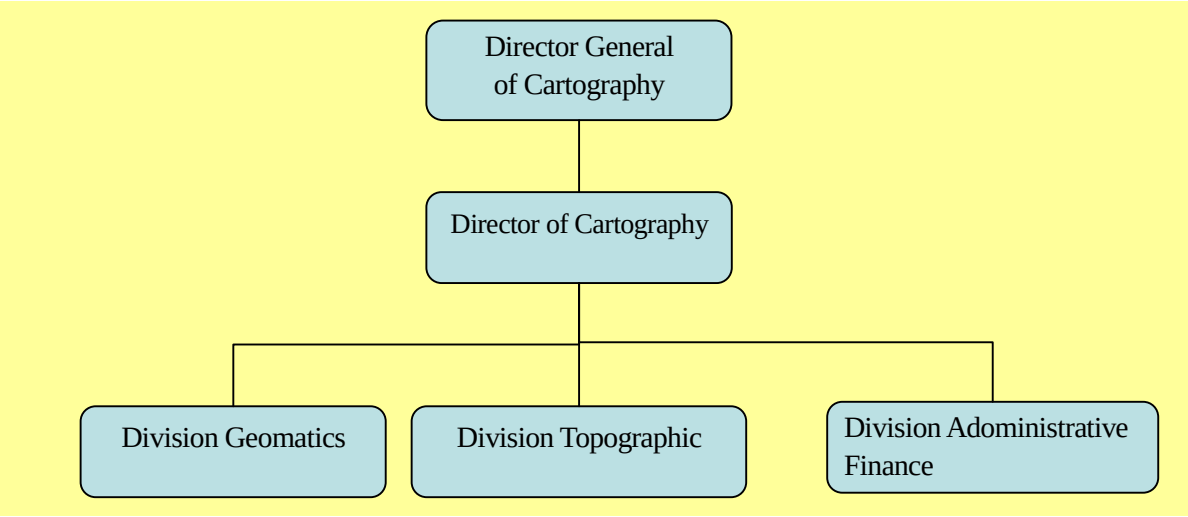


Figure 5 Organizational Structure and Personnel of the General Directorate of Cartography

DGC budget for 2013 is following. A budget for establishing reference points and updating new maps is not enough. In order to make a good use of mapping data and GIS data of the study (such as data updating, data sharing, and practical data application), a system that enables continuous update of mapping data needs to be arranged.

The evolution of the budget is as follows.

2013 Total amount : 57.214.600CFA, Personnel expenses: 33.214.600CFA, Operational costs : 24.000.000CFA

2012 Total amount : 48.764.600CFA, Personnel expenses: 33.214.600CFA, Operational costs :

15.550.000CFA

2011 Total amount : 45.004.600CFA, Personnel expenses: 33.214.600CFA, Operational costs : 11.800.000CFA

Therefore, as follows, a fund for depreciation expense and updating cost for the future need to be taken into account for a selling price of the mapping data in the study. In that way, a selling price of an old map and nearby countries can be used as references.

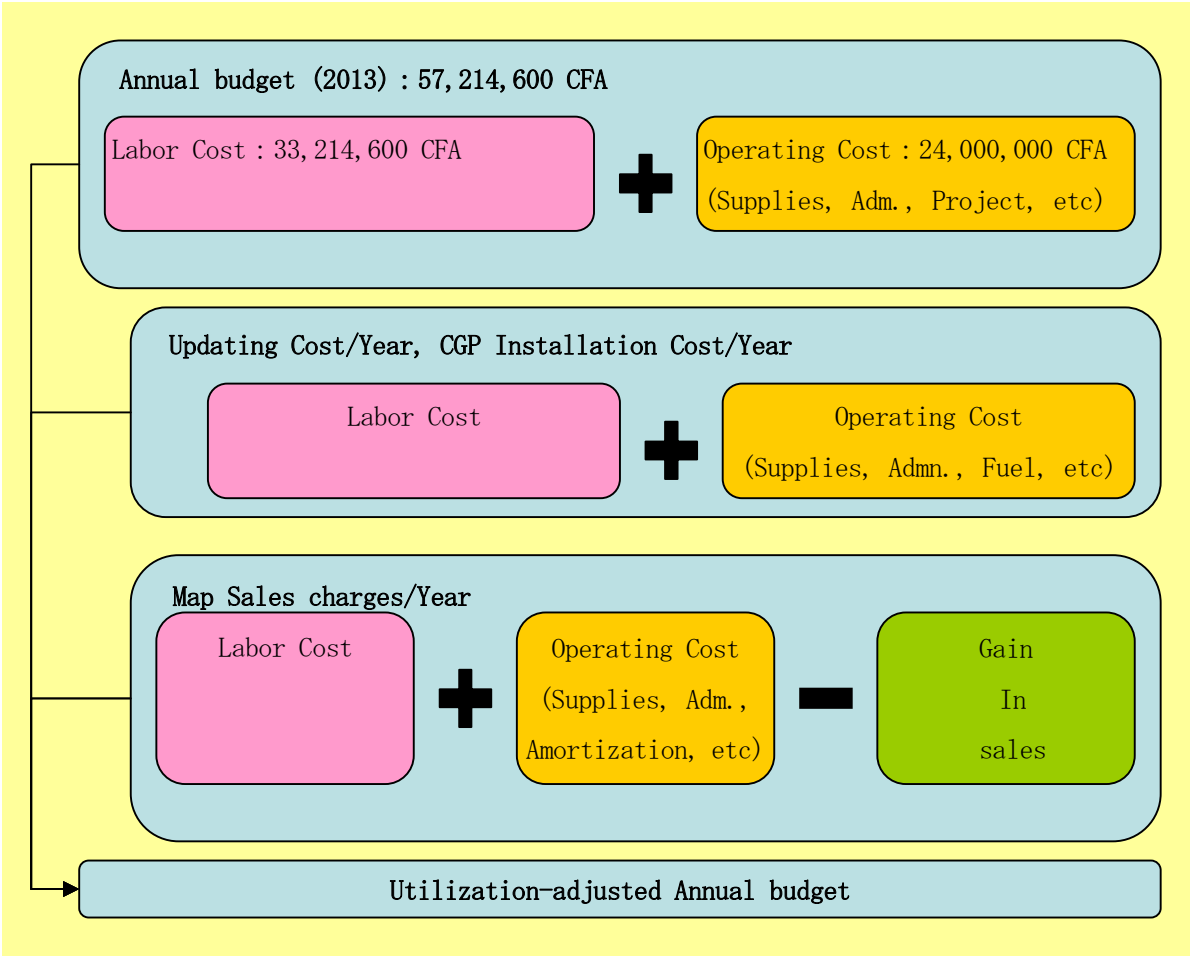


Figure 6 Idea of finance about budjet and utilization of the General Directorate of Cartography

Table 7 Selling Prices of Topographic Maps in Countries in the Region

Country	Scale	Price (CFA franc)	Remarks
Togo	1/15,000	5,000	
	1/50,000	Not on sale	IGN of France sells raster format maps at 60 euros per map.
	1/200,000	5,000	
	1/500,000	5,000	
Senegal	1/1,000	2,500	
	1/50,000	4,000	
	1/200,000	5,000	

	1/1,000,000	3,000	
Burkina Faso	1/50,000	2,000	
	1/200,000	2,000	
	1/500,000	2,000	
	1/1,000,000	5,000	
Mali	1/50,000	5,000	
	1/200,000	5,000	

2-2-2. Problems Related to Utilization of the Outputs

The mapping data and the GIS data produced in this project include a whole domain of Togo so that they are essential for basic social service (such as education, medical insurance, and water supply) and development project for disaster counter measurement that a country of Togo holds. Following actions are necessary to make a good use of these data

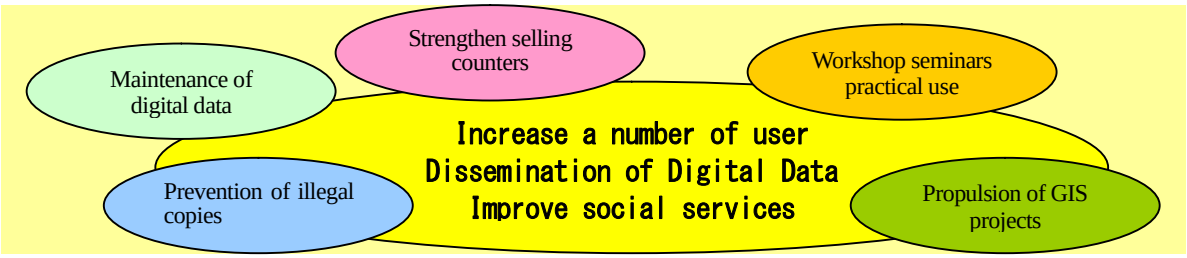


Figure 7 Strategies for Utilzation

2-2-3. Recommendations on Projects and Organizational Structure of DGC in Future

Large-scale (1/2,500 and 1/5,000) topographic maps will be required for the preparation of plans to alleviate the problems found in cities including the capital, Lomé, in future. Creation of such maps will require development of a geodetic control point network using the five control point origins established in this Study as reference points. Facilitation of these projects will require development of the capacity to solve the physical and technical problems mentioned below. It will also require solid independent status of DGC, as well as an increase in the importance of DGC, in the Government of Togo.

DGC is reportedly considering strengthening its organizational structure. If it materializes, the feasibility of the expansion of the scale of the organization is expected to increase and the problems in human resource and financial problems are expected to be alleviated. When these problems have been alleviated, an issue of training and education of staff members will remain. Solution of this issue will require implementation of technical cooperation projects by international aid agencies including the EU, Japan and the World Bank or the establishment of an educational institution for the entire region of West Africa.

Table 8 Problems in DGC

Area		Work and problems				
		Control point network development	**Update of topographic maps**	**Creation of large-scale topographic maps**	**Digital data management**	**Miscellaneous**
Physical	Budget	Shortage of budget for procurement of equipment, the costs associated with vehicles and the personnel cost	Shortage of budget for procurement of new imagery, costs associated with vehicles and personnel cost		Shortage of budget for the development of systems for maintenance and distribution of data	
	Organization and personnel	Shortage of human resource for the establishment and maintenance of control points and benchmarks	Shortage of human resource for the maintenance and update of the 1/50,000-scale topographic maps	Shortage of human resource for the creation of the large-scale topographic maps	Shortage of human resource for provision and promotion of the utilization of the topographic map data, GIS data, etc.	Shortage of human resource for overall planning and budgeting of DGC
Technical	Technology and knowledge	Lack of technical capacity of newly-employed personnel		Lack of technical capacity to create large-scale topographic maps	Lack of knowledge concerning sales of digital data	

2-3. Technology Transfer

2-3-1. Purposes of the Technology Transfer

Technology transfer to DGC in the series of work associated with the development of topographic maps was implemented even after the completion of the Study in order to ensure that DGC is capable of updating, maintaining and operating the data independently.

The Study Team established the objectives of the technology transfer mentioned in the table below before its commencement and selected the contents of the technology transfer in accordance with the experience, capacity and needs of the DGC engineers.

Most of the DGC engineers had no experience in the works concerned and were at an elementary level regarding basic works and manipulation of the equipment used. The Study Team implemented the technology transfer with the goal of equipping the counterparts with the experience and capacity mentioned above to implement the work required for data update independently in future in a limited time. The team evaluated the achievements of the technology transfer and defined a strategy for measures for the acquisition of knowledge and technology required after the completion of the Project. The details of the technology transfer in each subject are described in Chapter 4 below.

