Republic of Togo
Directorate General of Cartography

The Study on
Establishment of Topographic Database in Togo

Final Report

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 are the 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 of 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

<table>
<tr><th>Purpose</th><th colspan="2">Problem in achieving the purpose</th><th>Required capacity</th><th>Activity</th><th>Basic strategy</th><th>Achievement</th></tr>
<tr><td>Creation of digital topographic maps</td><td>Problem regarding quality</td><td>Updated survey standards or specifications have not been established</td><td>Establishment of survey standards
Establishment of the specifications for the quality of topographic maps</td><td>Various types of discussions
Quality control</td><td>Implementation of the work in accordance with the Survey International Specifications
Establishment of updated survey standards.
Creation of high-quality topographic map data</td><td>1/50,000-scale topographic maps of sufficient quality have been successfully created.</td></tr>
<tr><td rowspan="6">Technology transfer in the creation of digital topographic maps</td><td rowspan="5">Technical Problem</td><td rowspan="5">Technologies are to be transferred to staff members without experience in them.</td><td>Survey technology</td><td>Technology transfer in the control point survey</td><td rowspan="3">Technology transfer focused on basic technologies
Technology transfer with OJT
Clarification of problems with preparation of the technology transfer evaluation sheet</td><td rowspan="3">Technologies at the basic level have been successfully transferred.</td></tr>
<tr><td>Technology to create (compile) topographic map data</td><td>Field identification/ field completion
Aerial triangulation
Digital plotting/ compilation
Map symbolization</td></tr>
<tr><td>Technology to analyze topographic map data</td><td>Technology transfer in the data structurization and GIS analysis</td></tr>
<tr><td>Quality control technology</td><td>Inspection and preparation of the quality control tables</td><td>Implementation of technology transfer in the quality control</td><td>Inspection of accuracy of outputs and preparation of the quality control tables have been successfully implemented at each stage of the work.</td></tr>
<tr><td>PC technology</td><td>To be included in the technology transfer in each subject</td><td>Technology transfer focused on basic technologies</td><td>Technologies at the basic level have been successfully transferred.</td></tr>
<tr><td>Organizational problem</td><td>DGC does not have sufficient equipment for the creation and printing of topographic maps</td><td>Acquisition of required hardware and software</td><td>Provision of equipment</td><td></td><td>All the equipment to be procured have been procures.</td></tr>
</table>

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.
	Organiza-tional 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.
	Organiza-tional 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.

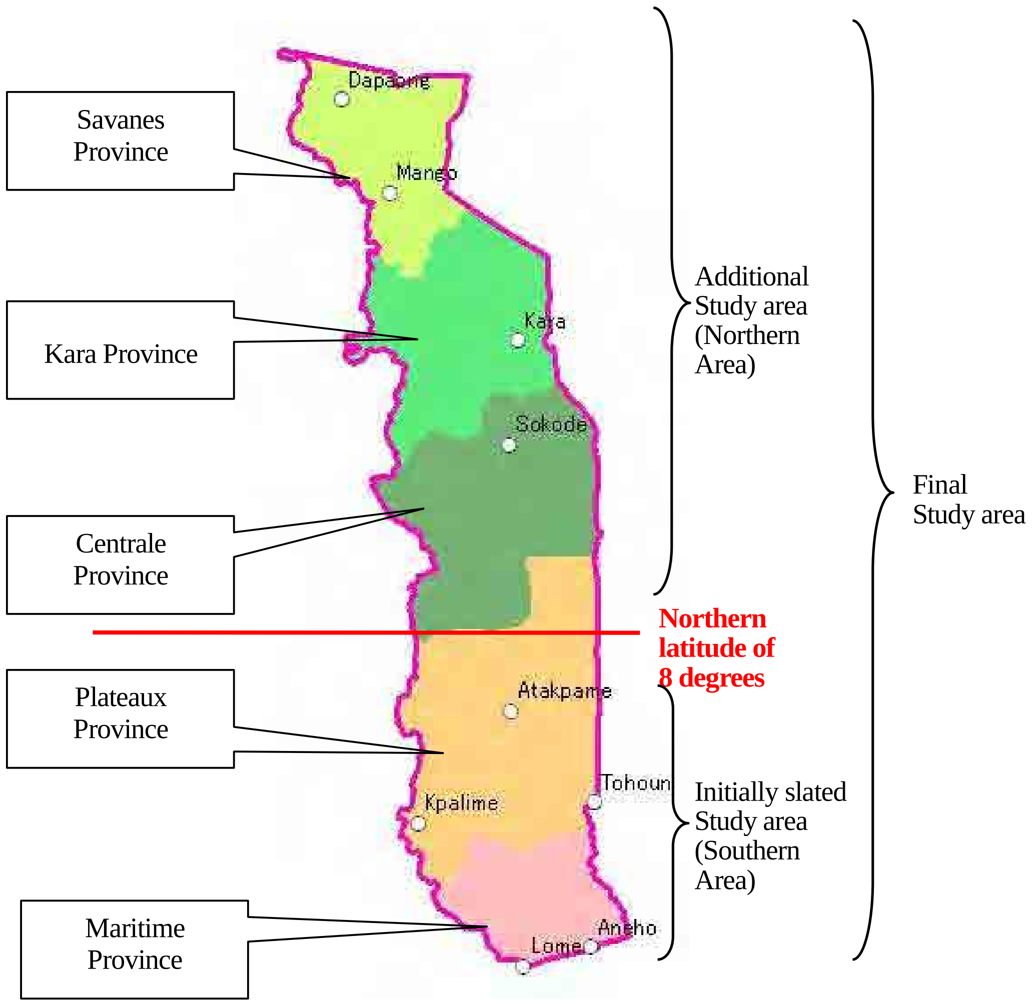


Figure 1 Study Area for Digital Topographic Map Development

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.

Year	Month	Work in Japan		Work in Togo
2011	Apr.	Collection, sorting and analysis of reference materials/information, preparation of IC/R		Discussion of IC/R, specifications and technology transfer
	May	Acquisition of satellite images		
	Jun.			Control point survey, leveling (Southern Area)
	Jul.			
	Aug.			
	Sep.		Aerial triangulation	Field identification (Southern Area)
	Oct.			
	Nov.			Control point survey, leveling (Northern Area)
	Dec.	Preparation of IT/R		
2012	Jan.	Digital plotting		Field identification (Northern Area)
	Feb.			Discussion of IT/R
	Mar.			
	Apr.		Digital compilation	
	May			
	Jun.			
	Jul.			Technology transfer (Aerial triangulation/digital plotting) (Digital compilation/data structurization)
	Aug.			
	Sep.			
	Oct.	Preparation of PR/R		Field completion (Southern Area)
	Nov.			Discussion of PR/R
	Dec.			
2013	Jan.	Map symbolization Data structurization	Digital compilation after field completion	Field Completion (Northern Area)
	Feb.			
	Mar.			
	Apr.			
	May		Quality control	Technology transfer (Aerial triangulation/digital plotting) (map symbolization/data structurization)
	Jun.		Creation of data files	
	Jul.	Preparation of DF/R		
	Aug.			Discussion of DF/R, dissemination of geospatial information, seminar
	Sep.	Preparation of Final Report		

Figure 2 Workflow of the Study

1-6-1. Members of the Study Team and Their Responsibilities

The members of the Study Team and their responsibilities are shown below.

Table 4 Members of the Study Team and Their Responsibilities

Responsibility	Description of the work	Responsibility
Mr. Akira SUZUKI	Team Leader/Discussion on specifications	・Management and supervision of the entire Study ・Planning and evaluation of the technology transfer (including seminars) ・Coordination with organizations concerned
Mr. Nobuhiro SATA	Control point survey 1 (South) Control point survey 1 (North)	・Guidance, supervision and technology transfer in the control point survey (GPS survey and leveling)
Mr. Takeshi TAKANASHI	Control point survey 2 (South) Control point survey 2 (North)	・Guidance, supervision and technology transfer in the control point survey (GPS survey and leveling)
Mr. Masakuni NAKAYAMA	Field identification1 (South)	・Guidance and technology transfer in field identification
Mr. Nobuhiro SATA	Field completion 1 (South) Field identification/Field completion 1 (North)	・Guidance and technology transfer in field identification and field completion for topographic map development
Mr. Ryusuke NAKATANI	Field identification/Field completion 2 (South) Field completion 2 (North)	・Guidance and technology transfer in field identification and field completion for topographic map development
Mr. Hidemi IZUTSU	Field identification 2 (North)	・Guidance and technology transfer in the field identification
Mr. Akira OTA	Aerial triangulation	・Guidance and technology transfer in aerial triangulation
Mr. Takashi KOGURE	Digital plotting	・Guidance and technology transfer in digital plotting
Mr. Takashi SHIMONO	Digital compilation/Digital compilation after field completion Map symbolization	・Guidance and technology transfer in digital compilation/digital compilation after field completion ・Guidance and technology transfer in map symbolization
Mr. Kenichi ARAI Mr. Ryusuke NAKATANI	Digital data structurization	・Technology transfer in digital data structurization
Mr. Takashi SHIRANI Mr. Tomoyuki OTANI	Interpreter	・Interpretation
Mr. Akira OTA	Coordinator/Assistant of digital plotting	・Project coordination ・Collection of information related to the digital plotting and assistance in the digital plotting

1-6-2. 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.

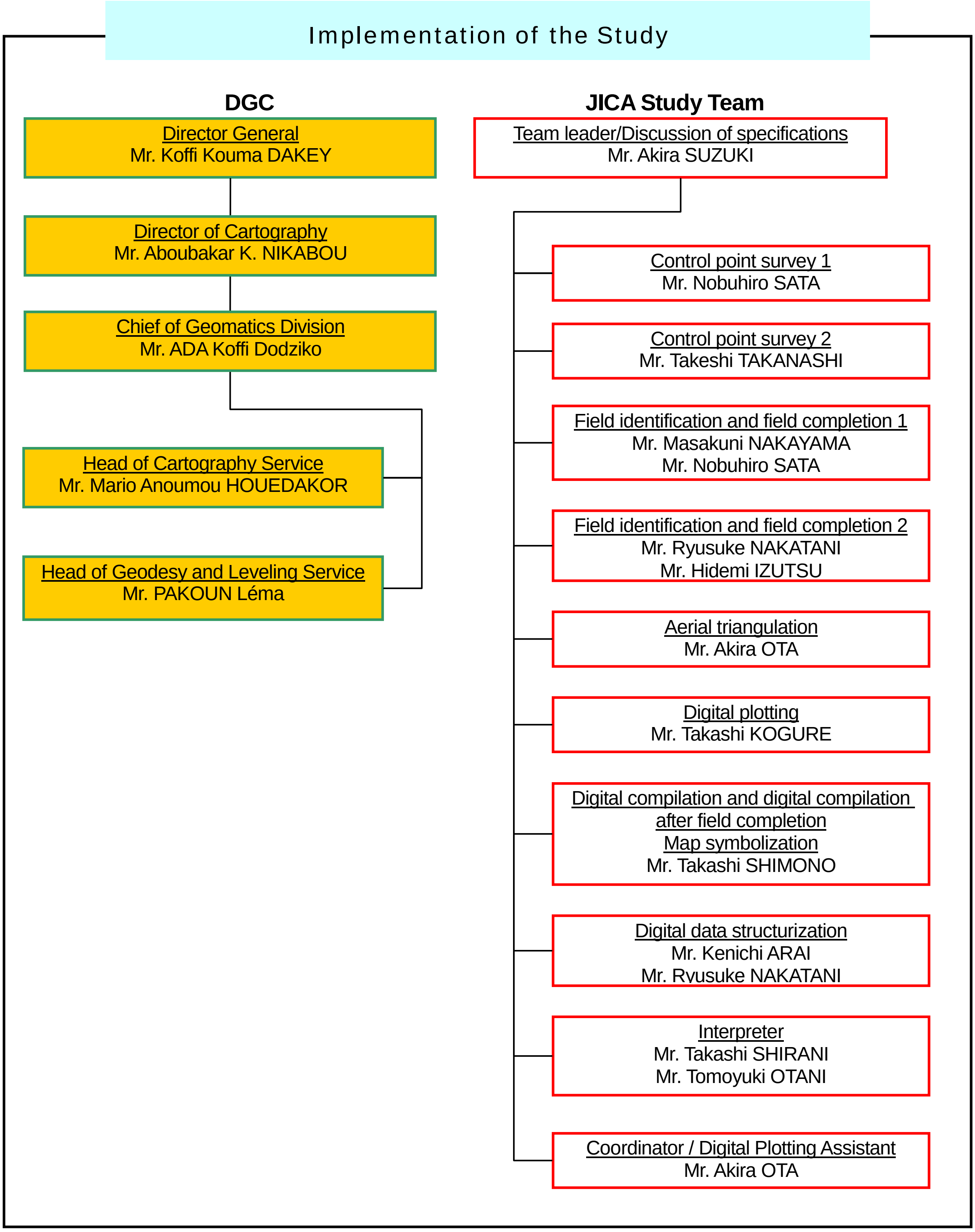


Figure 3 Organizational Structure for Implementation of the Study

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.

Meanwhile, establishment of an appropriate organizational structure for and allocation of sufficient personnel and budget to the distribution and updating of topographic maps in Togo or in DGC are required for development of a mechanism to share the 1/50,000-scale digital topographic maps developed for the entire country between DGC and organizations in need of the maps and development of a system to update the data in accordance with changes associated with economic activities in Togo.

In this chapter, cases of utilization and potential users of the topographic map data are described. In addition, recommendations on problems concerning extension of the utilization of the topographic map data are presented.

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

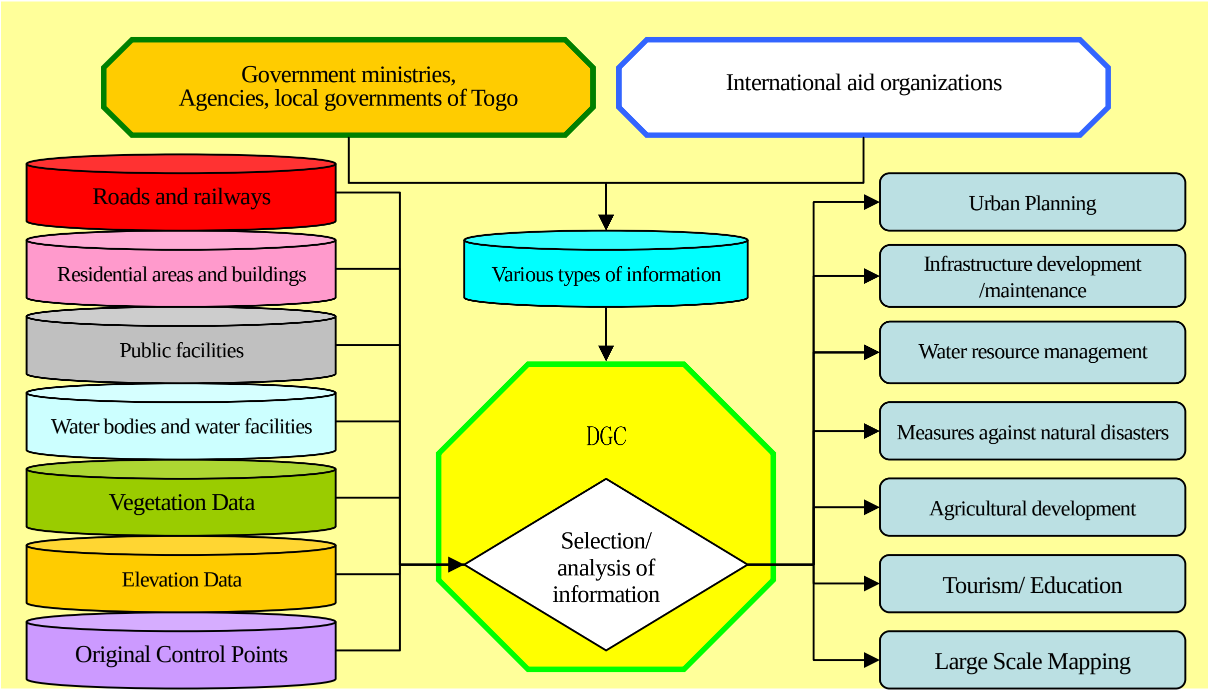


Figure 4 Conceptual Diagram of Data Utilization

- 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 Study Team organized IC/R and IT/R briefings for organizations considered to be potential users of the data developed in this Study (on May 11^{th}, 2011 and February 28^{th}, 2012, respectively).
While collecting reference materials during the field identification and field completion, 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 on manipulation of GIS software in data structurization, part of the transfer of laboratory technologies, 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	Explanation of the Project Questions and answers Questionnaire
Interim Report Seminar	February 2012	12 organizations	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

The table below shows the organizations expected to be the above-mentioned potential users selected on the basis of responses to the questionnaire and comments made in the question-and-answer sessions at the briefings and from the organizations interviewed by the Study Team that were requested to provide data by the Study Team and participated in the technology transfer.

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

The samples of planned roads provided by the General Directorate of Public Works were very useful in the technology transfer in partial correction in this Study and served as a very good example of a mechanism for updating topographic maps in future. Organizations such as the Ministry of Water, Sanitation and Rural Water Supply and Benin Electricity Community, which are in the process of digitizing data on infrastructure facilities, are expected to overlay the digitized data on the outputs of this Study without problem once the digitization has been completed. It is desirable to give priority to cases in which the developed data can be utilized in the near future such as the case mentioned above and to create a model case to which organizations maintaining their data in analog format and, thus, requiring a long period of time to develop an environment for the utilization of the developed data may refer.

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 counterpart organization of this Study, DGC, is under the Ministry of Urban Planning and Housing. It is headed by the Director General. In addition, there are the Director of Cartography, Division of Geomatics, Division of Topographic, and Division of Administrative Finance. The total number of staff members of DGC is 23, including the Director General.

The diagram below shows the current organizational chart of DGC.

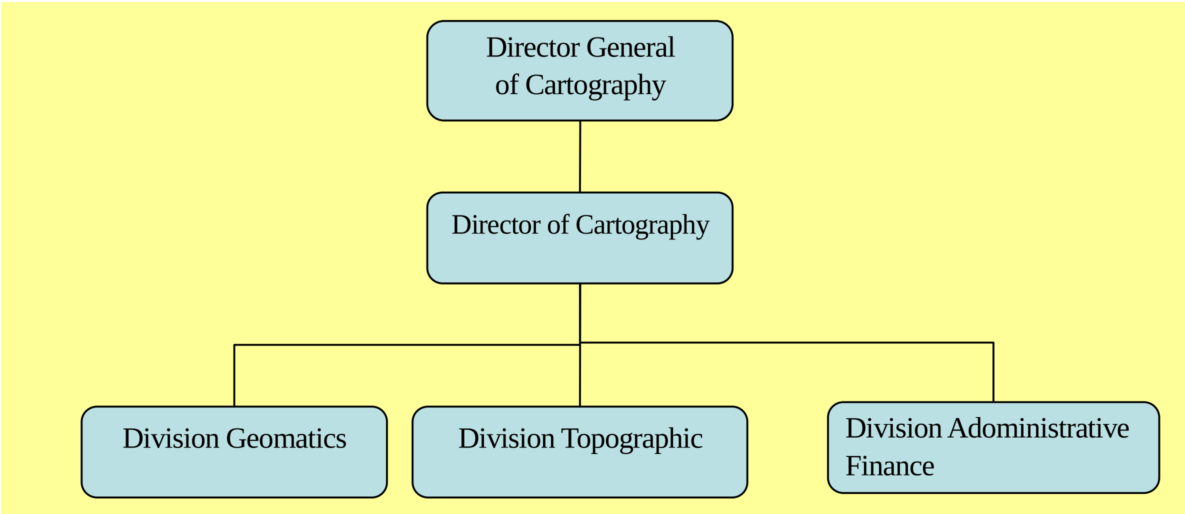


Figure 5 Organizational Structure and Personnel of the General Directorate of Cartography

The annual budget of DGC for 2013 is 57,214,600 CFA francs (approx. 11 million yen). However, the total amount of the budget may not be executed. Of the annual budget, 33,214,600 CFA francs are for personnel expenses and the remaining 24,000,000 CFA francs are for operating costs. The operating costs include costs for repair of equipment, maintenance of structures, purchase of consumables and project expenditure. 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

DGC does not have sufficient budget for establishment of control points and updating of topographic maps. Update of the outputs of the Study, topographic maps and GIS data, and promotion and extension of their utilization after the completion of this Project will require continued development of a system for provision of topographic map data. Financial measures to maintain a stock of consumables for printing and other materials required for continued data provision will also be required.

Depreciation expenses and savings for update of the topographic maps in future will have to be taken into consideration, as shown in the formula below, when the selling prices of the data to be developed in this Study, such as topographic maps, are established. The prices of existing maps and the selling prices of topographic maps in other countries in the region may be used as reference in establishing the prices.

Selling price of topographic map	=	Cost of printing the map + personnel expenses + depreciation expenses of equipment + cost of updating the map + overhead costs

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 existing (printed) maps of Togo are sold in the DGC Office building and in bookstores and hotels in the city of Lomé. Therefore, the capital city seems to have sufficient outlets for the distribution of map data.

The topographic map data and GIS data to be developed in the Study cover the entire territory of Togo. Such data are essential for the preparation of development plans required for the provision of basic social services (including education, health care and water supply) and implementation of measures against natural and other disasters, which are inadequate in Togo. Awareness creation activities by DGC are essential to get many organizations, both foreign and domestic, to use these data. The Study Team expects DGC to implement training sessions and seminars to extend utilization of the outputs and to implement GIS projects in cooperation with other organizations concerned.

There is also a need to conduct a study on maintenance of the digital data and measures to prevent unauthorized copying of the data.

The data shall be stored in appropriate folders in accordance with the rule to allow sharing of information within DGC and a backup file of the data shall be created on a regular basis. Unauthorized copying of the digital data made available by DGC, including topographic maps and orthophotos, shall be prevented by adopting a system in which those who intend to use the data submit an application for use of the outputs to DGC and obtain a written permit from DGC before doing so. Prohibition of copying of the data, the permissible range of data use, prohibition of use of the data for reasons other than those described in the application and penalties which may be applied to the permit holder if he/she violates the conditions of the permit shall be described in the permit.

Figure 6 Sales of Maps by DGC

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 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
		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

Item	Work	Objective
		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 10 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 11 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 12 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. (See Appendix-4 for the results of the questionnaire survey.)

Table 13 Participated Agencies and Q&As in the 1st Topographic Survey Database Seminar

Agencies	Q&A
Ministry of Foreign Affairs and Cooperation	On the relationships between the outputs of the project and the Ministry of Foreign Affairs
Office of the President	
Ministry of Urban Planning and Housing	
Ministry of Public Works	
Ministry of Water, Sanitation and Rural Water Supply	On a method to identify densely-populated areas
Ministry of Economy and Finance	On the sharing of the satellite imagery procured in the project
Ministry of Environment	On the Northern Area of Togo
Ministry of Territorial Administration	
Ministry of Agriculture	On methods of data updating and information disclosure
Ministry of Planning and Development	On standardization of the survey standards in Togo
Private Sector	On the control point origins established in the project

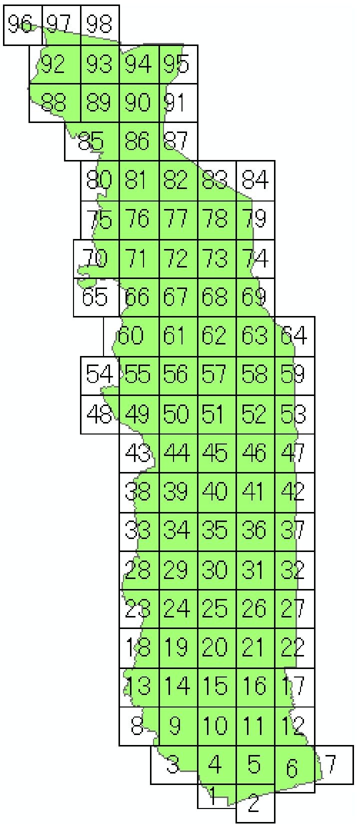
Figure 7 IC/R Briefing (Left: Briefing, Right: Reporting to the Minister of Housing)

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

<table>
<tr><th>Item</th><th colspan="2">Conclusion</th></tr>
<tr><td>Projection Method</td><td colspan="2">UTM（Universal Transverse Mercator）Zone 31</td></tr>
<tr><td>Geographic coordinate system</td><td colspan="2">ITRF94</td></tr>
<tr><td>Reference ellipsoid</td><td colspan="2">GRS80</td></tr>
<tr><td>Standard for elevation</td><td colspan="2">The existing control points to be used as control points</td></tr>
<tr><td>Area for the development of topographic maps</td><td colspan="2">The two parties agreed to develop maps of an area of approximately 56,000 km^2 (in October 2011).</td></tr>
<tr><td rowspan="2">Strategy on the use of reference materials in the development of topographic maps</td><td>Planimetric features</td><td>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.</td></tr>
<tr><td>Contour lines, etc.</td><td>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.</td></tr>
<tr><td>Scope of OJT for the transfer of laboratory technologies</td><td colspan="2">One 1/50,000-scale topographic map</td></tr>
<tr><td>Map symbols (Data acquisition items)</td><td colspan="2">See Appendix-6.</td></tr>
<tr><td>Boundaries/names of maps</td><td colspan="2">See Figure 8.</td></tr>
<tr><td>Marginal information</td><td colspan="2">See Figure 9.</td></tr>
<tr><td>Annotation</td><td colspan="2">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.)</td></tr>
</table>