Table 9 Participants in the Technology Transfer

Name		Control point survey	Field identification/ Field completion	Aerial triangulation Digital plotting	Digital compilation/ Symbolization Structurization	Remarks
1	PAKOUN Léma	2	2	2	2	Team 1
2	SODAGNI Yawo	2	2	2	2	
3	GUEGUE Diwèfé-Esso	1	1	1	1	
4	AGBOFOATI Kudzo	1	1	1	1	
5	KPODZRO Kwami Valentin	2	2	2	2	
6	BOURAIMA Soumaila				2	Directorate of Real Estate
7	Georges Laté LAWSON-BETUM				2	
8	HOUEDAKOR Anoumou Mario	2	2	2	2	Team2
9	ESTEVE Moudjibou			2	2	
10	ADJATI Amèvi Agossi	1	1	1	1	
11	ADJOH Mawussi	1	1	1	2	
12	BESSEH Koffitsè			2	2	
13	FAGBEDJI John				2	Ministry of Urban Planning and Housing

Table 10 Objectives Established for the Technology Transfer

Item	Work	Objective
Control point survey	Field reconnaissance for selection of control points	Comprehension of the basic concept of GPS (Comprehension of point allocation for aerial triangulation, interpretation of images and positional correlation)
	GPS survey	Acquisition of methods to manipulate equipment, prompt and accurate equipment setting
		Preparation of points control point details register
	GPS analysis	Data download from equipment
		Basic manipulation of software
		Verification and interpretation of the observation results
		Basic baseline analysis
		Advanced baseline analysis Comprehension of the parameters and analysis results
		Basic network adjustment
		Advanced network adjustment Comprehension of the parameters and analysis results
	Leveling	Prompt and accurate equipment setting, acquisition of methods to manipulate equipment
		Data download from equipment
		Verification and interpretation of the observation results
	Control point maintenance procedure	Creation of awareness of control points/dissemination of information on control points to area residents
Aerial triangulation	Aerial triangulation by satellite images	Basic manipulation of digital photogrammetry system (creation of projects, import of various types of data)
		Basic processing of satellite images
		Basic manipulation of the software for aerial triangulation

Item	Work	Objective
		Verification, interpretation and evaluation of the results of aerial triangulation
		Advanced manipulation of the software for aerial triangulation Comprehension of the parameters and the results of aerial triangulation
Field identification/ Field completion	Preliminary work	Comprehension of the work, sorting of existing materials, interpretation of images
	Field identification	Manipulation of handy GPS unit
		Prompt identification of features in the field
	Filing of survey results	Systematic representation of the results of identification on printed images
		Entry of the results of identification as data
Digital plotting	Digital plotting by use of satellite images	Basic manipulation of the digital photogrammetry system (for plotting)
		Basic manipulation of CAD software
		Advanced manipulation of CAD software (including detailed condition setting)
		Comprehension of map symbols
		Comprehension of data acquisition methods for different scales
		Comprehension of plotting planimetric features and plotting contour lines
		Different data interpretation methods for different types of satellite images
		Preparation of a work manual
Digital compilation/ Digital compilation after field completion	Digital compilation Digital compilation after field completion	Basic manipulation of CAD software
		Comprehension and implementation of data cleaning
		Comprehension and implementation of the creation of polygon data
		Edge matching with existing topographic map data
		Preparation of a work manual
Map symbolization	Allotment of symbols to topographic map data	Comprehension of map adjustment
		Comprehension of different symbolization methods for different map scales
		Basic manipulation of the software for symbolization
		Advanced manipulation of the software for symbolization (including detailed condition setting)
Digital data structurization	Digital data structurization GIS basic data creation	Comprehension of GIS (comprehension of the standard data structure)
		Basic manipulation of GIS software
		Advanced manipulation of GIS software
		Recommendations on utilization of GIS data
Promotion of utilization	Monitoring of need for topographic maps	Collection and sorting of reference materials
		Collection of information from organizations concerned
Quality Control	Quality control by work process Preparation of quality control table	Comprehension of quality control
		Preparation of quality control table
		Implementation of quality control

2-3-2. Technology Transfer in Quality Control

DGC had neither engineers with experience in the work required for the development of 1/50,000-scale topographic map data nor engineers with experience in quality control of such data. Therefore, the Study Team implemented the technology transfer aimed at enabling the staff members of DGC to prepare a quality control table in accordance with the Survey International Specifications at each stage of the work and to conduct inspections and verification and correction of errors in quality control.

Details of the technology transfer in quality control are mentioned in Chapter 4 below.

Table 11 Contents of the Technology Transfer in Quality Control

Item		Activities in quality control
Control point survey	GPS observation	Inspection of required equipment Verification of the observation results
		Evaluation of the results of baseline analysis Evaluation of the results of network adjustment
		Preparation of quality control table
	Leveling	Inspection of required equipment Verification of the observation results Preparation of quality control table
Aerial triangulation		Evaluation of the results of relative orientation
		Re-observation of tie points
		Evaluation of the results of adjustment calculation
		Re-observation of the control points and tie points
		Preparation of quality control table
Field identification/Field completion		Inspection of preliminary survey maps
		Inspection of the outputs of field identification
Digital plotting		Inspection of planimetric features
		Inspection of contour lines
		Preparation of quality control table
Digital compilation/Digital compilation after field completion		Edge-matching between maps
		Inspection and correction of logical errors in the data
		Topology check
		Preparation of quality control table
Map symbolization		Inspection of the status of data conversion
		Inspection of output maps
		Preparation of quality control table
Digital data structurization		Inspection of the status of data conversion
		Inspection of attributes of the created data

2-3-3. Technology Transfer in Partial Correction

The Study Team provided the counterparts with technology transfer in partial correction of the data on locations where correction was required at the stages of “digital plotting,” “digital compilation,” “symbolization” and “structurization,” so that DGC would be able to update the topographic map data to be developed in this Project.

In this part of the technology transfer, a data source likely to be used by DGC in the update of topographic maps in future was selected for the exercise. WorldView-2 satellite images taken in May 2012 and data on planned bridges and roads in a General Directorate of Public Works, Ministry of Public Works project were used as reference materials. The reference data and newly plotted topographic maps were comparatively analyzed and, if a change was identified, the cause/causes and extent of the change were identified. Whether or not to correct the data was determined in accordance with the criteria for correction and, when correction was deemed necessary, the work required for data correction was implemented.

Table 12 Setting of the Standards for the Selection of Data to be Corrected

Feature	Cause of change over time		
	Change associated with implementation of urban planning project, etc. by the administration	Change caused by disasters Natural change over time	Change caused by other artificial causes
Roads	Topographic maps shall be updated for changes on a scale which satisfies the standards for data acquisition for the development of 1/50,000-scale topographic maps. Urban planning maps etc. shall be used in the update as reference materials.	When a change in shape or an attribute of a permanent road is detected, the topographic map concerned shall be updated.	When a road with a width of 5.5 m or more has been constructed or the width of an existing road has been increased to the said width When a road with a width of 5.5 m or less which satisfies the conditions mentioned below has been constructed: 1. A road connecting villages and required to be included in the map data 2. A road leading to a major landmark 3. A road connected to a trunk road 4. A major road in a remote area, and 5. A road serving as a major boundary on farmland
Structures Residential areas	Topographic maps shall be updated for changes on a scale which satisfies the standards for data acquisition for the development of 1/50,000-scale topographic maps. Urban planning maps etc. shall be used in the update as reference materials.	When a change affecting an area of 150 m × 150 m or larger has occurred, the topographic map concerned shall be updated.	When a change affecting an area of 150 m × 150 m or larger has occurred, the topographic map concerned shall be updated.
Water bodies	Topographic maps shall be updated for changes on a scale which satisfies the standards for data acquisition for the development of 1/50,000-scale topographic maps. Urban planning maps etc. shall be used in the update as reference materials.	An attribute of a river shall be changed when it has changed from perennial to seasonal or from seasonal to perennial. The shape of a water body shall be corrected with the topography of the area concerned when it becomes necessary to correct the topology.	An attribute of a river shall be changed when it has changed from perennial to seasonal or from seasonal to perennial.
Vegetation, farmland, etc.	Topographic maps shall be updated for changes on a scale which satisfies the standards for data acquisition for the development of 1/50,000-scale topographic maps. Urban planning maps etc. shall be used in the update as reference materials.	When a change affecting an area of 150 m × 150 m or larger has occurred, the topographic map concerned shall be updated.	When a change affecting an area of 150 m × 150 m or larger has occurred, the topographic map concerned shall be updated.
Topography (including contour lines)	Topographic maps shall be updated for changes on a scale which satisfies the standards for data acquisition for the development of 1/50,000-scale topographic maps. Urban planning maps etc. shall be used in the update as reference materials.	When a change in altitude of 10 m or more has occurred, the topographic map concerned shall be updated.	When a change in altitude of 10 m or more has occurred, the topographic map concerned shall be updated.

2-3-4. Thoughts on Technology Transfer

The Study Team concluded that the technology transfer implemented in this Study has produced adequate outputs in all the subjects. As the Study attracted the interest of many people in Togo including the prime minister. A total of 13 officials from 3 government sections, 10 stuffs from DGC (3 stuffs and 7 prospects), 2 stuffs from Directorate of Real Estate, and 1 stuff from Ministry of Urban Planning and Housing, participated in the technology transfer.

The table below shows the measures taken by DGC and the Study Team which characterized the technology transfer in this Study and contributed to its success.

Table 13 Characteristics of, measures taken in and outcomes of the technology transfer

Measure	Work	Description of the measure	Outcome
Implementation of the work in two terms (one in Southern and the other in Northern Areas)	Control point survey Field identification/ field completion	The works in the Southern and Northern Areas were implemented in two different terms which were separated by some time.	The separation of terms created time for the participants to do basic practice, review the practice and overcome their shortcomings. The CPs managed to implement the works concerned almost by themselves in the Northern Area.
Reporting system	Aerial triangulation Digital plotting Digital compilation/ digital compilation after field completion Map symbolization Data structurization	The participants made report on the technology transfer to the Director General of Cartography at report meetings held on a regular basis.	All the participants take notes of the training seriously. The report meetings provided them with opportunities to share information and to clarify problems.
Implementation of the training in two terms	Aerial triangulation Digital plotting Digital compilation/ digital compilation after field completion Map symbolization Data structurization	Technology transfer of each of the subjects concerned was provided in two different terms separated by some time.	The separation of terms allow the participants to focus on learning the basics in the first term, practice them by themselves during the time between the terms and use them in the work in the second term. This measure allows the participants to train themselves while no team member was in Togo.
Working in two teams	Aerial triangulation Digital plotting Digital compilation/ digital compilation after field completion	As the number of participants exceeded ten, they were divided into two teams, which took turns in the work by day.	The participants were able to maintain concentration on the technology transfer every day. It was possible for all the participants to have sufficient time to practice the technologies. Leaders emerged among the participants and voluntarily provided the other participants with guidance.
	Map symbolization Data structurization		

In the technology transfer in control point survey, the participants managed to implement control point survey in the Northern Area without assistance from the Study Team using the technology acquired in the same work in the Southern Area. They also managed to implement GPS observation and leveling independently, from observation to analysis and preparation of quality control tables.

Although the study area in the Northern Area was huge, in particular, the counterparts prepared a plan for field identification and field completion in order to acquire data on all the survey items within the limited time by themselves and managed to complete the works within the given time periods.

Since the DGC staff members managed to implement and complete the work at all stages in the transfer of laboratory technologies, from aerial triangulation to digital data structurization, and control the quality of the work for the area of the map independently, the team concluded that they understood the concept and basic procedures at each stage of the work.

As they managed to create sample GIS models showing the photographs taken during field identification and representing three-dimensional topography in the technology transfer in digital data structurization, the team concluded that they have acquired the capacity required for creating new models in future.

The Study Team expects DGC to take the lead in utilization of the knowledge and technology obtained in the technology transfer in the Study to continue partial correction of the outputs of the Study with satellite images and input from various government ministries and offices. The team also expects them to carry out awareness creation activities to increase the number of donors of data to the GIS data and users of the GIS data in other government ministries and offices.

Chapter 3 Details of Work

3-1. Collection, Organization and Analysis of Related Materials/Information [Work in Japan]

The materials collected by the Preliminary Study Team, the information independently studied and acquired by the Study Team and the related information available in Japan were analyzed and arranged. The specifications (draft) of the map specifications and outputs were created with reference to the Survey International Specifications of JICA, the Collection of Map specifications/ Specifications issued by the Geospatial Information Authority, Ministry of Land, Infrastructure, Transport and Tourism, and experience and knowledge in similar projects that have been implemented by PASCO so far.

3-2. Preparation of Inception Report [Work in Japan]

Based on analysis and examination of the Terms of Reference (TOR), the Report on the Study of Detailed Plan Formulation in Togo (draft) and the collected materials, the Inception Report was prepared for implementation of this Study and the results of preliminary explanation to and discussions with JICA were also reflected to finalize the Inception Report. English, French and Japanese versions of the report were prepared.

3-3. Explanation and Discussion of Inception Report [Work in Togo]

The details of the Inception Report were explained to the DGC, and the items and policies of the Study were discussed with the DGC. The methods of the control point survey, field identification and field completion, and the areas for implementing OJT were determined through mutual discussions.

The progress and results of the discussions were summarized in the Minutes of Meeting (MM), which were signed by representatives of both parties. (See Appendix-1 for MM.)