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3	NB-31-XIII-4b	AMOUSSOUKOPE	53	NC-31-II-2c	YANDA
4	NB-31-XIII-4c	KPALIME	54	NC-31-II-3a	ADJENGRE
5	NB-31-XIII-4d	KATI	55	NC-31-II-3b	GOUBI
6	NB-31-XIV-1a	LOME	56	NC-31-II-3c	SOKODE
7	NB-31-XIV-1b	BAGUIDA	57	NC-31-II-3d	KOLOWARE
8	NB-31-XIV-1c	TSEVIE	58	NC-31-II-4a	KABOLI
9	NB-31-XIV-1d	HAHOTOE	59	NC-31-II-4c	KOUSSOUNTOU
10	NB-31-XIV-2c	ANEHO	60	NC-31-VII-1d	LEWOULBO
11	NB-31-XIV-2d	AVEVE	61	NC-31-VII-2a	BAGHAN
12	NB-31-XIV-3a	AGBELOUVE	62	NC-31-VII-2b	MALFAKASSA
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16	NB-31-XIV-4a	TABLIGBO	66	NC-31-VII-3d	KIDJABOUN
17	NB-31-XIV-4c	SEDOME	67	NC-31-VII-4a	GUERIN KOUKA
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19	NB-31-XIX-2b	AGAVE	69	NC-31-VII-4c	KATCHAMBA
20	NB-31-XIX-2c	DANYI-ELAVAGNON	70	NC-31-VII-4d	ATALOTE
21	NB-31-XIX-2d	AMLAME	71	NC-31-VIII-1a	AMAOUDE
22	NB-31-XIX-4a	BADOU	72	NC-31-VIII-1b	TCHAMBA
23	NB-31-XIX-4b	KOUGNOHOU	73	NC-31-VIII-1c	BAFILO
24	NB-31-XIX-4c	SEREGBENE	74	NC-31-VIII-1d	SOUDOU
25	NB-31-XIX-4d	KABAGNI	75	NC-31-VIII-2a	AFFEM-BOUSSOU
26	NB-31-XX-1a	WAHALA	76	NC-31-VIII-3a	KARA
27	NB-31-XX-1b	ASRAMA	77	NC-31-VIII-3b	KETAO
28	NB-31-XX-1c	GLEI	78	NC-31-VIII-3c	NIAMTOUGOU
29	NB-31-XX-1d	AKPARE	79	NC-31-VIII-3d	PAGOUDA
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31	NB-31-XX-2c	KPEKPLEME	81	NC-31-XIII-1d	MANGO
32	NB-31-XX-3a	ATAKPAME	82	NC-31-XIII-2a	SAGBIEBOU
33	NB-31-XX-3b	ADEGBENOU	83	NC-31-XIII-2b	KERAN
34	NB-31-XX-3c	ANIE	84	NC-31-XIII-2c	NAMONI
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37	NB-31-XX-4c	AFOLE	87	NC-31-XIII-3b	BARKOISSI
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39	NC-31-I-2b	PAGALA GARE	89	NC-31-XIII-3d	KORBONGOU
40	NC-31-I-2c	KOUI	90	NC-31-XIII-4a	TCHAMONGA
41	NC-31-I-2d	BLITTA	91	NC-31-XIII-4b	TAMBIGOU
42	NC-31-I-3b	TINDJASSE	92	NC-31-XIII-4c	DJABDJOARE
43	NC-31-I-3d	TAKA	93	NC-31-XIII-4d	MANDOURI
44	NC-31-I-4a	TASSI	94	NC-31-XIV-1a	NADOBA
45	NC-31-I-4b	SOTOUBOUA	95	NC-31-XIV-1b	TCHITCHIRA
46	NC-31-I-4c	DJARKPANGA	96	NC-31-XIX-1a	CINKASSE
47	NC-31-I-4d	LIMBOUA	97	NC-31-XIX-1a-ouest	GOULOUNGOUSSI
48	NC-31-II-1a	AGBANDI	98	NC-31-XIX-1b	SANFATOUTE
49	NC-31-II-1b	MORETAN			
50	NC-31-II-1c	KAZABOUA			

Figure 8 Boundaries and Names of Maps Agreed upon between DGC and the Study Team

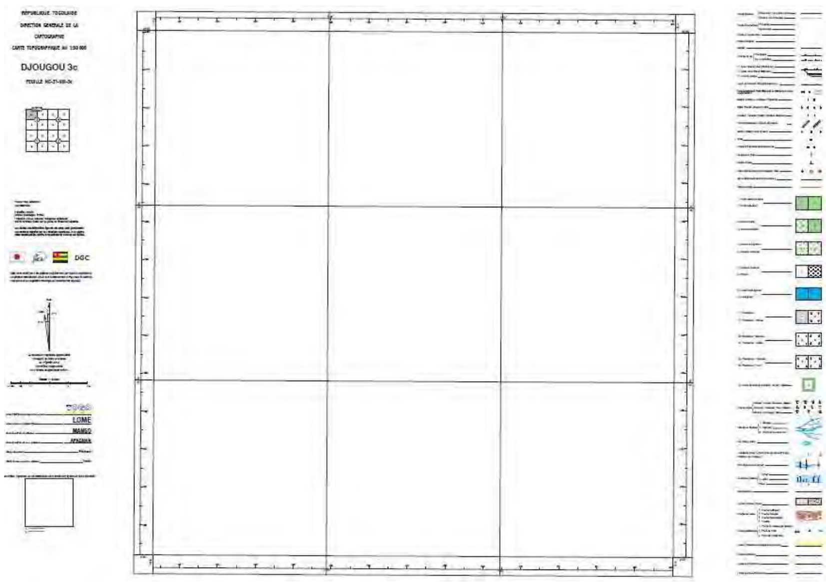


Figure 9 Marginal Information agreed upon between DGC and the Study Team

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 Outcome of the Discussions on Technology Transfer

<table>
<tr><th colspan="2">Item</th><th>Agreed matters</th></tr>
<tr><td rowspan="2">Field work</td><td>Control point survey and analysis of the survey results</td><td>DGC to assign at least eight technical staff members to the technology transfer</td></tr>
<tr><td>Field identification/field completion</td><td>DGC to assign at least eight technical staff members to the technology transfer</td></tr>
<tr><td rowspan="6">Laboratory work</td><td>Aerial triangulation</td><td>To provide exercises with not only ALOS satellite images but also aerial photographs (both analog and digital)</td></tr>
<tr><td>Digital plotting</td><td rowspan="5">The technology transfer to be implemented while the work for the development of a 1/50,000-scale topographic map is being implemented</td></tr>
<tr><td>Digital compilation/digital compilation after field completion</td></tr>
<tr><td>Map symbolization</td></tr>
<tr><td>Digital data structurization</td></tr>
</table>

The table below shows the equipment procured for the technology transfer and the dates of acceptance and validation of the equipment.

Table 16 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.

Table 17 List of Collected Existing Materials

Item	Source of Procurement
Table of National Control Points and Description of Points	Obtained from the DGC
Table of National Benchmarks and Description of Points	Obtained from the DGC
1/50,000-scale Topographic Maps	Purchased from the IGN, France
1/200,000-scale Topographic Maps	Purchased from the IGN, France

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 18 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

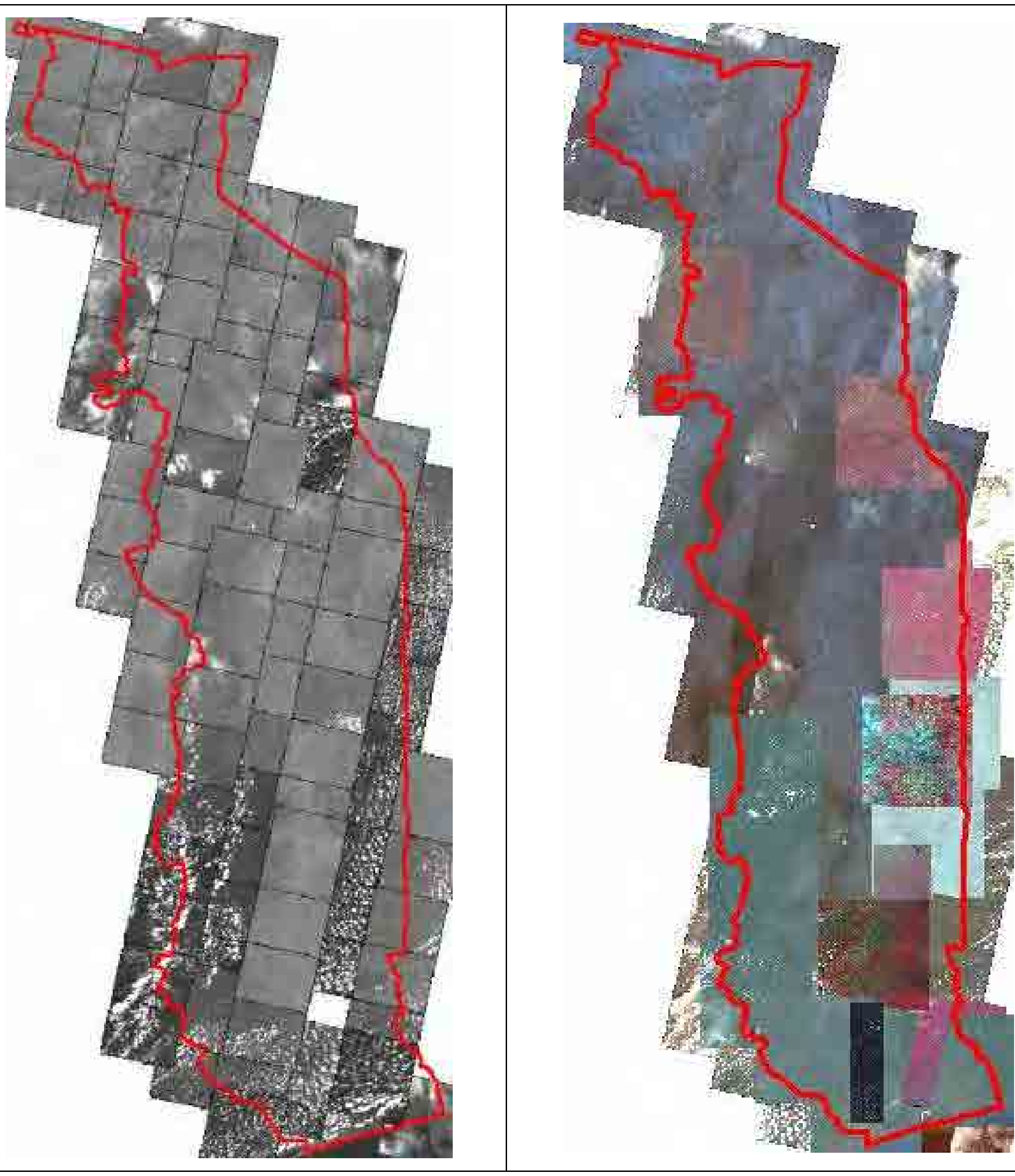
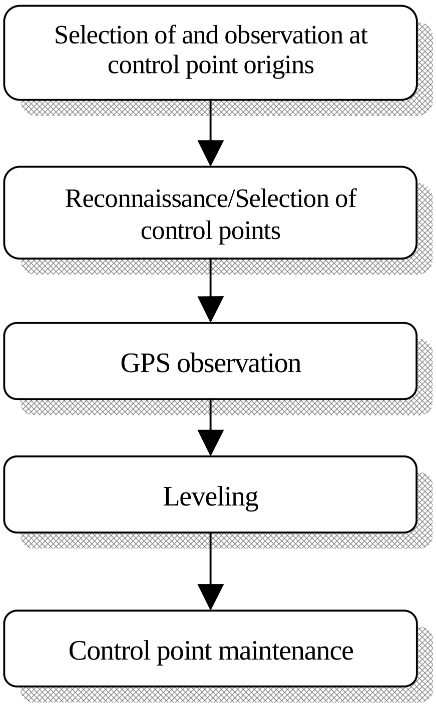


Figure 10 Procured Satellite Images (Left: ALOS image, Right: ALOS, SPOT, WorldView-2)

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.



Two national control points (the control point origins in this Study) were established (as permanent monuments) in the Southern Area and observation was carried out at the two points.

Thirty-two control points were established and marked by simple monumenting in the Southern Area.

A total of 14 sessions of simultaneous observation by the static method with four receivers at four locations was carried out.

The elevations of 20 control points were determined by direct leveling.

Information on the control point origins and the benchmarks used in the Study was maintained.

Figure 11 Workflow of Control Point Survey

1) Selection of and observation at the control point origins

As there were no reliable triangulation points to be used in this Study for the control point survey, it was necessary to establish control point origins which could be used as new national control points in this Study and future studies to be implemented in Togo.

Therefore, the Study Team selected two locations in the Southern Area, Lomé and Atakpamé, which were considered as optimal locations for the establishment of control point origins for their visibility from the sky, accessibility and ease of maintenance, in the discussions on control point origins with DGC prior to the control point survey.

The Study Team determined the coordinates of the said control point origins as a result of long baseline analysis of the results of simultaneous GPS observation of the origins by the IGS (International GNSS Service) Observation Station, NKLG, at N’koltang in Gabon in the region. The team also conducted the work required to make the control point origins into control points in the Study. The location of the IGS station and the results of the analysis are shown below.

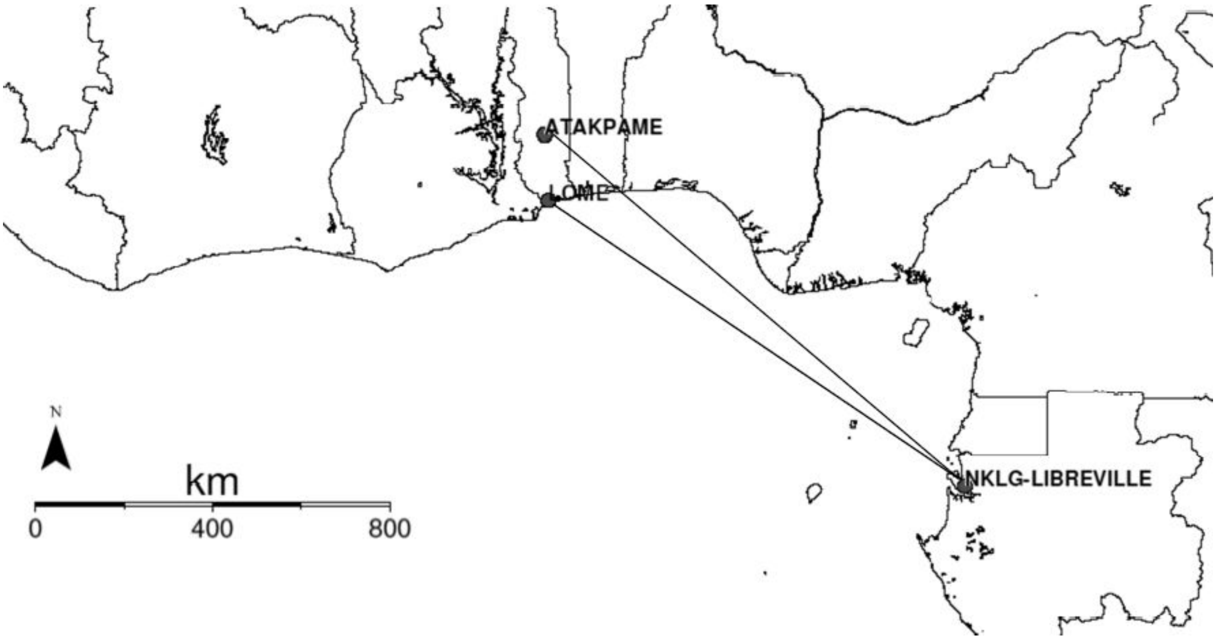


Figure 12 Locations of the Control Point Origins and the Results of Observation (adjustment map) in the Southern Area

2) Reconnaissance and Selection of Control Points

The candidate locations for the control points were selected taking into account the areas for satellite images and were plotted on the planned map.

In the field reconnaissance, problems such as accessibility as well as differences between the satellite images and the actual area conditions were confirmed. Then, the locations of the control points were determined. 34 control points including the control point origins were established. A control point details register accompanied by satellite images and ground photos was prepared to define the locations of the control points.

As a result of discussions with the DGC, it was decided to bury simple monuments instead of permanent stone monuments.

3) GPS Observation (Static Positioning)

For the 34 control points selected and established in the above work, a GPS observation session plan was drawn up with one session consisting of simultaneous observation by four GPS units. The GPS observation (static positioning) was carried out based on this session plan and in accordance with the specifications below.

The counterparts carried out GPS observation in four groups, each group consisting of two or three counterparts and survey assistants, with technical guidance from the member of the Study Team responsible for the control point survey.

After the observation, the counterparts confirmed whether the errors in the observations were within the stipulated range of accuracy or not by conducting a baseline analysis. If the errors were confirmed to be within the stipulated range of accuracy, they conducted three-dimensional network adjustment.

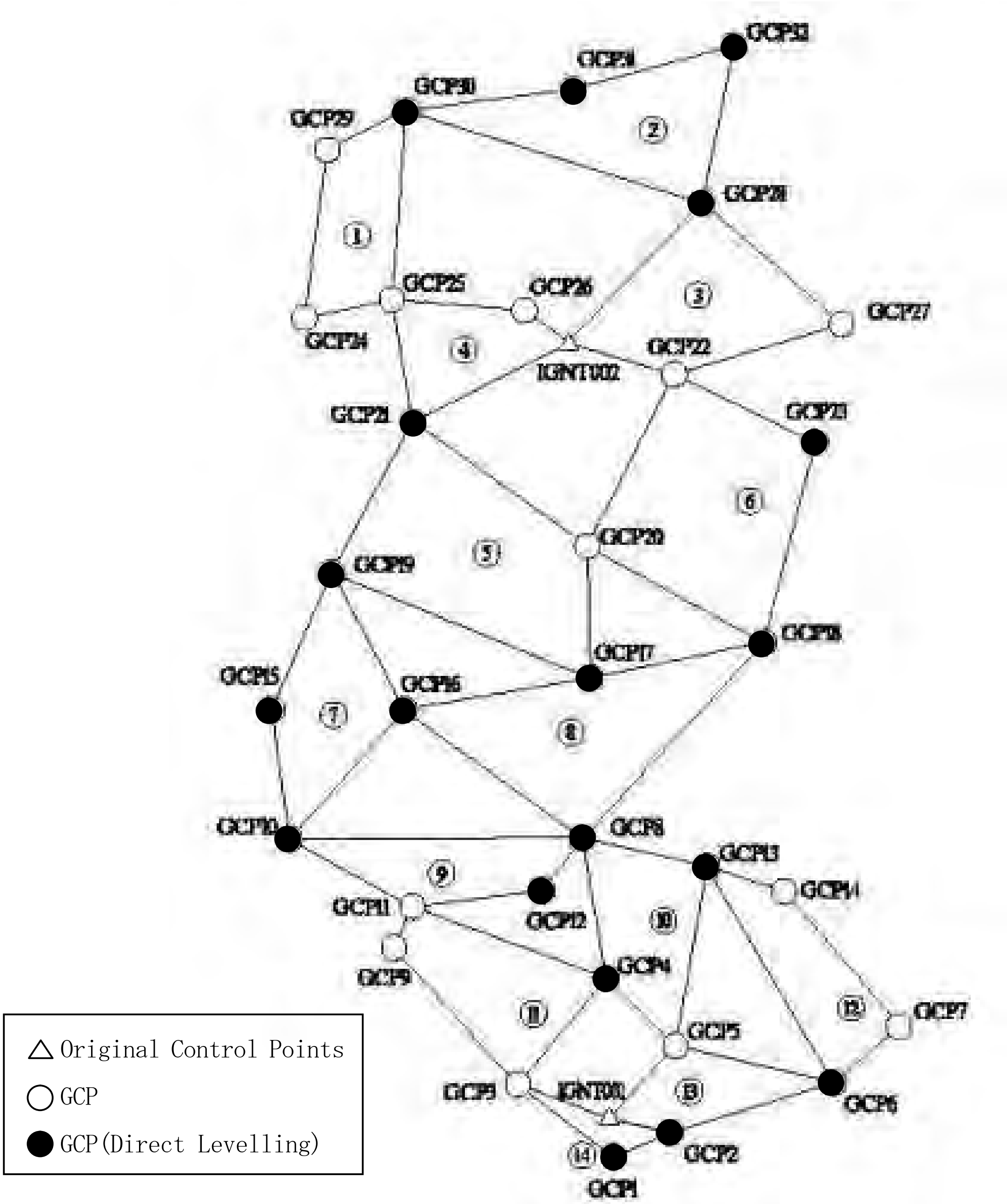


Figure 13 Locations of the Control Points and the Results of Observation (adjustment map) in the Southern Area

Table 19　Specifications and Tolerances for GPS Observation

Item			Specification	Remarks
1	Control Point	New survey origins	2 points	
2		New GPS survey points	32 points	
3	Observation	Ring closure error of each vector component of baseline	45mm√N	N: Number of sides
		Difference between vector components of duplicated baselines	45mm	
		Observation time	2 hours/session	
4	Personnel	Number of work groups	4 groups	2-3 staff members/group
5	Equipment	GPS observation	Leica GS10	4 units
6		GPS analysis	Leica Geo Office	Ver.8.0

Figure 14　Control Point Survey (Left: Control point origin, Right: Control point)

4)　Leveling

Each of the control points in the GPS survey work was installed at a height above the national benchmark.　As a result of the survey on given points, it became clear that many national benchmarks remained.　Therefore, 20 control points were established with the elevation by direct leveling survey.

Table 20 Leveling Specifications

Item			Specifications	Remarks
1	Leveling Survey	Simple leveling route length	Approx. 70km	
2		Leveling method	Simultaneous one-way leveling by two units	
3		Number of leveling points	20 points	Control points
		Leveling accuracy	50mm√S	S=Route length (km)
		Inspection of national benchmarks	Three benchmarks inspected	No problems
		Pricking	Pricking was not performed because existing benchmarks were found near the control points.	
4	Personnel	Number of work groups	Two groups	Four persons/group Two levels/group
5	Equipment	Level	Leica Sprinter 150	Auto level

Figure 15 Leveling (Left: Observation, Right: Existing benchmark)

5) Control Point Maintenance

The national benchmarks that were confirmed in this Study, the two newly installed control point origins and the benchmark at the top of Mount Agou, the highest mountain in Togo, are important for national land management and social and economic activities in Togo. Therefore, the Study Team shall conduct the technology transfer to the DGC so that the public agencies and local residents will be taught to be aware of the importance of the control points and to maintain and use them in an appropriate way.

Table 21 Considerations for Control Point Maintenance

Type of Control Point			Considerations	Remarks
1	Existing Control Points	National benchmark (IGN)	An existing benchmark control sheet including horizontal positions and field photos will be prepared. For some poorly preserved points, countermeasures such as relocation will be examined.	Points installed by the IGN, France
2		National benchmark (DGN)		Points installed by the DGC
3	Control point origins	LOME	Maintenance will be performed by indications on monuments and enhancement of awareness of site administrators.	New points installed in this Study
4		ATAKPAME		
5	New Benchmark	Mount Agou		

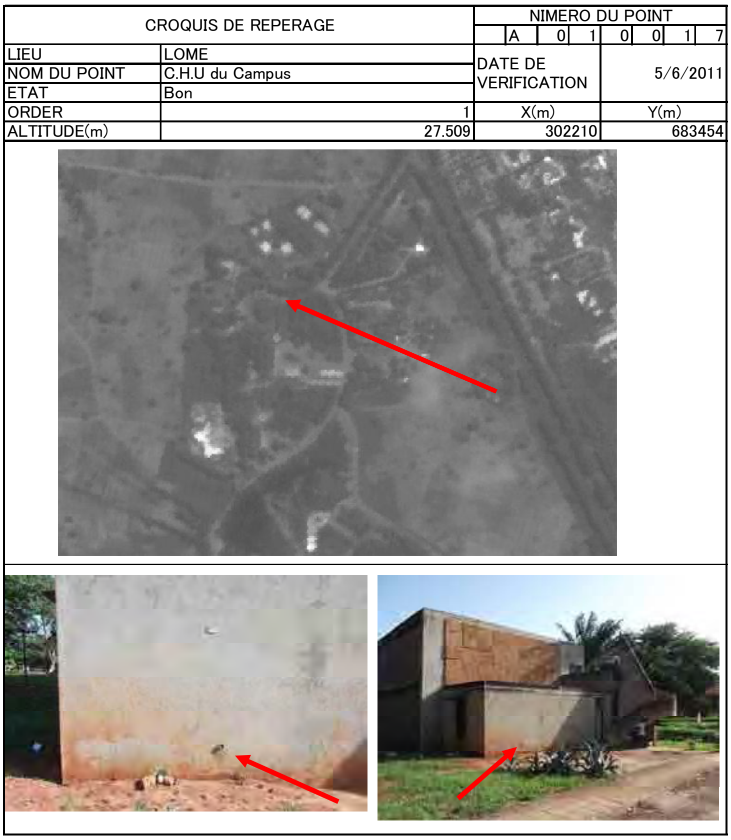


Figure 16 Existing Benchmark Control Sheet

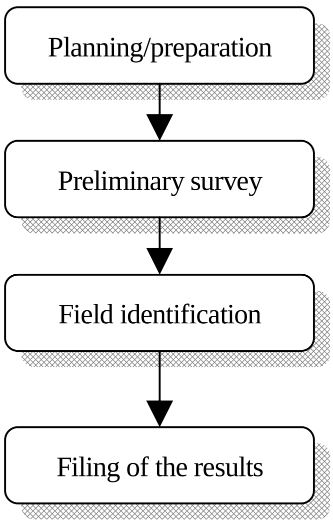
The technology transfer in control point survey in the form of OJT was implemented with guidance, supervision and work management by the member of the Study Team responsible for control point survey. (See Chapter 4.)

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 17 Workflow of Field Identification in Southern Area

1) Planning/Preparation

The member of the Study Team responsible for field identification briefed the DGC staff members on the details of the work and the methods used in the work, prepared a work schedule taking into consideration the “road conditions,” “distribution of villages and features” and “experience of the participants”, formed work groups and assigned an area of the map to each group. Eight DGC staff members participated in the technology transfer in field identification. They were divided into four groups of two and each group was equipped with the following materials and equipment.