On May 11th, 2011, a seminar was held under the auspices of the DGC and members of the related ministries and agencies who are expected to be future users participated in the seminar in which the Inception Report was explained to the members. Following organizations participated to the meeting and implemented question-and-answer session.


Figure 8 IC/R Briefing (Left: Briefing, Right: Reporting to the Minister of Housing)

3-4. Discussions on Specifications [Work in Togo]

The work items and work processes were explained to the counterpart agency through discussion of the detailed specifications including the survey standards, data acquisition items in the digital plotting work, map specifications, annotation specifications and data structures. As a result, the discussions led to mutual agreement by both parties.

Table 14 Finalized Map Specifications

Item	Conclusion	
Projection Method	UTM（Universal Transverse Mercator） Zone 31	
Geographic coordinate system	ITRF94	
Reference ellipsoid	GRS80	
Standard for elevation	The existing control points to be used as control points	
Area for the development of topographic maps	The two parties agreed to develop maps of an area of approximately 56,000 km^2 (in October 2011).	
Strategy on the use of reference materials in the development of topographic maps	Planimetric features	The two parties agreed to procure ALOS, SPOT and WorldView-2 satellite images, in this order, to obtain images covering the entire study area and to use the existing topographic maps as reference materials to obtain data on areas which had not been captured on any of satellite images.
	Contour lines, etc.	The two parties agreed to use ALOS satellite images and existing topographic maps, in this order, to obtain data on the entire study area and to use existing aerial photographs to obtain data on areas which did not appear on either ALOS images or the maps. The parties agreed to use an interval of 20 m between principal contour lines.
Scope of OJT for the transfer of laboratory technologies	One 1/50,000-scale topographic map	
Map symbols (Data acquisition items)	See Appendix-6.	
Boundaries/names of maps	See Figure 8.	
Marginal information	See Figure 9.	
Annotation	Cette carte numérique a été préparée conjointement par l'Agence Japonaise de Coopération Internationale (JICA) et le Gouvernement du Togo dans le cadre du Programme de la Coopération Technique du Gouvernement Japonais. (This digital map was prepared jointly by the Japan International Cooperation Agency (JICA) and the Government of Togo under the Japanese Government Technical Cooperation Program.)	

3-5. Mutual Discussions on Technology Transfer [Work in Togo]

The Study Team presented proposals for OJT and technology transfer, and requested assignment of local workers to the DGC in the mutual discussions. As a result, the following items were agreed upon by both parties as shown below.

Although the IC/R described two maps as the target of the scope of work in the transfer of laboratory technologies, the two parties reached a final agreement to reduce the scope to one map on the basis of the results of analysis of the technical capacity of the participants at the time of the discussions on IT/R.

Table 15 Equipment and Materials for Technology Transfer

Name of Equipment	Q'ty	Acceptance and validation of equipment
GPS Survey Equipment	4	April 2011
GPS Mobile Station Equipment	3	April 2011
GPS Analyzer	1	April 2011
Leveling Equipment	4	April 2011
Handy GPS (incl. rechargeable dry cell batteries)	4	April 2011
Digital Camera (incl. data recording media)	4	April 2011
Basic Software for Aerial Triangulation/ Plotting/Compilation (LPS Core)	1	July 2012
Software for Aerial Triangulation/Plotting/Compilation (LPS Stereo)	1	July 2012
Software for Aerial Triangulation (Adjustment calculation portion) (ORIMA DP-TE/GPS)	1	July 2012
Software for Aerial Triangulation (DEM creation portion) (LPS ATE)	1	July 2012
Basic Software for Plotting/Compilation (PRO600 FOR LPS/DPW)	1	July 2012
Software for Plotting/Compilation (DEM compilation portion) (LPS TE)	1	July 2012
Software for Plotting/Compilation (Bentley MicroStation)	2	July 2012
Software for Plotting/Compilation (Bentley Map)	1	July 2012
Software for GIS Structurization (ESRI ArcGIS / ArcInfo)	1	July 2012
Software for GIS Application (ESRI 3D Analyst)	1	July 2012
Software for GIS Application (ESRI Spatial Analyst)	1	July 2012
Software for GIS Application (ESRI Network Analyst)	1	July 2012
Software for Map symbolization (Adobe Illustrator)	1	July 2012
Image Processing Software (Adobe Photoshop)	1	July 2012
Workstation (for Plotter)	1	July 2012
Personal Computer (incl. peripheral equipment)	2	July 2012
Stereo Image Display Unit	1	July 2012
Mouse for Photogrammetry	1	July 2012
Hard Disk for Data Server	1	July 2012
Uninterrupted Power Supply (UPS)	4	July 2012
Scanner & Printer for Map Output (A0 size) (incl. consumables)	1	June 2013
Color Laser Printer (A3 size, incl. consumables)	1	June 2013

3-6. Collection and Organization of Existing Materials [Work in Togo]

In addition to the materials collected in "(1) Collection, Organization and Analysis of Materials/Information" in the Preparatory Work in Japan, additional related materials and information were collected in Togo.

3-7. Acquisition of Satellite Images [Work in Japan]

Satellite images covering the entire national land of Togo (approx. 56,000 km^2) were acquired and the quality of the satellite images was checked taking into consideration whether or not the following were appropriate: (1) capability of stereoscopic viewing; (2) images photographed in and after 2006; (3) quality of satellite images; (4) amount of haze and cloud; and (5) overlap and side lap. It follows that ALOS (PRISM) images were preferentially acquired, however, it was impossible to acquire ALOS satellite images due to failure of the satellite since April 22nd, 2011. Therefore, images acquired during the period of aerial photography from November 16th, 2006 to December 23rd, 2010 were to be procured.

ALOS (AVNIR) images covering the area for the procurement of ALOS (PRISM) images were procured for the creation of color orthophotos.

SPOT5 or WorldView-2 satellite images were to be used for areas which had not been captured on ALOS images or areas for which data could not be obtained from the ALOS images because of cloud cover.

These satellite images were used in the control point survey and the field identification, and little difference was observed between the planimetric features on the ground and on the satellite images. Even if there happens to be a significant difference, it can be corrected in the field identification. Thus, these observations confirmed absence of problem in using the satellite images for mapping work. The satellite images are therefore deemed to have a quality required for developing topographic maps.

The table below shows the ALOS (PRISM) images and other types of satellite images procured in the Study covering the entire country and the areas covered by the different types of satellite images.

Table 16 Procured Satellite Images

Item	Specification	Description
ALOS-PRISM	Monochrome, Stereo-images, GSD: 2.5m	297 scenes (99 scenes * front view + orthotropic view + back view)
ALOS-AVNIR	Color, Single-image, GSD: 10m	99 scenes
SPOT5	Color, Single-image, GSD: 2.5m	14 scenes
WorldView-2	Color, Single-image, GSD: 0.5m	Approx. 1,280 km^2

3-8. Control Point Survey in Southern Area [Work in Togo]

The Study Team carried out the control point survey (GPS observation and leveling) in accordance with the workflow shown below. The allocation of the control points at which GPS observation was carried out and the specifications followed in the GPS observation are described in the following.

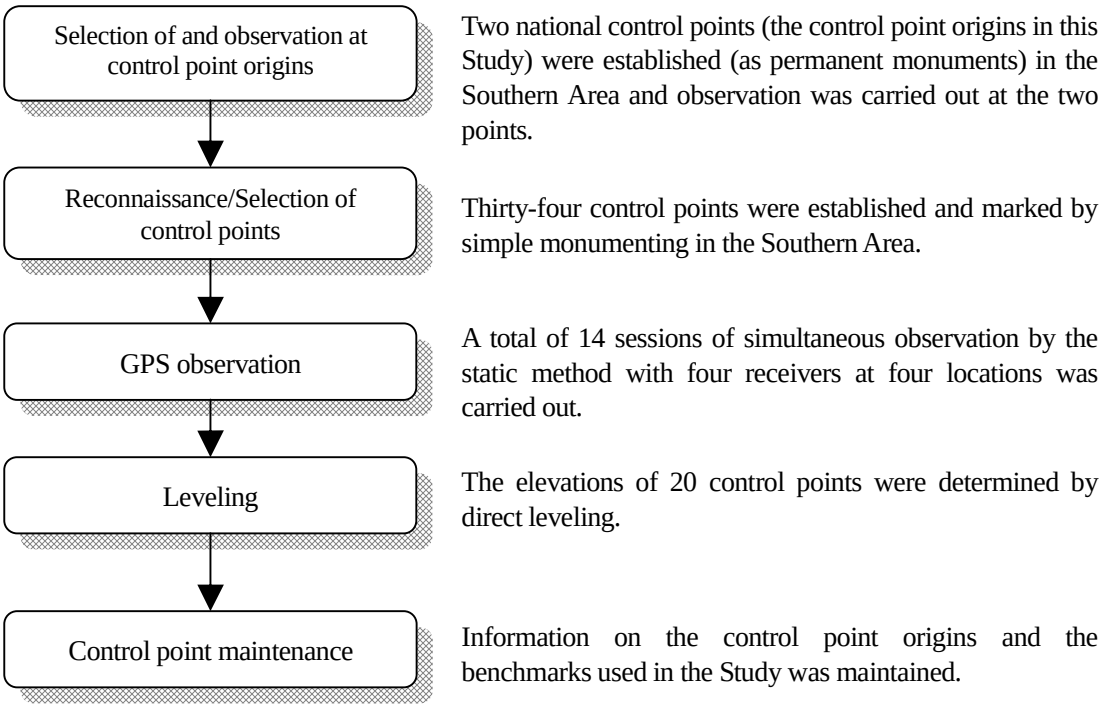


Figure 9 Workflow of Control Point Survey

Figure 10 Control Point Survey (Left: Control point origin, Right: Levelling)

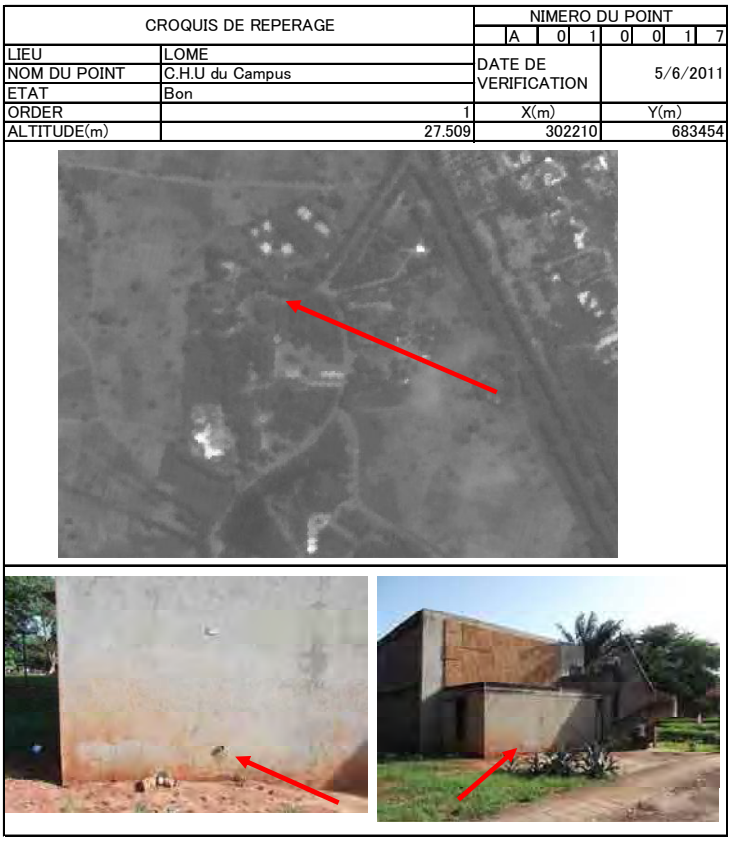


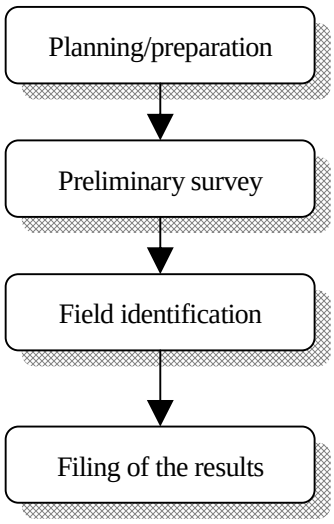
Figure 11 Existing Benchmark Control Sheet

3-9. Discussions on Expansion of Study Area [Work in Togo]

The Study Team recommended to the DGC that the work area determined in "3-4 Discussions on Specifications" in October 2011 be expanded from approx. 22,000km^2 (Southern Area) to 56,000km^2 (the whole area of Togo), and the DGC agreed to it.