- 1/50,000 orthophoto output, existing 1/50,000 map and existing 1/200,000 map

- Table of symbols for field identification (Table of data acquisition criteria)
- Clipboard and set of stationery (pens, rulers, notepads, etc.)
- Handy GPS unit and digital camera
- Manual describing points requiring attention and list of mobile telephone numbers of persons concerned (for the safety of the participants)

2) Preliminary Survey

Photo interpretation of the satellite images was conducted before the field identification by referring to the existing 1/50,000-scale and 1/200,000-scale topographic maps to extract the planimetric features to be examined in the field identification. Photo interpretation was performed of skeleton features such as roads and villages, and geographic names, and the extracted planimetric features were depicted on the orthophotos. Public buildings and facilities such as schools, churches, mosques and graveyards were also traced from the existing maps and depicted on the orthophotos.

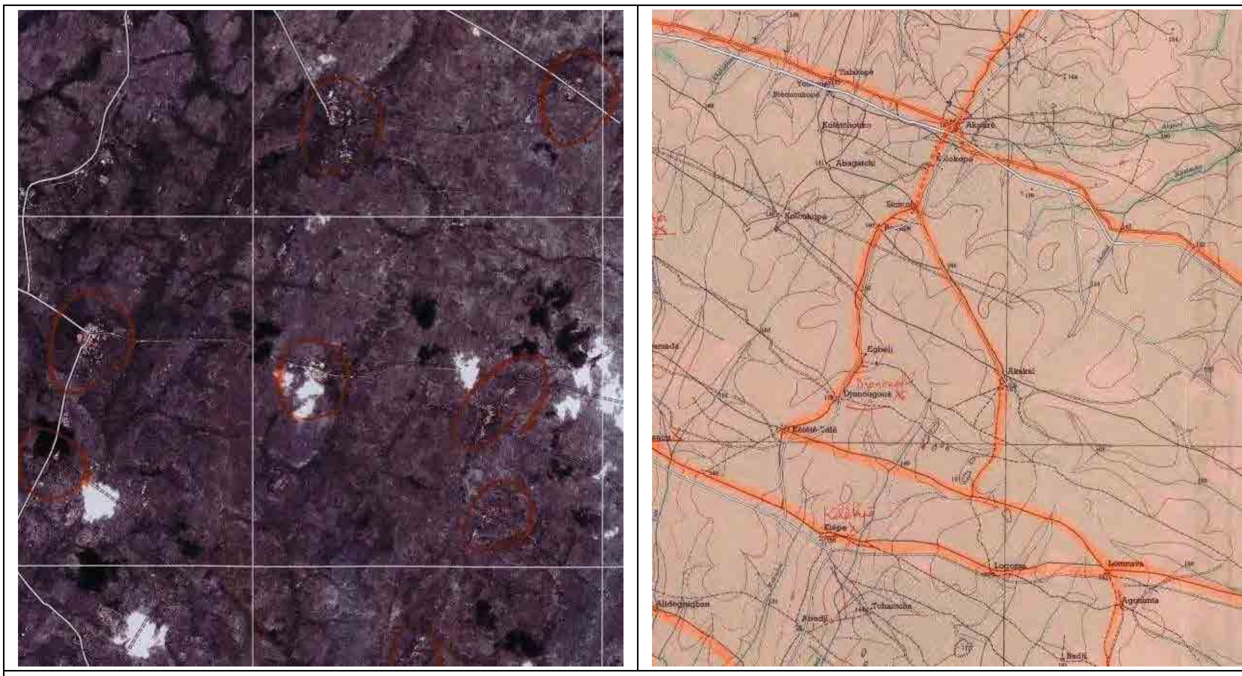


Figure 18 Left: Orthophoto after the preliminary survey, Right: Existing topographic map (1/50,000)

3) Field Identification

The field identification members reached the destination point by means of the handy GPS unit which indicated the 1/200,000 topographic map and carried out the survey work making effective use of the handy GPS unit and the orthophoto to collate the target planimetric features with their positions on the orthophoto by referring to the coordinate values on the handy GPS unit and the grid values on the orthophoto in accordance with the following specifications.

Table 22 Specifications of Field Identification

Item			Specifications	Remarks
1	Field Identification	Number of maps	37	
2		Existing topographic map	1/50,000	Existing map (1970)
3			1/200,000	Existing map (1987)
4		Simplified ortho image	1/50,000	Planimetric features such as roads and facilities for the survey have been indicated.
5		Map specifications	As decided in discussions	Only the planimetric features for the field identification are extracted. Codes for the field identification are indicated.
6	Personnel	Number of work groups	Four groups	2 – 3 staff members/group
7	Equipment	Handy GPS unit	One unit/group	The coordinate values of the target features are acquired and the codes and attributes are entered.
8		GPS camera	One unit/group	Photos showing the positional relationship of the target features and the surrounding features are taken and the coordinate values of the target features are acquired.
9		Triangle scale	One unit/group	The coordinates of the target features are checked and plotted on the orthophoto.

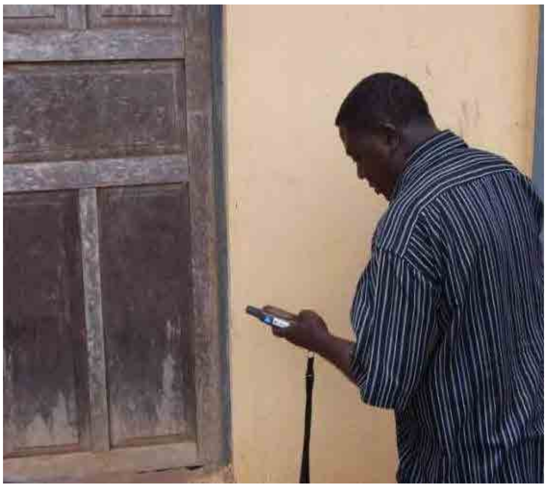


Figure 19 Left: Interview survey, Right: Entry of coordinates (handy GPS unit)

4) Sorting of Field Identification Results

After the field identification, the target planimetric features were sorted. The map on which the field identification results have been arranged and the table of coordinates and attributes, etc. of the target planimetric features are shown below.

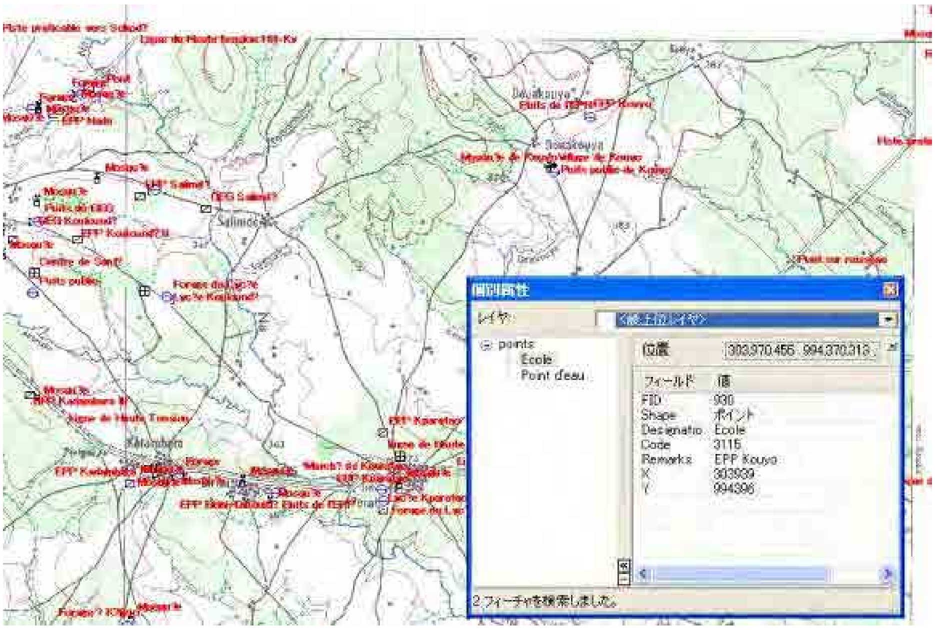


Figure 20 Data on which the Results of Field Identification have been Plotted

Table 23 Excel Sheet Indicating Field Identification Results

Date2	Designation	Code	Remarks	X	Y	Date	Sheet No.
2012/1/17	Mosquée	3105	Mosquée	305034	1058060	1/17/2012 10:54:33 AM	NC-31-VIII-3-a
2012/1/17	Ecole	3115	EPC Lassa-Elimdè	305081	1058236	1/17/2012 11:00:56 AM	NC-31-VIII-3-a
2012/1/17	Ecole	3115	CEG Lassa-Elimdè	306031	1058685	1/17/2012 11:12:40 AM	NC-31-VIII-3-a
2012/1/17	Puits	5003	Puits	306177	1058662	1/17/2012 11:20:12 AM	NC-31-VIII-3-a
2012/1/17	Eglise	3103	Eglise Néo Apostolique	305921	1059391	1/17/2012 11:30:18 AM	NC-31-VIII-3-a
2012/1/17	Ecole	3115	EPP LAO	305976	1059741	1/17/2012 11:36:16 AM	NC-31-VIII-3-a
2012/1/17	Pont	5201	Pont sur la riviere	306169	1060243	1/17/2012 11:40:55 AM	NC-31-VIII-3-a
2012/1/17	Mosquée	3105	Mosquée	306422	1060793	1/17/2012 11:43:44 AM	NC-31-VIII-3-a
2012/1/17	Centre de Santé	3114	USP Lassa-bas	306477	1060913	1/17/2012 11:46:54 AM	NC-31-VIII-3-a
2012/1/17	Marché	3112	Marché	306610	1061229	1/17/2012 11:50:30 AM	NC-31-VIII-3-a
2012/1/17	Ecole	3115	EPP Lassa-Ahodo	306658	1061557	1/17/2012 11:53:25 AM	NC-31-VIII-3-a
2012/1/17	Ligne	3200	Ligne de haute tension	307528	1061807	1/17/2012 11:59:19 AM	NC-31-VIII-3-a
2012/1/17	Ecole	3115	EPP Lassa Tchow (Lassa)	307859	1061565	1/17/2012 12:01:49 PM	NC-31-VIII-3-a
2012/1/17	Pont	5201	Pont sur la rivière Ahodo	306754	1061948	1/17/2012 12:07:55 PM	NC-31-VIII-3-a

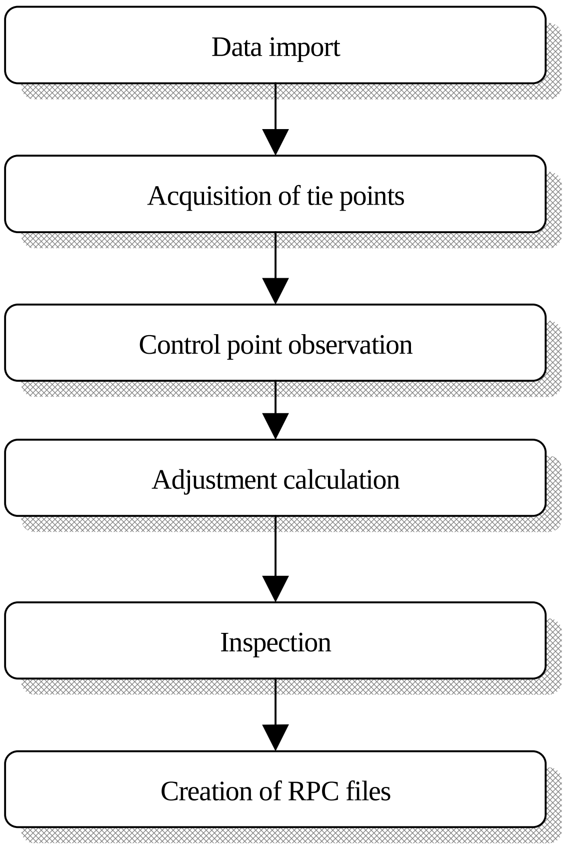
The technology transfer in field identification was implemented in the form of OJT with guidance, supervision and work management by the member of the Study Team responsible for field identification. (See Chapter 4.)

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).



Data on ALOS/PRISM images and control points (control point origins and control points) are imported and plotted.

Automatic observation of pass points and tie points is carried out using image-matching technology and the results of the observation are inspected.

Control points are identified on images and the locations of their centers are observed.

Adjustment calculation by the bundle-adjustment method is carried out. Coordinates of principal points and attitude angles (external orientation parameters) of all images are obtained from the adjustment calculation.

Control point residuals are calculated. If the calculated residual exceeds the tolerance, recalculation is carried out for the point concerned.

A RPC file reflecting the results of the adjustment calculation was created for each image.

Figure 21 Workflow of Aerial triangulation

1) Data Import

Data on 111 (37 x 3) ALOS/PRISM satellite images and control points (two control point origins and 32 control points) were imported.

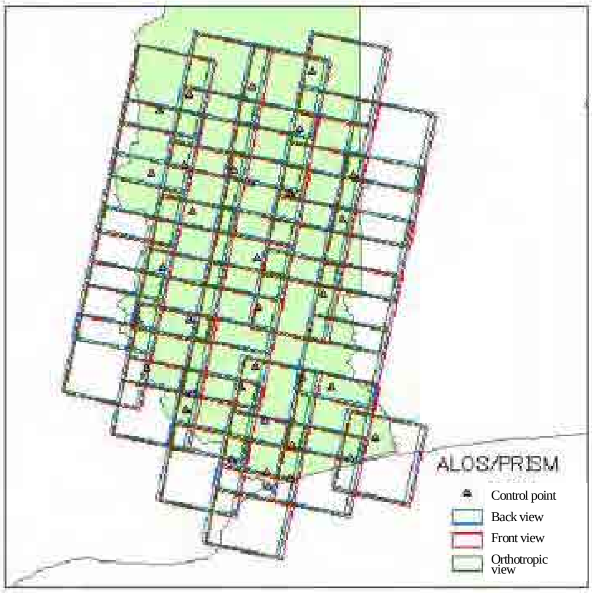


Figure 22 Development of ALOS/PRISM Images and Control Points

2) Acquisition of Tie Points

A total of 3,143 tie points were acquired by automatic and manual operations.

3) Control Point Observation

Control points were measured manually by comparing the ALOS images with the register of control points in which the results of the control point survey had been compiled.

4) Adjustment Calculation

Adjustment calculation was carried out and residuals of tie points and control points obtained from the results of the adjustment calculation were examined. If the residual was not smaller than the tolerance, new observation of the tie point or control point concerned and new adjustment calculation were repeated until the residual obtained became smaller than the tolerance. The table below shows the results obtained from the above-mentioned process.

Table 24 Residuals of Tie-points and Control Points as Adjustment Results (Southern Area)

	Q'ty	Unit	Error	X	Y	Z	Tolerance	
							XY	Z
Tie-point	3,143	Pixel	RMSE	0.191	0.225		<1	<1
			MAX	1.249	1.332		<2	<2
Control Point	34	M	RMSE	0.670	0.908	0.638	<10	<5
			MAX	1.639	1.890	1.499	<20	<10

5) Creation of RPC Files from the Results of the Adjustment Calculation

Positional information (RPC file) of each satellite image in which the results of the adjustment calculation were incorporated was created in order to develop a stereo model which could be used in the subsequent digital plotting.

The technology transfer in aerial triangulation was carried out twice, in June – July 2012 and May – June 2013. The contents of the technology transfer were decided during the discussions between DGC and the Study Team. A workstation for photogrammetry and software for photogrammetry (LPS: Leica Photogrammetry Suite) were used in the technology transfer.

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.

1) Selection of and Observation at the Control Point Origins

The Study Team and DGC held discussions on the control point origins in the Northern Area and decided to establish them at three locations, Sokodé, Kara and Mango. The team carried out simultaneous GPS observation at the three locations and IGS observation stations in the region, BJCO in Benin and NKLG in Gabon, for at least 48 hours and used the results of the observations in the long baseline analysis. The IGNT002 data was included in the analysis for the purpose of verifying the accuracy of the coordinates of one of the control point origins in the Southern Area. The team used the results of the analysis for the establishment of the control points for this Study.

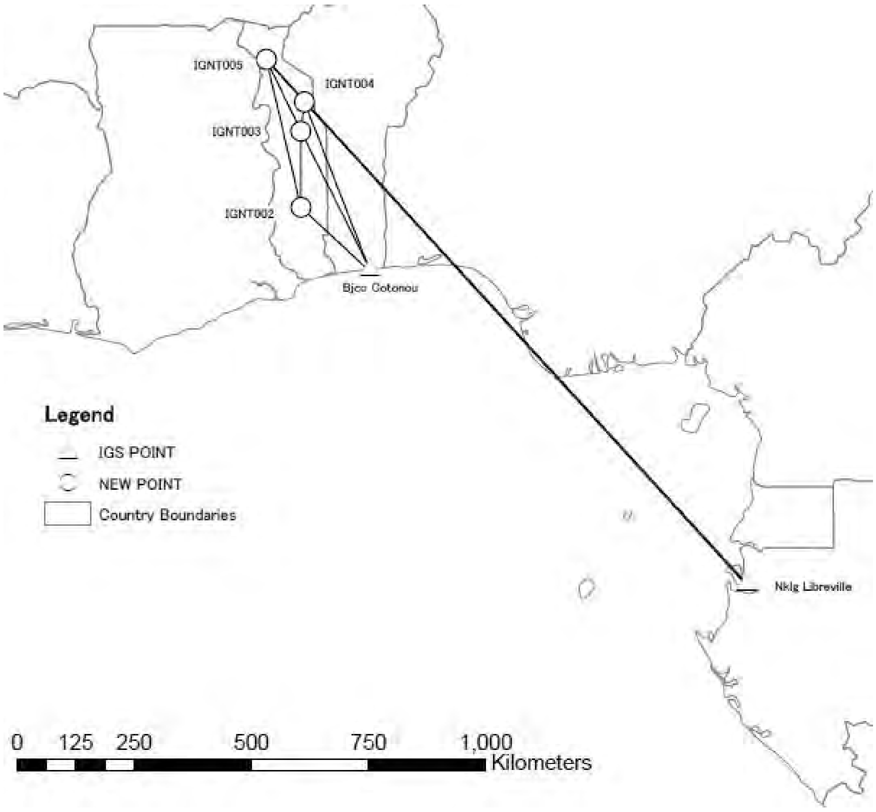


Figure 23 Locations of the Control Point Origins and the Results of Observation (adjustment map) in the Northern Area

2) Reconnaissance and Selection of Control Points

The candidate locations for the control points were selected taking into account the areas for satellite images and were plotted on the planned map.

In the field reconnaissance, problem such as access as well as differences between the satellite images and the actual area conditions were confirmed. Then, the locations of the control points were determined. 32 control points including the control point origins were established. A control point details register accompanied by satellite images and ground photos was prepared to define the locations of the control points.

3) GPS Observation (Static Positioning)

For the 32 control points selected and established in the above work, 13 sessions of GPS observations (static positioning) were carried out.

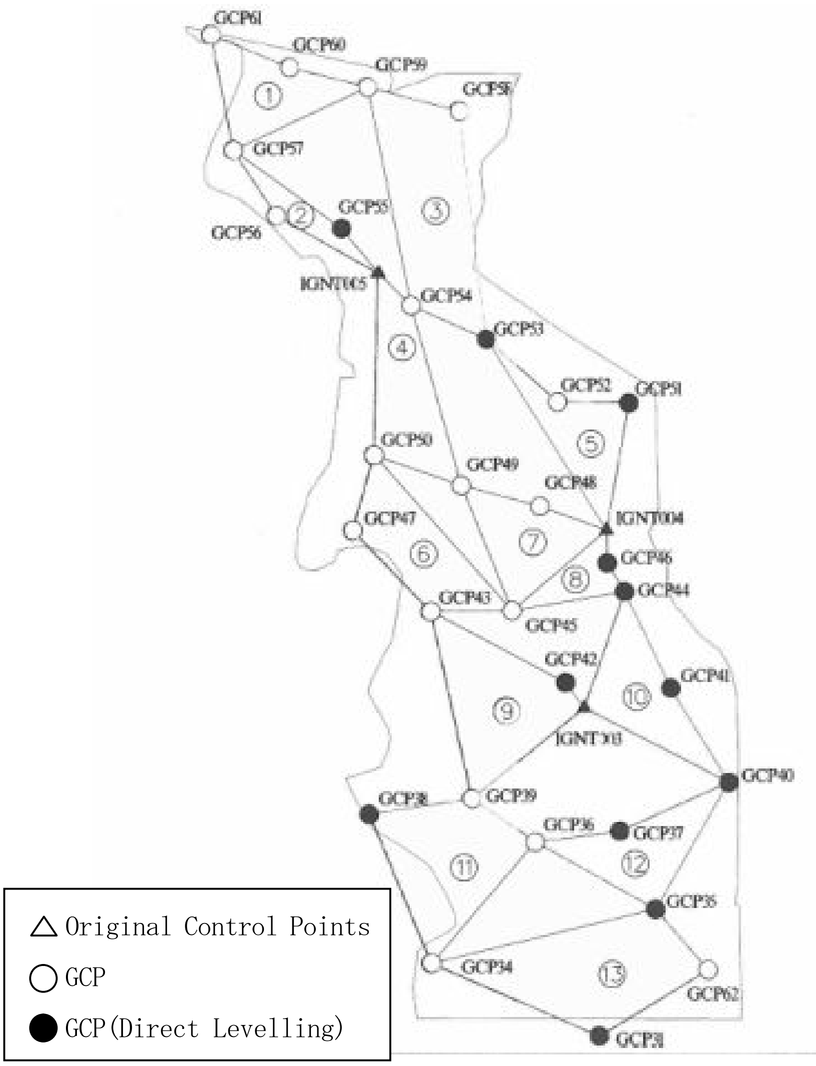


Figure 24 Locations of the Control Points and the Results of Observation (adjustment map) in the Northern Area

4) Leveling

The survey of reference benchmarks revealed the existence of many national benchmarks in the Study Area, as in the Southern Area. The Study Team implemented direct leveling to provide 11 control points with elevation data.

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.

1) Planning/Preparation

The same eight DGC staff members who had participated in the field identification in the Southern Area participated in the field identification in the Northern Area. Therefore, after review of the field identification in the Southern Area and the safety control measures, a schedule for the field identification in the Northern Area was prepared, work groups were formed and a map area for field identification was assigned to each group. Four work groups of two participants each were created as in the field identification in the Southern Area.

2) Preliminary Survey

The participants conducted photo interpretation of satellite images using existing 1/50,000-scale and 1/200,000-scale topographic maps as reference and identified features to be identified in the field before the field identification. Skeleton features, such as roads, villages and geographic names, and public buildings and facilities, such as schools, churches, mosques and graveyards, were interpreted. These features were traced from interpreted images and existing maps to orthophotos.

3) Field Identification

The field identification members reached the destination point by means of the handy GPS unit which indicated the 1/200,000 topographic map and carried out the survey work making effective use of the handy GPS unit and the orthophoto to collate the target planimetric features with their positions on the orthophoto by referring to the coordinate values on the handy GPS unit and the grid values on the orthophoto.

4) Filing of the Outputs of Field Identification

Coordinates and attributes of features obtained as outputs of the field identification were separately sorted and filed as data.

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

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

Table 25 Participants from Related Agencies in IT/R Briefing

Date and time	Tuesday, February 28th, 2012	9:30-11:00
Venue	Conference Room, Ministry of Foreign Affairs and Cooperation	

	Name	Affiliation	Post
1	BELEYI Essokilina	Ministry of Water and Sanitation	Water and Sanitation Engineer
2	AGOUDA Kpadja	Ministry of Water and Sanitation	Head of the Section of Ground Water
3	AKAKPO Wohou	Ministry of Water and Sanitation	Director of the Water Resource Planning and Management
4	KOMBATE Yendouhame	Ministry of Environment and Forest Resources	Officer in charge of follow-up survey and evaluation
5	TCHARIE Kokou	HCRAH, Ministry of Higher Education and Research	Professor in Mathematics, University of Kara
6	LARE Douti	Directorate of Public Works, Ministry of Public Works	Head of the Division of Structural and Hydraulic Studies and Planning
7	GNASSINGBE Eyabah	Ministry of Territorial Administration	Officer in Charge of Geographic Studies
8	PASSEM Aféitom	Ministry of Energy and Mines	Benin Electric Community and Environmentalist
9	LABARI Essoham Komlan	Directorate of Domanial and Cadastral Affairs, Ministry of Economy and Finance	Officer in charge of Cadastral Affairs
10	NABEDE Sanda Essoham	Directorate of Domanial and Cadastral Affairs, Ministry of Economy and Finance	Senior geometric technician
11	DOTSEVI Atsoutsè	Directorate of Domanial and Cadastral Affairs, Ministry of Economy and Finance	Head of the General Affairs Section
12	KANYI Akutété Sêh	Ministry of Developmental Planning and Regional Planning	General Director of the Developmental Planning and Regional Planning
13	KONDI Mani	Ministry of Foreign Affairs and Cooperation	Advisor to the Minister
14	AFOKPA Védomé Kodjovi	Ministry of Foreign Affairs and Cooperation	Director of Cooperation
15	TAY AFBTIS Abra	Ministry of Foreign Affairs and Cooperation	Director
16	MAGNON Afi	Ministry of Foreign Affairs and Cooperation	
17	Engineer	Ministry of Agriculture, Livestock and Fisheries	
18	OHOUNKO Olivier	Ministry of Urban Planning and Housing	Chief Secretary
19	AYESSOU Adadé	Ministry of Urban Planning and Housing	Technical Advisor attached to the Minister's Secretariat
20	MAGNON Kokou	Ministry of Urban Planning and Housing	Officer in charge of Accounting, Minister's Secretariat
21	DAKEY Koffi Kouma	Directorate General of Cartography/Ministry of Urban Planning and Housing	Director General of the Cartography
22	NIKABOU Kpapou	Directorate General of Cartography/Ministry of Urban Planning and Housing	Director of the Cartography
23	ADA Koffi Dodziko	Directorate General of Cartography/Ministry of Urban Planning and Housing	Head of the Geomatic Service
24	PAKOUN Léma	Directorate General of Cartography/Ministry of Urban Planning and Housing	Head of the Photogrammetric Service
25	HOUEDAKOR Anoumou	Directorate General of Cartography/Ministry of Urban Planning and Housing	Head of the Geographic Work Service
26	GUEGUE Diweéfè-Esso	Directorate General of Cartography/Ministry of Urban Planning and Housing	Senior Geometric Technician
27	ADJATI Amévi	Directorate General of Cartography/Ministry of Urban Planning and Housing	Senior Geometric Technician
28	SODAGNI Yawo	Directorate General of Cartography/Ministry of Urban Planning and Housing	Senior Geometric Technician
29	AGBOFOATI Kudzo	Directorate General of Cartography/Ministry of Urban Planning and Housing	Topographic Operator
30	KUDITE Koffi	Directorate General of Cartography/Ministry of Urban Planning and Housing	Head of the Informatics, Maintenance and Network Services
31	SUZUKI Akira	JICA Study Team	Team Leader
32	OTA Akira	JICA Study Team	Coordinator
33	SHIRANI Takashi	JICA Study Team	Interpreter