3-10. Field Identification in Southern Area [Work in Togo]

In the Study, the field identification was conducted as follows using simplified orthophotos produced from satellite images for field identification and existing materials, etc. in order to examine the planimetric features, public buildings, linear objects (power lines and pipelines) and public facilities (including water sites), road types, administrative names, annotations and other objects which were difficult to interpret from the satellite images during mapping work. These items were also verified by collecting existing materials as well as interviews with related agencies.



An overall work plan is prepared for efficient implementation of field identification and materials required for field identification are prepared.

The main objects of field identification are identified using the results of photo interpretation, existing topographic maps and existing reference materials.

Positional information on the identification objects is obtained with a handy GPS unit, photographs are taken on the ground and their locations are marked on the existing 1/50,000-scale topographic maps.

Reference materials for subsequent plotting are created by sorting the results of identification by location (coordinates) and detail (attributes and name).

Figure 12 Workflow of Field Identification in Southern Area

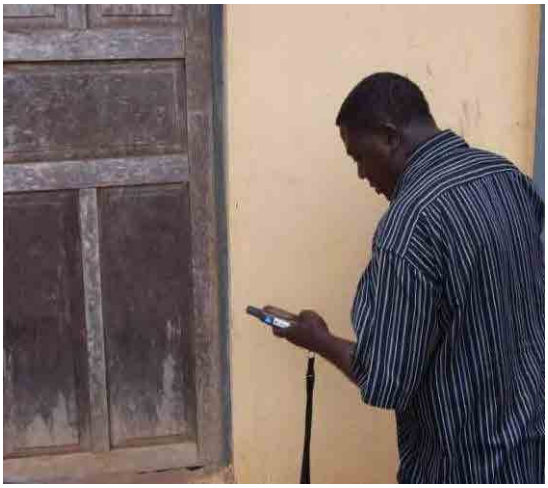


Figure 13 Left: Interview survey, Right: Entry of coordinates (handy GPS unit)

3-11. Aerial Triangulation in Southern Area [Work in Japan / Work in Togo]

The aerial triangulation survey was carried out as follows based on the results of the control point survey as well as the satellite images.

The acquired satellite images and incidental RPC (Rational Polynomial Coefficient) file were imported to the digital photogrammetry system and the control points and tie points were observed. Then, bundle adjustment was performed.

The aerial triangulation was carried out in accordance with the Survey International Specifications and the Survey International Work Manual (for Base Maps) for Satellite Image-based Photogrammetry (issued by JICA in December 2006).

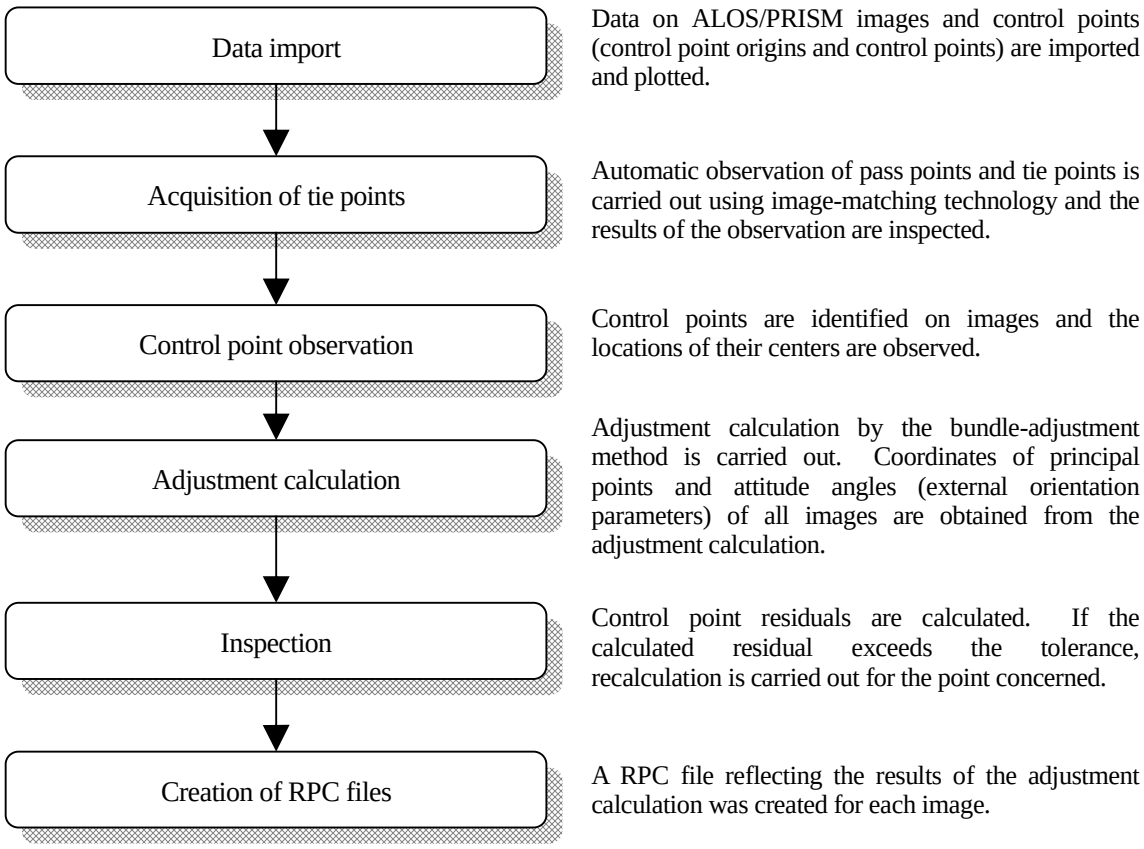


Figure 14 Workflow of Aerial triangulation

3-12. Control Point Survey in Northern Area [Work in Togo]

The control point survey in the Northern Area was implemented by the same method as that used in the same work in the Southern Area.

3-13. Field Identification in Northern Area [Work in Togo]

The field identification in the Northern Area (an area covered by 61 1/50,000-scale topographic maps) was carried out using the same method as that used in the same work in the Southern Area.

3-14. Explanation and Discussion of Interim Report [Work in Togo]

The Study Team prepared IT/R, explained the contents of IT/R to DGC, held discussions with DGC on the outputs produced so far in the Study and the schedule of the Study and compiled the details of the discussions and decisions reached in the discussions, including agreement that the transfer of laboratory technologies was to be implemented for one map, into minutes of meeting (MM) (see Appendix-2). The two sides authorized the MM with the signatures of their respective representatives.

DGC sponsored a seminar, to which members of government ministries and offices who were potential users of the topographic data had been invited, on February 28th, 2012. Presentations focused on the issues mentioned below were made in the seminar. The participants of the seminar included not only members of the ministries and government offices which had sent their representatives to the IC/R seminar, but also members of the "Ministry of Water, Sanitation and Rural Water Supply," the "Ministry of Environment and Forest Resources," the "Ministry of Higher Education and Research" and the "Ministry of Mines and Energy." There was a lively exchange of opinions among the participants in the seminar. Articles in newspapers and television programs on the seminar drew the attention of many people to the seminar. The participants of the seminar and a summary of the question-and-answer session which took place in the seminar are shown below. (See Appendix-5 for the results of the questionnaire survey.)

- Expansion of the Study area (from the Southern Area to the whole of Togo)
- Explanation of the Interim Report
- Demonstration on examples of the use of the data to be created in this project

Figure 15 Seminar on the ITR (Left: Presentation, Right: People from a TV station and the Director General of DGC)

3-15. Aerial triangulation in Northern Area [Work in Japan / Work in Togo]

Aerial triangulation was carried out in accordance with the same specifications as those used in the same work in the Southern Area. In order to improve the accuracy of aerial triangulation in the whole of Togo, not only the satellite images of the Northern Area and the outputs of the control point survey of the Northern Area, but also the outputs of the survey of the Southern Area, were used in the aerial triangulation.

3-16. Digital Plotting [Work in Japan / Work in Togo]

The digital plotting was conducted based on the results of the aerial triangulation. Topographic map data at a scale of 1/50,000 was created by using a digital plotter for measuring the oriented stereo models and acquiring shapes and locations of features as graphic data, in accordance with the conclusions of the discussion on the specifications. Features were classified by type of feature (feature type) provided in the specifications.

In addition, efficiency of the work was improved by actively importing the data of the results of the field identifications obtained with the handy GPS units into CAD data.

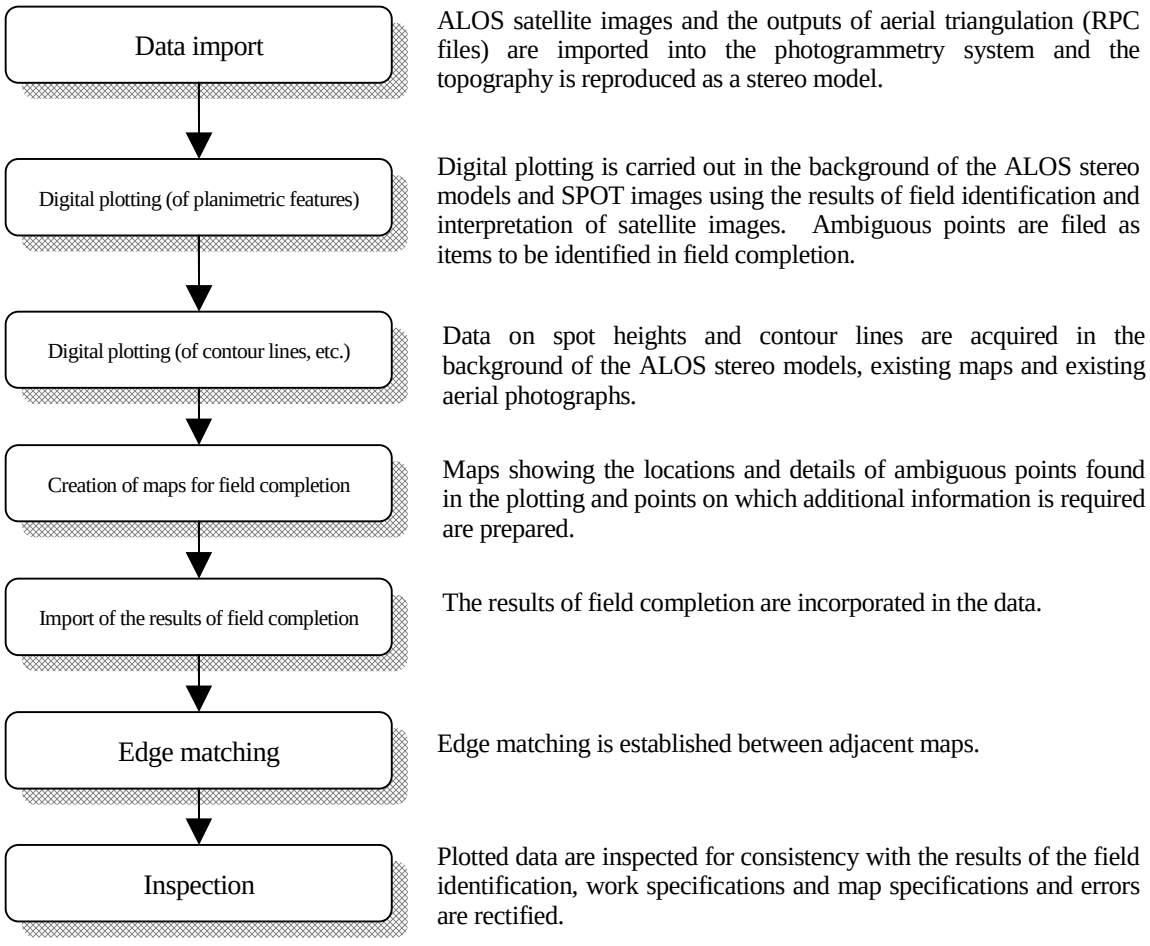


Figure 16 Workflow of Digital Plotting

3-17. Digital Compilation [Work in Japan / Work in Togo]

Digital compilation was a process to create topographic map data by processing digitally plotted data. The process included connection of lines, creation of polygons, data cleaning including deletion of unnecessary data, in accordance with the results of the field identification, data acquisition items and data acquisition criteria and addition of data on administrative boundaries and annotations. At the same time, edge matching with adjacent map sheets was also confirmed.