Table 26 Answers by the Director General, DGC (with additional comments by Team Leader Suzuki)

No.	Question	Questioner's affiliation	Answer
1	The Ministry of Water and Sanitation is managing water sources in the entire country with each local office managing water sources in the area of its jurisdiction using the local code numbers. How can this code-based management be processed and integrated in this mapping project?	Directorate of the Water Resource Planning and Management, Ministry of Water and Sanitation	Topographic data of all water sources in the whole of Togo, including water supply points equipped with pumps, has been acquired in this mapping project. However, this data has not been coded yet. It is possible to integrate the codes of water sources in this digital mapping project if the Ministry of Water and Sanitation has a database of coded water sources and provide us with the database.
2	Data of several new prefectures has not been included in the GIS models created in the JICA project.	Ministry of Territorial Administration	This project is only for the purpose of simulation. What is important is use of the same standards in different regions. We have to ask your ministry to provide us with the very information on the administrative boundaries of the prefectures. The data of the prefectural boundaries will form a database at the national level like that of the postal codes.
3	I am pleased with the expansion of the study area of this project from only the Southern Area in the original plan to the entire country. The issue of the greatest interest of our ministry is how our territorial land is occupied. Our ministry collected data in the ten-year period between 2000 and 2010 to formulate sector-specific development plans for the health, education, water, mining, agriculture and other sectors. We would like to use GIS to formulate long-term development plans for the next 30 years or so with the data we have collected with technical assistance from Japan.	Ministry of Developmental Planning and Regional Planning	We conducted continuous GPS observation for three consecutive days for the establishment of the survey origins. As a result, we have the survey origins which are positioned accurately enough to increase density of geodetic network in the entire country. Therefore, we expect the outputs of this project to be used for the implementation of various long-term projects.
4	While the conventional maps were created with the surveys using constellations, a latest technology called GPS is used in the current JICA project. Will this technology enable accurate positioning of all villages, cantons, prefectures, etc.?	Ministry of Territorial Administration	Such accurate positions can be achieved with the use of the new survey origins established in this project by all those requiring such data. However, two-way cooperation in which various ministries and government offices first provide a project team with the data that they have and, then, the project team provides the ministries and offices with the digital data created from the provided data. This transfer of data will have to be structured in the entire government. Therefore, all those concerned will have to work together.
5	Creation of basic data for the development of the national territory requires cooperation of regions and subordinate municipalities. Our ministry is interested in how our territorial land is occupied. At present, the area used as quarries and sandpits is on the increase and we are particularly interested in identifying their locations. The number of filling stations is also on the increase. We consider it important to have them in a uniform density throughout the country.	Ministry of Environment and Forest Resources	It is important to establish a sector-wide mechanism shared by different sectors, such as national land development and mining. Once we have been provided with data that you have, we will be able to devise unlimited number of ways to utilize it.
6	I feel uneasy about the situation in which DGC under the Ministry of Housing monopolizes the management of the database of topographic data. Once DGC has become an autonomous organization, it will be easy for the other ministries and government offices to use the database.	Directorate of Domanial and Cadastral Affairs, Ministry of Economy and Finance	The issue is sharing of the data, which requires integration of the data on different sectors in a single system and construction of an all-inclusive server. The database created in this project is available for use at all ministries and offices of the government of Togo. In fact, as a draft cabinet ordinance to upgrade DGC to IGN has already been submitted to the Office of the Prime Minister, it is expected to be promulgated in near future.
7	I heard that high-resolution satellite imagery was used in this project. Can the state of land occupancy on the ground be fully understood with such imagery? How useful will the topographic maps to be created in this project be for land distribution for specific purposes?	Ministry of Agriculture, Livestock and Fisheries	It is possible to find a way to solve various problems of your ministry with the use of high-resolution satellite images as the ones which we are using in this project. For example, if you use satellite images with a resolution of 50 cm, you can identify quite small planimetric features.
8	We established ten survey origins in a cadastral project supported by Germany in the past. However, they are no longer in use. I heard that the JICA project had established five survey origins. For the cadastral work, it is preferable to have control points to the fifth grade. A scale of 1/50,000 is the scale of the topographic maps created in this project. Will it be possible to create maps of larger scale, for example, 1/15,000?	Directorate of Domanial and Cadastral Affairs, Ministry of Economy and Finance	The five survey origins were established in this project for the purpose of creating basic topographic maps. It will be possible to increase the density of the geodetic network in the entire country by adding data to the basic maps created in this study and to create 1/15,000-scale topographic maps by using satellite images of a resolution of 50 cm, once the engineers of DGC who have participated in the technology transfer have once accumulated sufficient experience.
9	If maps containing sufficient data are created as the final outputs, they can be used in the tourism sector to attract foreign tourists to Togo. Can the maps created in this project represent tourist destinations sufficiently?	Advisor to the Minister of Foreign Affairs and Cooperation	DGC will have to gather expectations of all the ministries and government offices for the maps to create final outputs. For example, in the tourism sector, necessary information can be represented visually. When I accompanied the field identification team to Dapaong in the north, I visited a village designated by UNESCO as a World Heritage Site and took photographs. You could include appropriate elements such as these photographs in the database of the digital topographic maps.
10	For a person working at a university, information on researchers in universities and locations of laboratories is important. What are the margins of errors of these maps?	HCRAH, Ministry of Higher Education and Research	Sufficient data on universities can be incorporated in the database. It is also possible to identify types of plants in accordance with the firmly established standards and to include knowledge of experts in the database. Editing of the acquired data is in progress. Once this process has been completed and required data has become available, margins of errors of the maps including those on areas can be calculated.
11	Will the routes of the latest roads be represented on the maps to be created in this project?	Directorate of Public Works, Ministry of Public Works	It is possible to distinguish roads by class or type of pavement in this project. Therefore, for example, you can use the database to find the best route from Atakpame to a certain village when you have to go there for emergency, humanitarian or medical assistance.
12	Can we use the satellite imagery data?	Directorate of Public Works, Ministry of Public Works	Although only DGC can use the satellite imagery data, government ministries and offices will be able to have access to them by launching joint programs with DGC.
13	We are interested in how the territorial land of Togo is used for agriculture, the mainstay of Togo's economy. Our particular interest is in the difference in land use between the dry and rainy seasons. How can we use this mapping project to solve environmental problems and problems caused by floods and other natural disasters? How are you going to expand this project?	Ministry of Developmental Planning and Regional Planning	The scope of the work of the JICA Study Team of Japan does not include a study on the difference in the land use between the dry and rainy seasons. If you are interested in it, you should go to areas of your interest both in the dry and rainy seasons and collect data of your interest.

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.

1) Data Import

294 ALOS/PRISM satellite images (98 x 3 scenes) and 64 control points were imported.

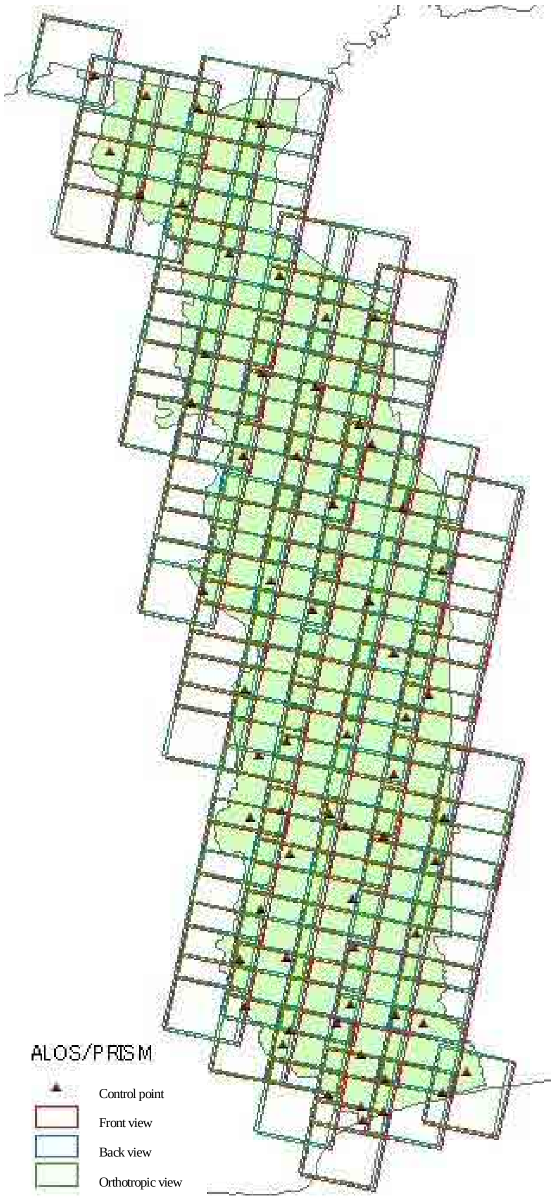


Figure 26 Development of ALOS/PRISM Images and Control Points (whole area of Togo)

2) Acquisition of Tie Points

A total of 15,282 tie points were acquired by automatic and manual operations.

3) Control Point Observation

The control points were measured manually by comparing the ALOS images with the register of control points in which the results of the control point survey had been compiled.

4) Net Adjustment

The net adjustment was carried out and the results of the adjustment were used to inspect the residuals of the tie points and control points. If a residual of the tie/control points was not below the corresponding tolerance, measurement of such points and net adjustment were carried out again. The measurement and adjustment was repeated until the results with all the residuals below the corresponding tolerances had been obtained. The final results of the measurement are shown below.

Table 27 Residuals of Tie-points and Control Points (Southern and Northern Areas)

	Q'ty	Unit	Error	X	Y	Z	Tolerance	
							XY	Z
Tie-point	15,282	Pixel	RMSE	0.170	0.160		<1	<1
			MAX	1.160	1.140		<2	<2
Control point	64	M	RMSE	0.450	0.460	0.513	<10	<5
			MAX	1.131	-1.306	1.505	<20	<10

5) Creation of RPC File for Adjustment Results

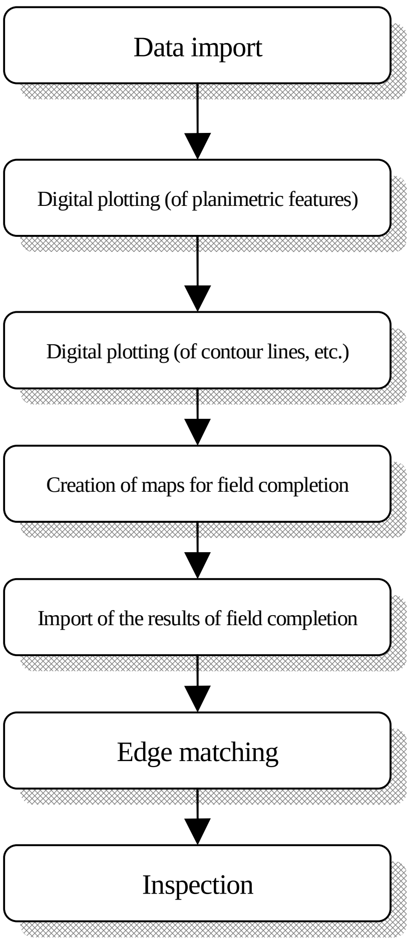
Positional information (RPC file) of each satellite image in which the results of adjustment calculation were incorporated was created in order to develop a stereo model which could be used in the subsequent digital plotting.

Technology transfer in aerial triangulation was carried out twice, in June – July 2012 and May – June 2013. The contents of the technology transfer were decided during the discussions between DGC and the Study Team. A workstation for photogrammetry and software for photogrammetry (LPS: Leica Photogrammetry Suite) were used in the technology transfer.

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.



ALOS satellite images and the outputs of aerial triangulation (RPC files) are imported into the photogrammetry system and the topography is reproduced as a stereo model.

Digital plotting is carried out in the background of the ALOS stereo models and SPOT images using the results of field identification and interpretation of satellite images. Ambiguous points are filed as items to be identified in field completion.

Data on spot heights and contour lines are acquired in the background of the ALOS stereo models, existing maps and existing aerial photographs.

Maps showing the locations and details of ambiguous points found in the plotting and points on which additional information is required are prepared.

The results of field completion are incorporated in the data.

Edge matching is established between adjacent maps.

Plotted data are inspected for consistency with the results of the field identification, work specifications and map specifications and errors are rectified.