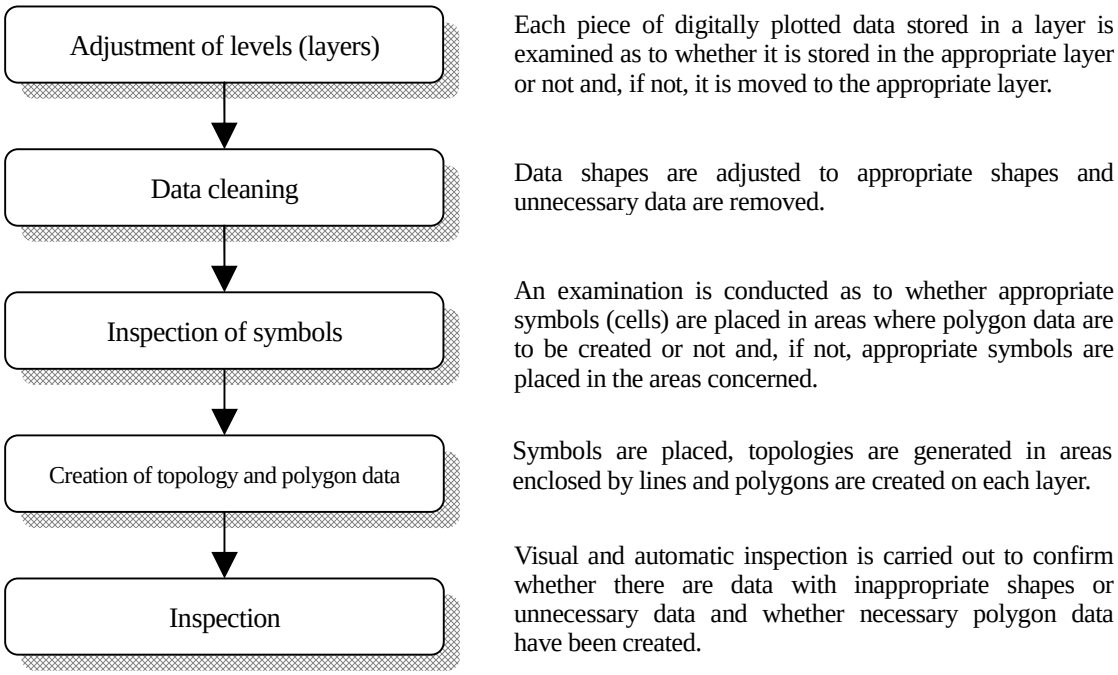


Figure 17 Workflow of Digital Compilation

3-18. Field Completion in Southern Area [Work in Togo]

The field completion was carried out for the purpose of improving the quality of topographic map data by clarifying uncertain elements revealed in the digital plotting and digital compilation in the field. Confirmation of annotation data including information on administrative boundaries and geographic names, such as names of rivers, and names of universities to be shown on topographic maps was also carried out. The field completion was carried out in the same area as the field identification.

Before the field completion, simple map symbolization of the topographic map data created in the digital compilation was carried out and the results of the symbolization were printed out on a scale of 1/50,000. The participants took copies of the printout map to the field completion.

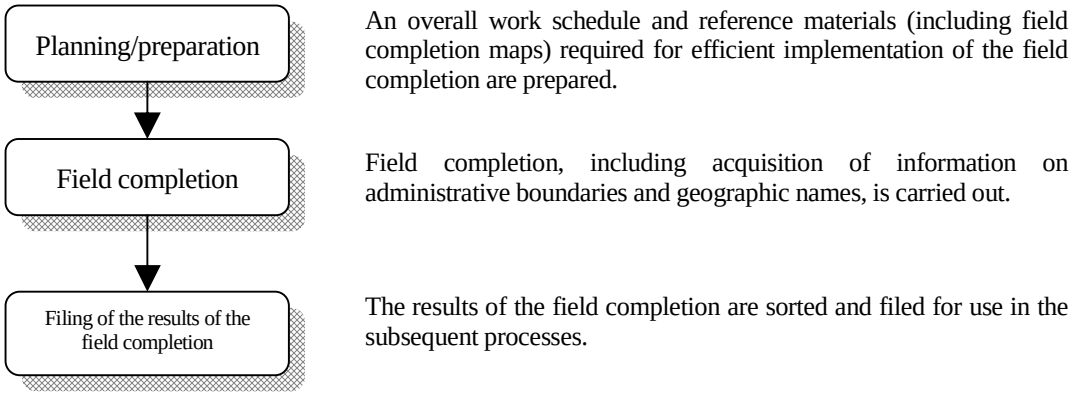


Figure 18 Workflow of Field Completion

3-19. Field Completion in Northern Area [Work in Togo]

Field completion in the Northern Area was implemented in the same way as in the Southern Area.

The technology transfer concerned was implemented in the form of OJT with guidance, supervision and work management by the members of the Study Team responsible for field completion. (See Chapter 4.)

3-20. Digital Compilation after Field Completion [Work in Japan / Work in Togo]

The plotted data were inspected and corrected for edge matching, etc. after the results of field completion in the Southern and Northern Areas were imported. Then, the data was cleaned by connection of line data, creation of polygon data and deletion of unnecessary data. Finally, data on administrative boundaries and annotation data were added to the cleaned data to develop topographic map data.

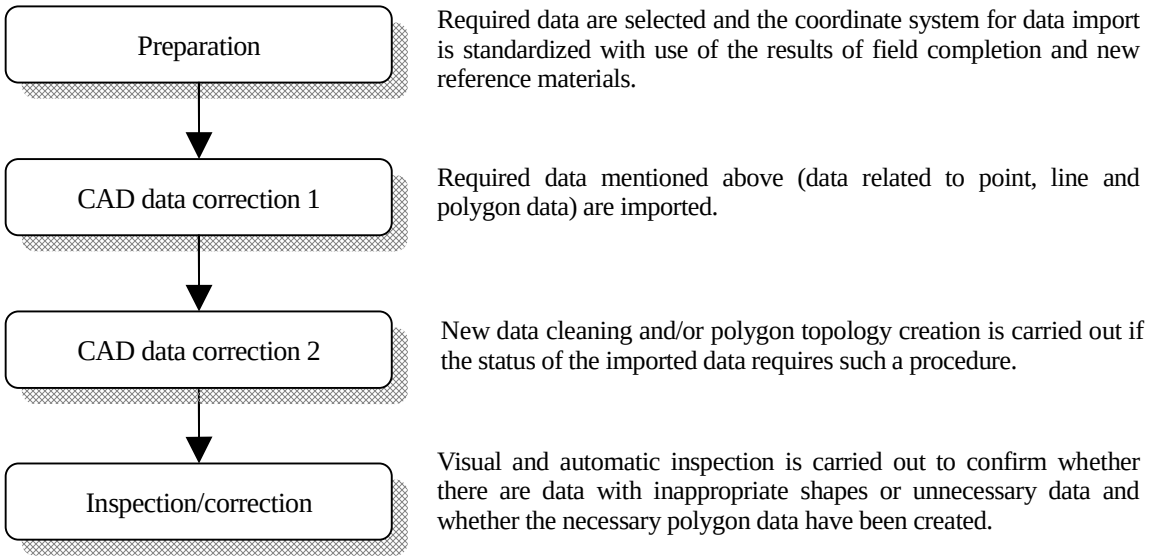


Figure 19 Workflow of Digital Compilation after Field Completion

3-21. Digital Data Structurization [Work in Japan / Work in Togo]

The digital topographic map data created in the digital compilation after field completion were structured in accordance with the outcome of the discussions on the specifications in order to make the data usable with GIS. Practical, user-friendly and versatile GIS basic data were created in the data structurization.

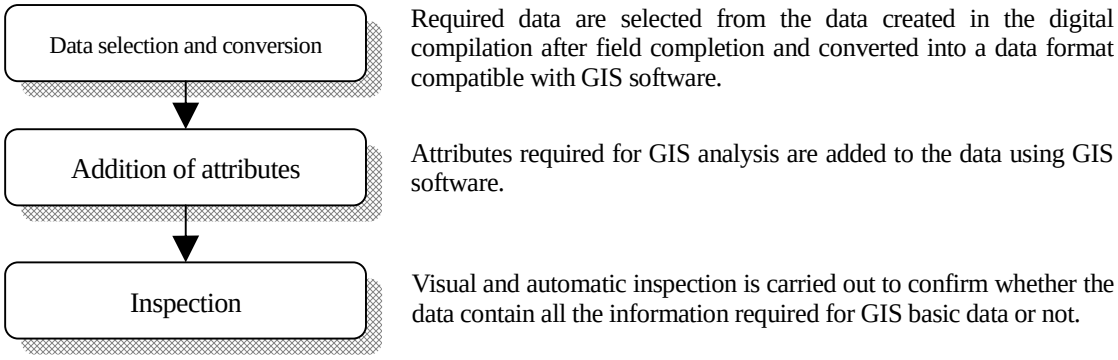


Figure 20 Workflow of Data Structurization

3-22. Map Symbolization [Work in Japan / Work in Togo]

Map symbolization, the addition of map symbols to the topographic map data created in the digital compilation after field completion, was carried out in accordance with the specifications agreed upon in the discussions on specifications. Illustrator, which can be used for creation of design data, storage of data in PDF files and creation of color separation data for DTP, was used as a tool for map symbolization.

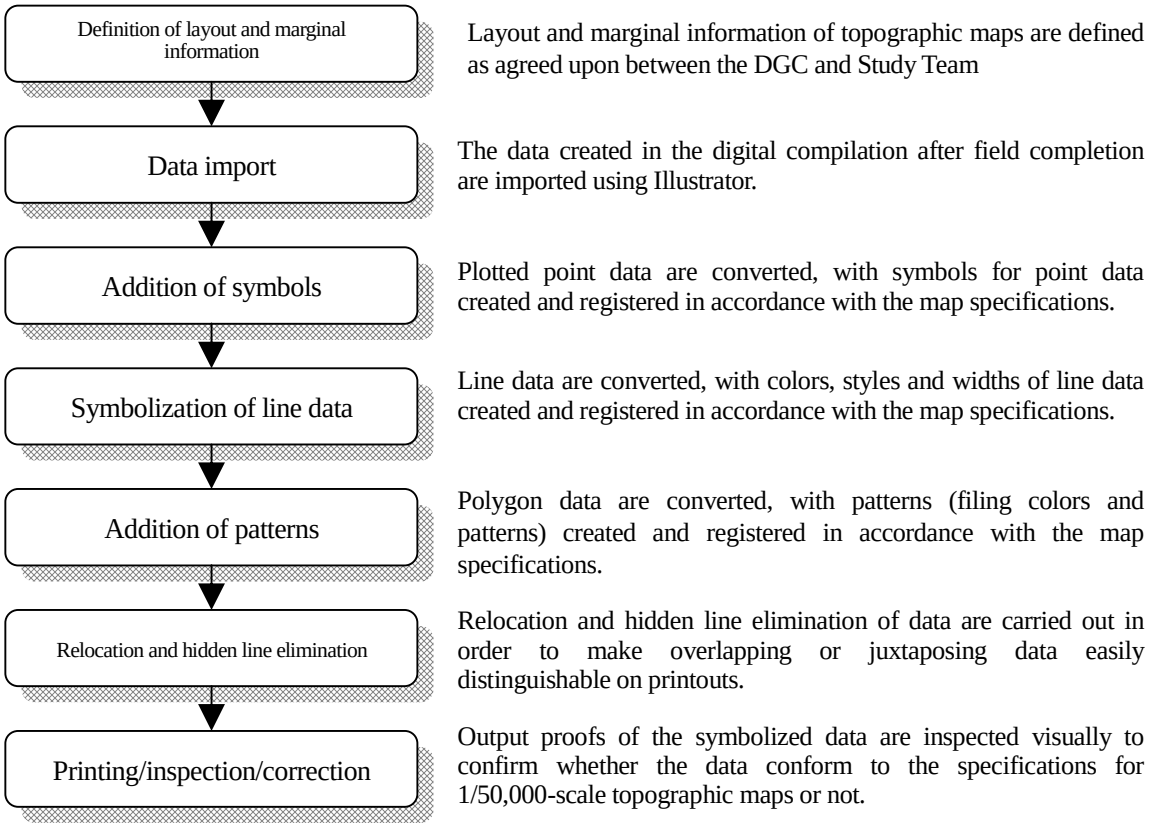


Figure 21 Workflow of Map Symbolization

3-23. Preparation of Progress Report (PR/R) [Work in Japan]

The results of the Study conducted after the Interim Report (IT/R), the progress of the technology transfer and topographic map data development, and the future plans and schedule were summarized to prepare the Progress Report (PR/R). The contents of this report were explained to JICA before preparation and approval was obtained.

3-24. Explanation and Discussion of Progress Report (PR/R) [Work in Togo]

The prepared Progress Report (PR/R) was submitted to the DGC and the details were explained to and discussed with the DGC. Decisions were made on the names of the maps and administrative annotations in the discussions. Details of the discussions were summarized in the minutes of meeting (MM). The two parties approved the MM with the signatures of their respective representatives. (See Appendix-3 for MM.)

3-25. Creation of Data File [Work in Japan / Work in Togo]

The created data outputs were stored in appropriate external storage media (external hard disk and DVD). When storing the data, a password was set to protect the data against disclosure.

Technology transfer in format conversion was also provided.

3-26. Promotion of Utilization [Work in Togo]

On 28th August 2013, the final seminar was held to promote the utilization of the project's results. There were the participants from various government ministries of Togo, local governments, and international aid organizations. Before the date of seminar, the Study Team paid a visit to the President of Togo, giving a report. Also, the Minister of Urban Planning and Housing visited the Study Team's room. Since these events were reported by the mass media such as television and newspapers, the seminar was informed to the public beforehand. On the day of the seminar, there were the opening speech by the Minister of Urban Planning and Housing and the Representative Resident of JICA in Ivory Coast. Then, the following presentations were made.

- Explanation of the work in this Study
- Explanation of outputs
- Elucidation of the digital technology used in this Study
- Introduction of ways of using the topographic map data and GIS base data developed in this Study
- Recommendations for usage trends and spread of geographic information

There were many participants from organizations and agencies expected as potential users. Thus, confirmed the importance of the close contact between DGC and these organizations.

3-27. Preparation of Draft Final Report (DF/R) [Work in Japan]

The work that had been carried out was summarized to prepare the Draft Final Report. The Work Manual that had been prepared in the course of the work was compiled separately from the Draft Final Report in consideration of usability. The contents of the Draft Final Report are as follows.

- Outline of the Study
- Comprehensive report on development of topographic map data
- Comprehensive report on technology transfer
- Recommendations for technical capacity building from the organizational and systematization aspects
- Recommendations for joint use of geographic information

The details of the Draft Final Report had been explained to JICA in advance, getting its approval.

3-28. Explanation and Discussion of Draft Final Report (DF/R) [Work in Togo]

The draft of the final report was handed to the FGD, and its content was discussed. The two parties agreed on the marginal information, the symbols of topographic map, etc. The content of this discussion was summarized in the minutes (MM), where the two parties have signed.

3-29. Preparation of Final Report (F/R) [Work in Japan]

The Final Report was completed upon receiving comments from the counterpart agency, reflecting them in the report and making the necessary additions and corrections. As with the Draft Final Report, the Work Manual was prepared as a separate volume from the Final Report in consideration of usability.

Chapter 4 Technology Transfer

Technology transfer in the series of work required for the development of topographic map data was conducted in this Study.

The Study Team evaluated the technical capacities of the counterparts in order to identify problems and establish targets appropriate for their technical capacities prior to the technology transfer.

4-1. Technology Transfer in Control Point Survey

The technology transfer in control point survey/establishment of aerial markers was implemented in the form of OJT in accordance with the scheduled workflow.

4-1-1. Purposes and Principal Objectives

The technology transfer in control point survey was carried out with the principal objectives mentioned in the table below.

Table 17 Objectives and Evaluation Procedures of the Technology Transfer in Control Point Survey

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
Control point survey	Comprehension of effective allocation and control point details register	Field reconnaissance for selection of control points	Comprehension of basic theory (Control point allocation, image interpretation, positional correlation)	1-2	Improvement in operation speed and accuracy through OJT (First, middle, last stage)	Qualitative evaluation by members of the Study Team
		GPS survey	Speedy and accurate equipment setting Learning of equipment manipulation	1-2	Self-setting and manipulation by the C/P	
			Preparation of control point details register	1-2	Self-creation of the details register by the C/P	Evaluation based on the checklist for the details register
		GPS analysis	Data download from equipment	1-2	Self-manipulation by the C/P	Evaluation by an examination in later period and qualitative evaluation by members of the Study Team
			Basic manipulation of software	1-2		
			Verification and comprehension of results	2	Self-preparation of quality control table by the C/P	Evaluation of the quality control table by members of the Study Team
			Fundamental baseline analysis	2	Self-report preparation by the C/P	Evaluation by an examination in later period and qualitative evaluation by members of the Study Team
			Basic network adjustment	2	Self-report preparation by the C/P	
		Leveling	Speedy and accurate equipment setting Learning of equipment manipulation	1-2	Self-setting and manipulation by the C/P	Evaluation by an examination in later period and qualitative evaluation by members of the Study Team
			Data download from equipment	1-2	Self-manipulation by the C/P	

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
			Verification and comprehension of results	2	Self-report preparation by the C/P	Evaluation based on the checklist for the report
		Control point maintenance procedure	Edification and publicity about control points to peripheral people	1-2	Self-preparation of signs and publicity by the C/P	Qualitative evaluation by members of the Study Team

4-1-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

The staff members of DGC managed to implement the inspection survey independently and obtained good results from the survey and subsequent data analysis in GPS observation in the Northern Area. They also managed to prepare the quality control table by themselves.

They managed to inspect the results of their own observations and prepared the quality control table in leveling in the Northern Area.

The above-mentioned facts prove that the staff members of DGC acquired the capacity to implement the control point survey independently during the technology transfer.

Figure 22 Technology Transfer in Control Point Survey (Top left: Joint training, Top right: Selection of control points, Bottom left: Leveling, Bottom right: Network adjustment)

4-2. Technology Transfer in Field Identification

4-2-1. Purposes and Principal Objectives

The technology transfer in field identification was implemented with the principal objectives shown in the table below.

Table 18 Objectives and Evaluation Procedures of the Technology Transfer in Field Identification

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
Field identification/ Field completion	Comprehension of specifications Arrangement of feature trend of urban area, rural area, mountain area	Preliminary work	Comprehension of work Filing of existing materials Image interpretation	1-2	Self-implementation by the C/P	Qualitative evaluation by members of the Study Team
		Field identification	Manipulation of mobile GPS	1-2	Self-manipulation by the C/P	Qualitative evaluation by members of the Study Team
			Speedy detection of destination on the field	1-2		
		Filing of results	Filing of results on printed image	1-2	Visual evaluation on printed map	Scoring with the comparison with a model data
			Data filing of results	2	Evaluation by completeness and thematic accuracy	

4-2-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

The eight DGC staff members carried out the field identification in four work groups. The member of the Study Team in charge of field identification accompanied different teams on different days to provide OJT. The team member evaluated the DGC staff members' progress in understanding the activities in field identification by observing their attitude in the field and inspecting the detailed results of the field identification in the second half of the technology transfer.

In the first half, the participants occasionally used the wrong code numbers for the identification objects, failed to identify them or marked them in the wrong locations on the maps. However, with continuous instruction and advice from the team member, the participants improved their understanding of the identification objects and the number of omissions and errors decreased as the technology transfer progressed.

Although the participants took a long time to master the interpretation of ALOS images, they acquired the capacity to interpret ALOS images independently through the field identification work in the Southern and Northern Areas and the technology transfer in digital plotting.

Although the counterparts had difficulty in the beginning in handling data with the hardware (handy GPS unit) and software (Microsoft Excel and CAD) used in the Study, they had acquired the capacity to do so independently and without problem by the completion of field identification in the Northern Area.

Figure 23 Technology Transfer in Field Identification (Left: Preliminary survey, Right: Manipulation of equipment)

4-3. Technology Transfer in Aerial Triangulation

4-3-1. Purposes and Principal Objectives

The technology transfer in aerial triangulation was implemented with the principal objectives shown below.

Table 19 Objectives and Evaluation Procedures of the Technology Transfer in Aerial Triangulation

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
Aerial triangulation	Comprehension of working process and focusing to basic techniques	Basics of Digital Photogrammetric system	Basic manipulation of digital photogrammetric system	1-2	Self-manipulation by the C/P	Evaluation by an examination in later period Qualitative evaluation by members of the Study Team
			Basic data processing of satellite imagery	1-2		
		Aerial Triangulation	Basic manipulation of AT software	1-2		
		Filing of AT Results	Verification and comprehension of AT results	1-2	Self-report preparation by the C/P	Evaluation of the quality control tables for completeness

4-3-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

The participants had acquired the capacity to conduct aerial triangulation independently based on understanding of the differences among “analog aerial photographs,” “digital aerial photographs” and “satellite images” by the end of the technology transfer through repeated exercises in the first and second sessions. The outputs of their aerial triangulation satisfied the specifications for the development of 1/50,000-scale topographic maps. They also acquired the capacity to evaluate the outputs independently.

These facts prove that the participants have acquired the capacity to carry out aerial triangulation independently using “analog aerial photographs,” “digital aerial photographs” and “satellite images” in future projects.

Meanwhile, some of them made mistakes when entering the sensor parameters or data on control points. When aerial triangulation is conducted with a large number of images, a long time is required for data processing. In order to prevent such a long time loss because of errors in the parameter settings, the input data will have to be inspected at each step of the work.

Figure 24 Technology Transfer in Aerial Triangulation (Left: Lecture on theory, Right: Practice)

4-4. Technology Transfer in Digital Plotting

4-4-1. Purposes and Principal Objectives

The technology transfer in digital plotting was implemented with the principal objectives shown in the table below.

Table 20 Objectives and Evaluation Procedures of the Technology Transfer in Digital Plotting

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
Digital plotting	Comprehension of scale-based method Quality control, achieving consistency Manual preparation Supplement for areas where image interpretation is difficult	Digital plotting with satellite images	Basic manipulation of Digital photogrammetric system (for plotting)	1-2	Self-manipulation by the C/P	Evaluation by an examination in later period Qualitative evaluation by members of the Study Team
			Basic manipulation of CAD software	1-2		
			Comprehension of map symbols	1-2	Evaluation of OJT result (1 Sheet)	Qualitative evaluation by members of the Study Team
			Comprehension of scale-based data acquisition	1-2	Evaluation of OJT result (1 Sheet) Evaluation on printed map	
			Comprehension of planimetric feature plotting	1-2	Evaluation of OJT result (1 Sheet) Evaluation by comparison to sample data	Scoring with the comparison with a model data
			Comprehension of contour plotting	1-2		
			Preparation of Work Manual	1-2	Evaluation of level-based description in the manual	Third-party evaluation using questionnaire

4-4-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

In the first session, the counterparts still had problems. In the second session, all the participants showed progress in manipulation of the mouse and software and had improved their understanding of map representation on a scale of 1/50,000. The number of locations with inconsistencies between spot elevations and contour lines declined drastically. Although it was still difficult for them to create perfect data, they had acquired the capacity to inspect and correct their outputs and prepare the quality control table by themselves. Therefore, the Study Team recommends that they should continue to use their energy and ingenuity to improve the outputs to completeness.

As it is difficult even for Japanese operators with ample experience to plot contour lines of tree-covered areas, the counterparts will have to repeat the practice tenaciously.

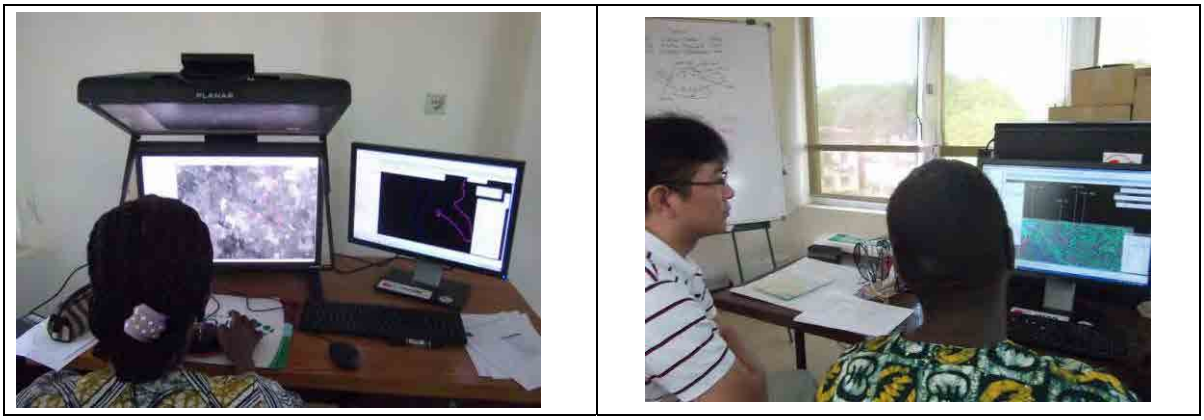


Figure 25 Technology Transfer in Digital Plotting (Left: Practice in contour lines, Right: Inspection and correction of data)

4-5. Technology Transfer in Field Completion

4-5-1. Purposes and Principal Objectives

The technology transfer in field completion was implemented with the principal objectives shown in the table below. The objectives and the technologies to be acquired are the same as those in the field identification. As the participants had achieved the objectives of the technology transfer in field identification, the Study Team selected principal objectives that were different from those achieved in the field identification, *i.e.* interpretation of completion maps and improvement in the efficiency of filing outputs (from the level at the time of field identification), for this technology transfer.