Figure 27 Workflow of Digital Plotting

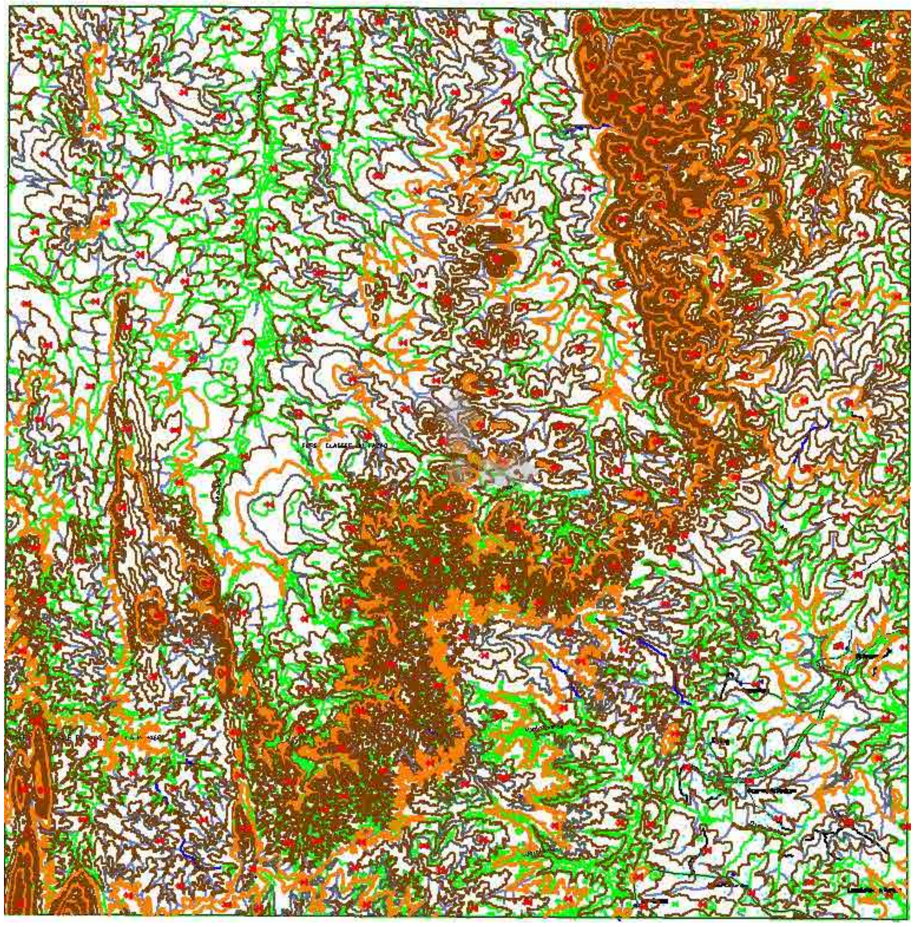
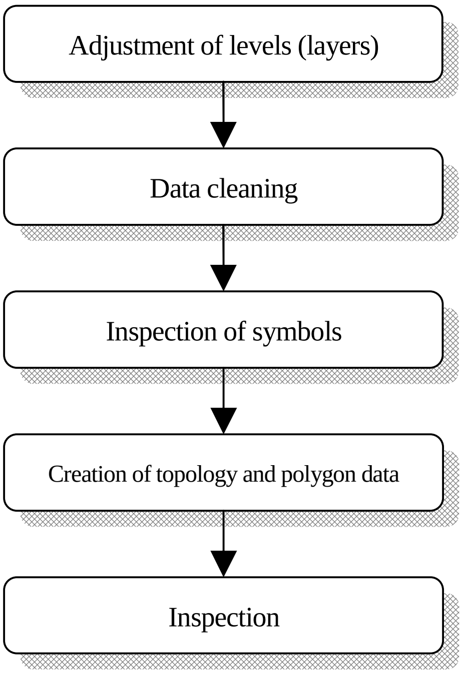


Figure 28 Digital Plotting

Technology transfer in digital plotting was carried out twice, in June – July 2012 and May – June 2013. The contents and target area of the technology transfer were decided during discussions between the DGC and the Study Team. A workstation for photogrammetry, software for photogrammetry and CAD were used in the technology transfer. (See Chapter 4.)

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.



Each piece of digitally plotted data stored in a layer is examined as to whether it is stored in the appropriate layer or not and, if not, it is moved to the appropriate layer.

Data shapes are adjusted to appropriate shapes and unnecessary data are removed.

An examination is conducted as to whether appropriate symbols (cells) are placed in areas where polygon data are to be created or not and, if not, appropriate symbols are placed in the areas concerned.

Symbols are placed, topologies are generated in areas enclosed by lines and polygons are created on each layer.

Visual and automatic inspection is carried out to confirm whether there are data with inappropriate shapes or unnecessary data and whether necessary polygon data have been created.

Figure 29　Workflow of Digital Compilation

Technology transfer in digital compilation was carried out twice, in July – August 2012 and June – July 2013.　The contents and target area of the technology transfer were decided during discussions between the DGC and the Study Team.　CAD was used in the technology transfer. (See Chapter 4.)

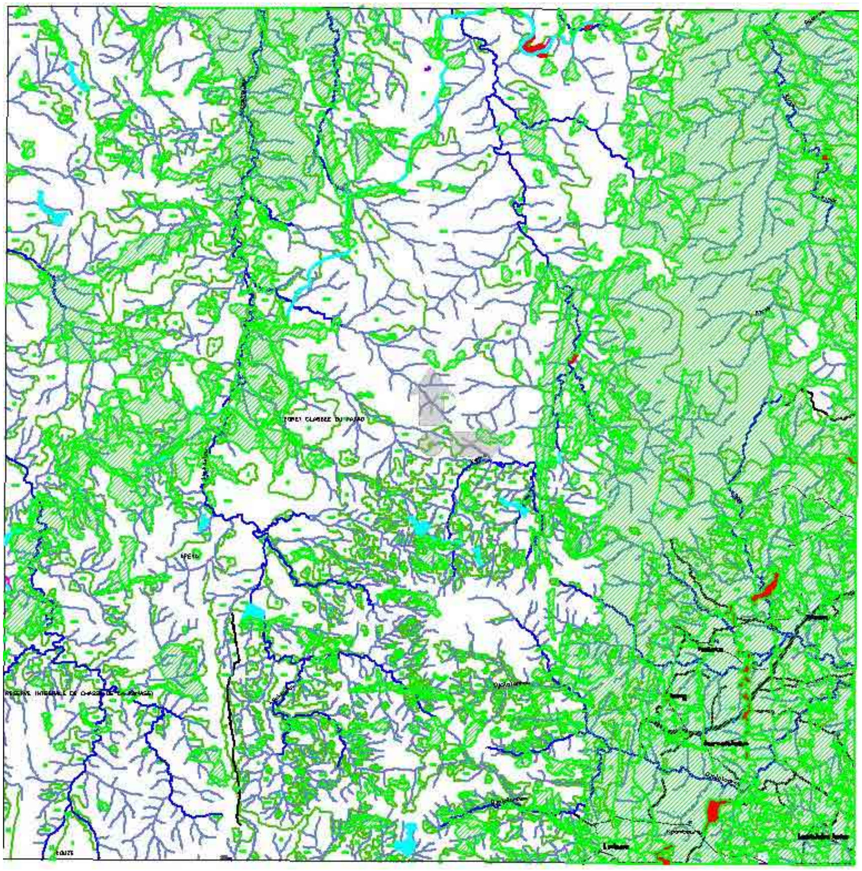


Figure 30 Digital Compilation (features other than contour lines)

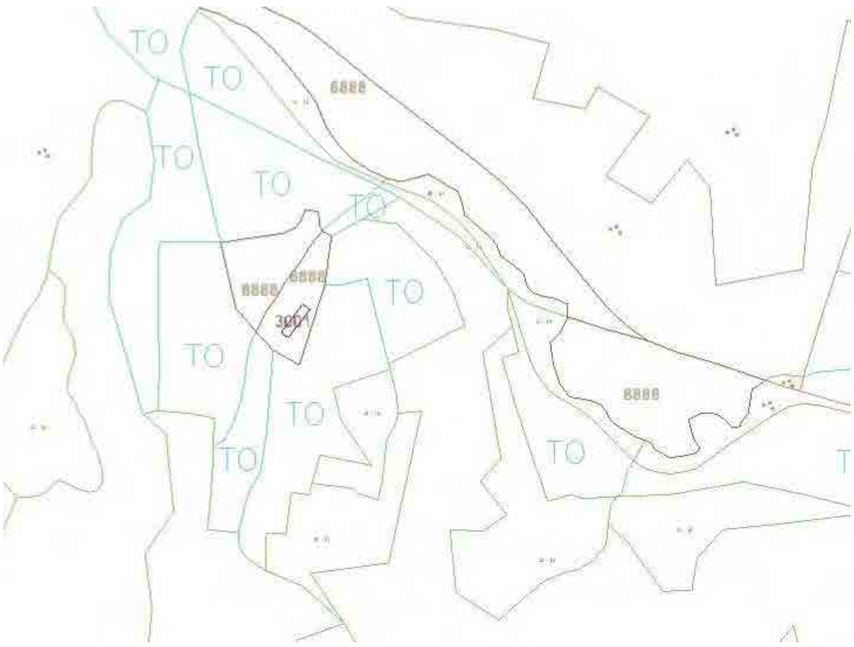


Figure 31 Digital Compilation (inspection of symbols for polygon creation)

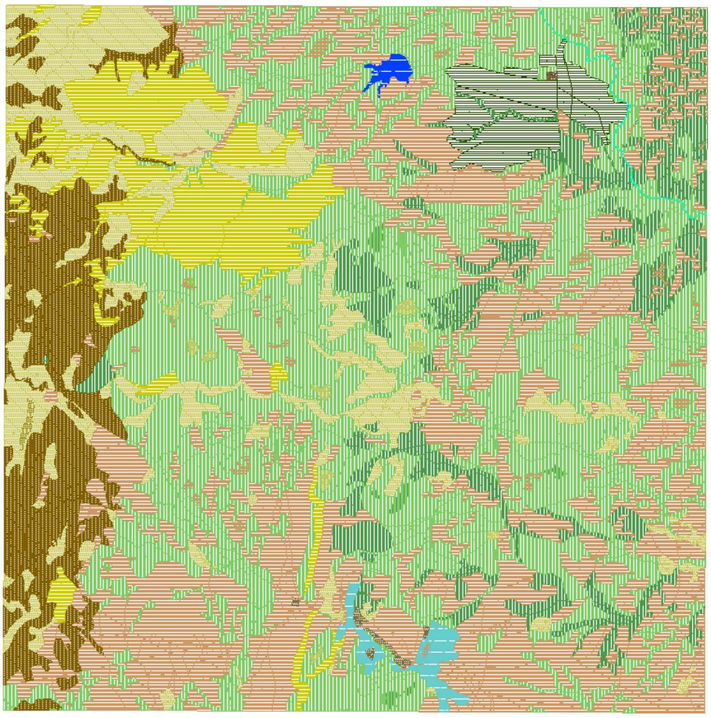


Figure 32 Digital Compilation (created polygons)

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.

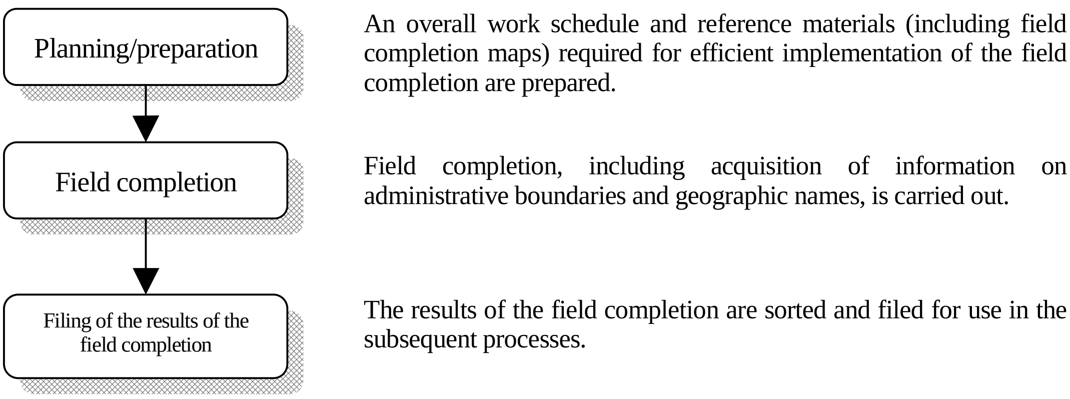


Figure 33 Workflow of Field Completion

1) Planning/Preparation

The same eight DGC staff members who participated in the technology transfer in field identification participated in the technology transfer in field completion. Therefore, after review of the field identification in the Southern Area and safety control measures, a schedule for field completion in the Southern Area was prepared, work groups were formed and a map area for field identification was assigned to each group. Four work groups of two participants each were formed as in the field identification in the Southern Area.

2) Field Completion

The participants carried out field completion of the survey objects described on the printed 1/50,000-scale completion maps. They entered the results of the completion directly on the completion maps and obtained the coordinates of some objects by