Table 21 Objectives and Evaluation Procedures of the Technology Transfer in Field Completion

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
Field identification/ Field completion	Comprehension of specifications Arrangement of feature trend of urban area, rural area, mountain area	Preliminary work	Comprehension of work Filing of existing materials Image interpretation	1-2	Self-implementation by the C/P	Qualitative evaluation by members of the Study Team
		Field Completion	Manipulation of mobile GPS	1-2	Self-manipulation by the C/P	Qualitative evaluation by members of the Study Team
			Speedy detection of destination on the field	1-2		
		Filing of survey results	Filing of results on printed image	1-2	Visual evaluation on printed map	Scoring with the comparison with a model data
			Data filing of results	2	Evaluation by completeness and thematic accuracy	

4-5-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

The staff members of DGC prepared the plan for field completion and managed to verify all the objects of the completion within the given time by themselves. They were unable to carry out the work of filing the data obtained in the field completion on maps and data smoothly and made mistakes in the work during the field completion in the Southern Area. However, by the end of the field completion in the Northern Area, they had acquired the capacity to perform the work properly and detect and correct errors in the data by themselves.

They further improved their understanding of the method for filing the outputs of the field completion in the review of the method during the data import in the digital compilation after field completion provided later in the Study.


Figure 26 Field Completion (Left: Interview survey, Right: Filing of the results)

4-6. Technology Transfer in Digital Compilation/Digital Compilation after Field Completion/Map Symbolization

4-6-1. Purposes and Principal Objectives

The technology transfer in digital compilation/digital compilation after field completion was implemented with the principal objectives shown in the table below.

Table 22 Objectives and Evaluation Procedures of the Technology Transfer in Digital Compilation/Digital Compilation after Field Completion

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
Digital compilation/ Digital compilation after field completion	Comprehension of scale-based method Quality control, achieving consistency Manual preparation Supplement for areas where image interpretation is difficult	Digital compilation Digital compilation after field completion	Basic manipulation of CAD software	1-2	Self-manipulation by the C/P	Evaluation by an examination in later period Qualitative evaluation by members of the Study Team
			Comprehension and practice of Data cleaning	1-2	Evaluation of OJT result (1 Sheet) (Automatic checking)	
			Comprehension and practice of polygon creation	1-2		
			Preparation of Work Manual	1-2	Evaluation of level-based description in the manual	Third-party evaluation using questionnaire
Map symbolization	To follow the conclusions of the discussions on specifications	Allocation of symbols to topographic map data	Understanding of map adjustment	1-2	Evaluation of OJT result (1 Sheet) Evaluation by comparison to sample data	Qualitative evaluation by members of the Study Team
			Understanding of different symbolization procedures for different scales	1-2		
			Basic manipulation of the software for symbolization	1-2		

4-6-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

At the first technology transfer, attendees could comprehend a concept of digital compilation and the basic operation of the software, yet, few problems have left at some stages of work.

At the second technology transfer, attendees could solve the problems that have left at the first technical transfer by repetition training. Regarding data cleaning and polygon making, more repetition training arranged by attendees themselves would be desirable after the project.

Figure 27 Digital Compilation and Map Symbolization (Left: Practice in digital compilation, right: Lecture on map symbolization)

4-7. Technology Transfer in Data Structurization

4-7-1. Purposes and Principal Objectives

The technology transfer in data structurization was implemented with the principal objectives shown in the table below.

Table 23 Objectives and Evaluation Procedures of the Technology Transfer in Data Structurization

Item	Consideration	Work	Goal	Level	Objectively Verifiable Indicators	Means of Verification
Digital data structurization	Easy-to-use GIS creation	Digital data structurization GIS basic data creation	Comprehension of GIS (Standard data structure)	2	Self-report preparation by the C/P	Evaluation based on the checklist for the report
			Basic manipulation of GIS software	1-2	Self-manipulation by the C/P	Evaluation by an examination in later period Qualitative evaluation by members of the Study Team
			Recommendation for utilization of GIS data	2	Self-presentation data preparation by the C/P for seminar	Third-party evaluation using questionnaire

4-7-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

In the first session, all the participants acquired the capacity to perform basic manipulation of the software including addition of new data, drawing, addition of attributes, setting of data representation by attribute and simple calculation of distance and area. However, their capacity had not reached the level of conducting analysis applicable to their work. Therefore, acquisition of such capacity was decided to be the goal of the second session.

In the second session, all the participants mastered the procedures for simple geospatial analysis, in addition to basic manipulation of the software. They also mastered the procedures for two-dimensional representation of maps and three-dimensional representation of topography. Some of the participants even tried more sophisticated geospatial analysis and obtained the expected results.

In addition, all the participants acquired the capacity to create structured data as they had already mastered basic manipulation of the software through repeated self-practice.

Figure 28 Data Structurization (Left: Data analysis, Right: Creation of structured data)

4-8. Technology Transfer in Quality Control

4-8-1. Purposes and Principal Objectives

The technology transfer in quality control was implemented with the principal objectives shown in the table below and as part of the technology transfer at each stage in the development of topographic map data.

Table 24 Objectives and Evaluation Procedures of the Technology Transfer in Quality Control

Stage	Timing	Activity	Description of the transferred technology
Control point survey	Before observation	Inspection of the required equipment	Procedures for preparation of the inspection lists
	After completion of GPS observation	Inspection of the required equipment Verification of the observation results	Procedures for preparation of the inspection lists
	After completion of leveling		
	Baseline analysis	Evaluation of the results of baseline analysis	Procedures for automatic evaluation by software
	Network adjustment	Evaluation of the results of network adjustment	Procedures for automatic evaluation by software Procedures for preparation of the quality control table
Aerial triangulation	After GCP and tie point observation	Evaluation of the results of relative orientation	Procedures for automatic evaluation by software
		Re-observation of tie points	Manipulation of software and re-evaluation procedures
	After implementation of adjustment calculation	Evaluation of the results of adjustment calculation	Procedures for automatic evaluation by software
		Re-observation of GCPs and tie points	Manipulation of software and re-evaluation procedures
		Preparation of quality control table	Procedures for preparation of the quality control table
Field identification Field Completion	Before the work	Inspection of the preliminary survey maps	Methods of visual inspection
	During the work	Inspection of the outputs of field identification	Methods of visual inspection (for completeness, positional accuracy and thematic accuracy)
Digital plotting	After digital plotting	Inspection of planimetric features	Procedures for visual inspection using output maps (for completeness, positional accuracy appropriate for the map scale and thematic accuracy such as attributes)
			Procedures for inspection of attributes by software manipulation
		Inspection of contour lines	Procedures for visual inspection using output maps
			Procedures for automatic inspection of non-elevation data
			Procedures for automatic inspection of contour lines and spot elevations
		Preparation of quality control table	Procedures for preparation of the quality control table
Digital compilation Digital compilation after field completion	After digital compilation After digital compilation after field completion	Edge matching between maps	Procedures for automatic inspection of data and correction of erroneous data
		Inspection of the data for logical errors and correction of erroneous data	Procedures for automatic inspection of data (for logical consistency) and correction of erroneous data
		Topology check	Procedures for automatic inspection of data (for logical consistency) and correction of erroneous data
		Preparation of the quality control table	Procedures for preparation of the quality control table

Stage	Timing	Activity	Description of the transferred technology
Map symbolization	After map symbolization	Inspection of the status of data conversion	Procedures for automatic inspection of data (for completeness) and correction of erroneous data
		Inspection of output maps	Procedures for visual inspection using output maps
		Preparation of the quality control table	Procedures for preparation of the quality control table
Digital data structurization	After digital data structurization	Inspection of the status of data conversion	Procedures for automatic inspection of data (for completeness) and correction of erroneous data
		Edge matching between maps	Procedures for automatic inspection of data and correction of erroneous data

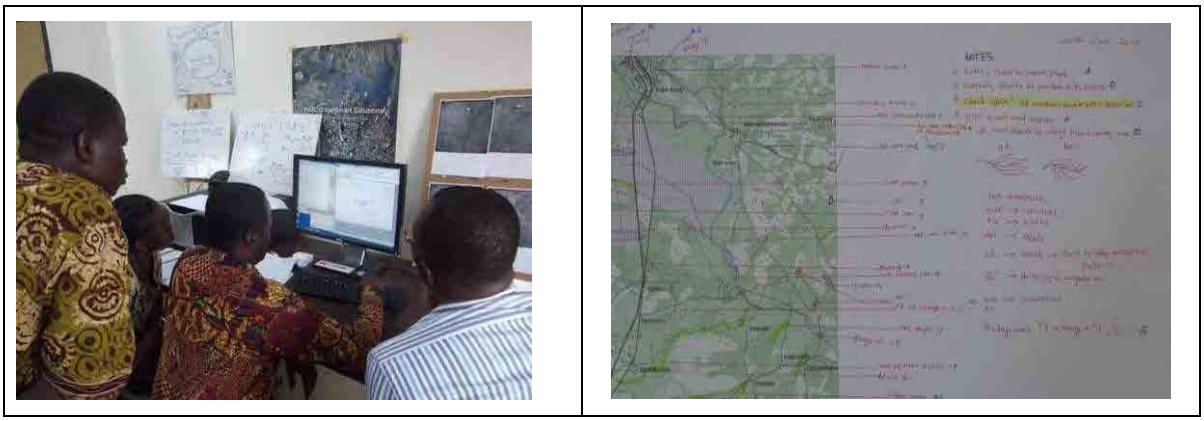


Figure 29 Technology Transfer in Quality Control (Left: Preparation of quality control table of the results of aerial triangulation, Right: Symbolization composition chart)

4-8-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

The table below shows the results of evaluation of the outputs of the technology transfer in quality control.

The participants acquired the capacity to inspect and correct the outputs by themselves and to prepare the quality control table, the document in which the quality of the final outputs of each stage is compiled systematically at the stages at which quality control is required.

The participants are expected to continue their endeavors to maintain documents in which the results of evaluation of the quality of the outputs at each stage of the project are kept in projects to be implemented in future and to standardize the procedures at the stages, such as digital plotting, in which the quality of the outputs is likely to vary among operators.

4-9. Technology Transfer in Partial Correction

4-9-1. Purposes and Principal Objectives

The technology transfer in partial correction was implemented with the principal objectives shown in the table below and as part of the technology transfer at each stage of the development of topographic map data.

WorldView-2 Satellite images taken in May 2012 and data on bridges and roads planned in a General Directorate of Public Works, Ministry of Public Works project were used in the technology transfer as reference data.

The technologies used in the processes, consisting of 1) comparative analysis of the reference materials mentioned above and newly plotted topographic maps for changes, 2) sorting of the changes by cause and scale, if changes were detected, 3) study of the changes requiring correction in accordance with the criteria for correction and 4) update of data where the corrections had been deemed necessary, were transferred.

The area with the highest density of features to be corrected in the outputs of digital plotting was selected for the technology transfer in partial correction in digital compilation, map symbolization and data structurization.

Table 25 Features Used as Objects of the Technology Transfer in Partial Correction

Feature	Cause of change	Scale of change	Criterion	Changes made	Reference data
Road	Urban planning (Road development)	Length: approx. 30.0 km	Construction of road with width of 5.5 m or more/expansion of road width to 5.5 m or more	Data copying Layer change Translocation/ deletion of buildings Edge matching	General Directorate of Public Works, Ministry of Public Works project
		Length: approx. 5.6 km Width: approx. 25.0 m	Construction of road with width of 5.5 m or more/expansion of road width to 5.5 m or more	Addition of new data Change in data shapes Translocation/ deletion of buildings Edge matching	WorldView-2
		Length: approx. 2.0 km Width: approx. 40.0 m			
Bridge	Urban planning (Bridge construction)	Length: approx. 7.0 m	Road width of 5.5 m or more	Data copying Edge matching	General Directorate of Public Works, Ministry of Public Works project
High density residential area	Population influx (farmland → high density area)	Area: approx. 1.0 km^2	150m×150m or larger	Change in data shapes Change of symbols Deletion of buildings Addition of symbols	Practical exercises
Vegetation	Afforestation (farmland → forest)	Area: approx. 0.5 km^2	150m×150m or larger	Addition of vegetation boundaries Change of symbols	Practical exercises

Table 26 Activities in the Technology Transfer in Partial Correction

Stage	Activity
Digital plotting	Detection of area requiring update by cause and scale of change over time Data update Edge matching with surrounding area
Digital compilation Digital compilation after field completion	Data cleaning appropriate for the condition of the areas requiring data update Generalization of polygons
Map symbolization	Conversion of data on the locations requiring update Edge matching with surrounding area
Digital data structurization	Conversion of data on the locations requiring update Edge matching with surrounding area

Figure 30 Technology Transfer in Partial Correction (Left: Digital plotting, Right: Symbolization)

4-9-2. Outputs and Impact on DGC of the Technology Transfer and Problems Found in the Technology Transfer

The table below shows the results of the evaluation of the technology transfer in partial correction.

Roads, a bridge, a high-density residential area and vegetation were the features requiring partial correction in the area selected for the technology transfer. The participants were able to practice all the manipulations required for partial correction, *e.g.* changing the point, line and polygon data layers, copying/deleting data, changing the data shapes and edge-matching.

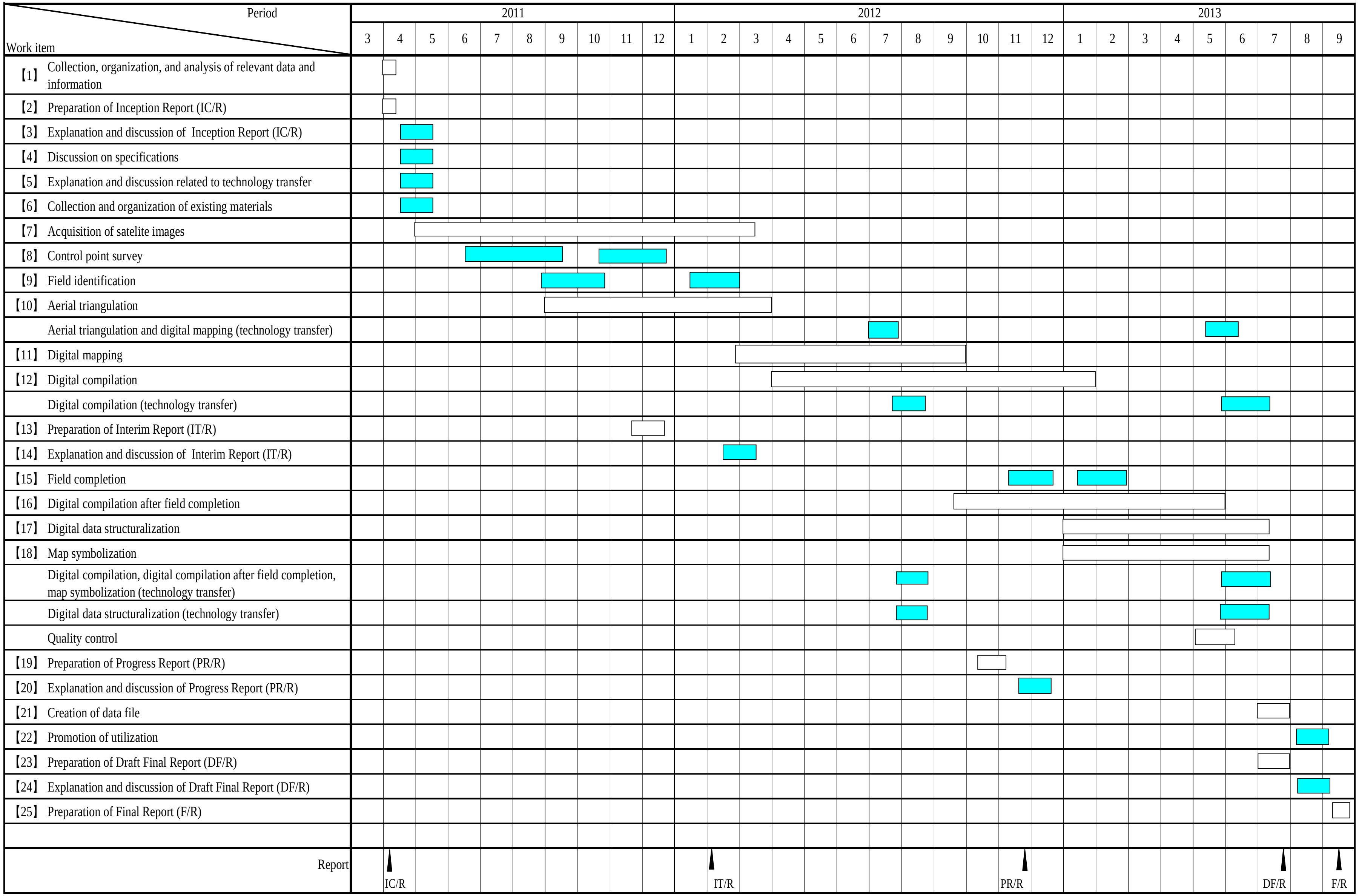
Although it was not possible to handle three-dimensional partial changes such as changes in topography in the technology transfer, the participants will be able to handle such changes without problems by applying the contents of the technology transfer to digital plotting. The Study Team expects that DGC, as the manager of the topographic map data, will take the lead in the establishment of a mechanism by which the topographic map data are shared between DGC and users and updated with feedback from the users to DGC on the outputs of projects planned with the use of the topographic map data.

Chapter 5 Work Process Schedule and Personnel Plan

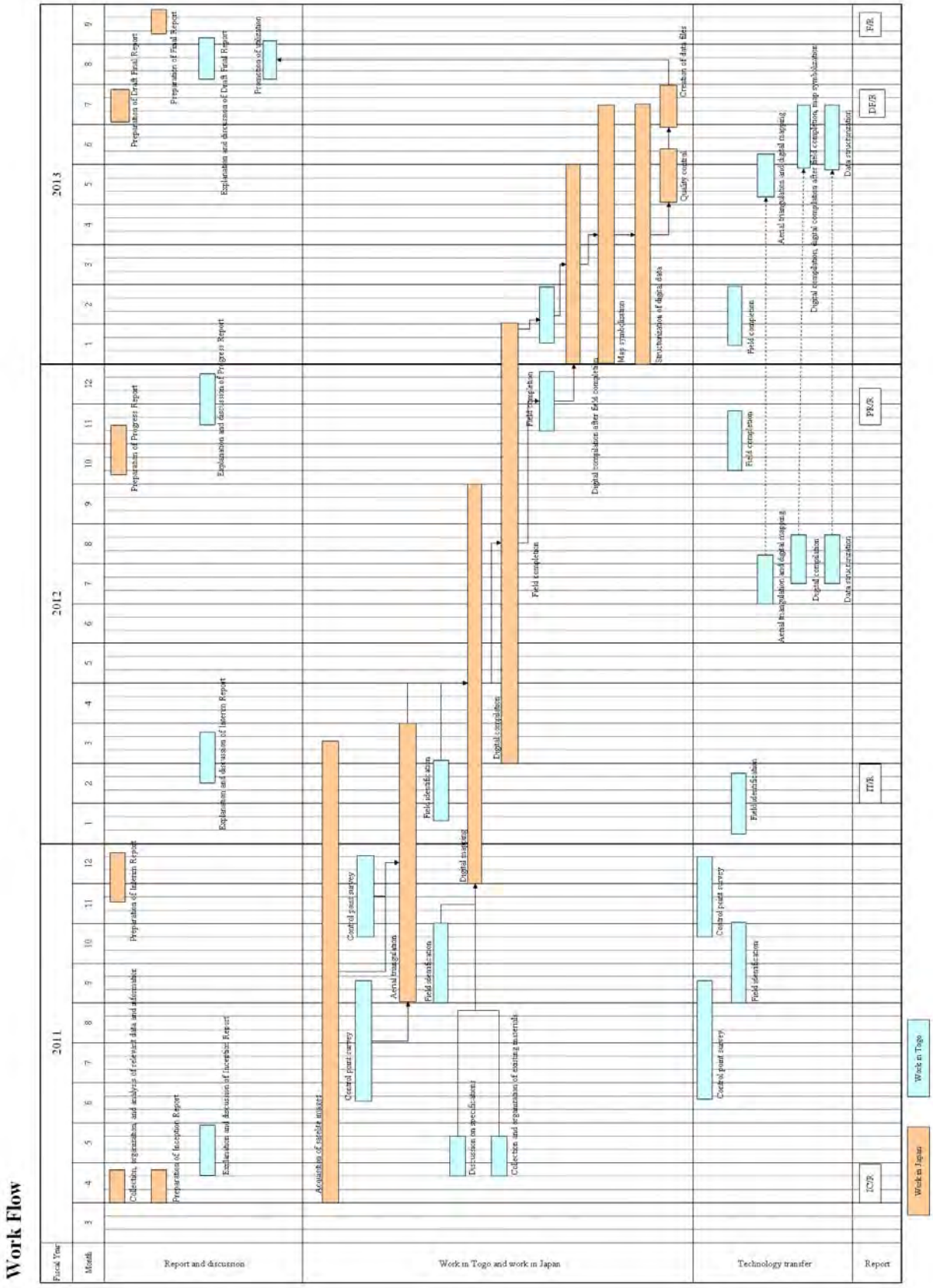
5-1. Work Process Schedule and Work Flowchart

The Work Process Schedule and Work Flowchart for this Study are shown in the following pages.

Work Plan


Period
Work item
2011
2012
2013
3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9
【1】 Collection, organization, and analysis of relevant data and information
【2】 Preparation of Inception Report (IC/R)
【3】 Explanation and discussion of Inception Report (IC/R)
【4】 Discussion on specifications
【5】 Explanation and discussion related to technology transfer
【6】 Collection and organization of existing materials
【7】 Acquisition of satelite images
【8】 Control point survey
【9】 Field identification
【10】 Aerial triangulation
Aerial triangulation and digital mapping (technology transfer)
【11】 Digital mapping
【12】 Digital compilation
Digital compilation (technology transfer)
【13】 Preparation of Interim Report (IT/R)
【14】 Explanation and discussion of Interim Report (IT/R)
【15】 Field completion
【16】 Digital compilation after field completion
【17】 Digital data structuralization
【18】 Map symbolization
Digital compilation, digital compilation after field completion, map symbolization (technology transfer)
Digital data structuralization (technology transfer)
Quality control
【19】 Preparation of Progress Report (PR/R)
【20】 Explanation and discussion of Progress Report (PR/R)
【21】 Creation of data file
【22】 Promotion of utilization
【23】 Preparation of Draft Final Report (DF/R)
【24】 Explanation and discussion of Draft Final Report (DF/R)
【25】 Preparation of Final Report (F/R)
Report
IC/R
IT/R
PR/R
DF/R
F/R

Work Flow


Fiscal Year
2011
2012
2013
Month
Report and discussion
Work in Togo and work in Japan
Technology transfer
Report
Preparation of Inception Report
Explanation and discussion of Inception Report
Preparation of Progress Report
Explanation and discussion of Progress Report
Preparation of Final Report
Explanation and discussion of Draft Final Report
Preparation of Draft Final Report
Collection, organization and analysis of relevant data and information
Acquisition of satellite imagery
Control point survey
Aerial triangulation
Field identification
Digital compilation
Field completion
Digital compilation after field completion
Map symbolization
Digitalization of digital data
Quality control
Creation of data files
Discussion on specifications
Collection and organization of existing materials
Field identification training
Aerial triangulation and digital mapping
Digital compilation, digital compilation after field completion, map symbolization
Data structurization
Data structurization
ICR
IT/R
PR/R
DF/R
FR
Work in Japan
Work in Togo

5-2. Personnel Plan

The personnel plan is as follows: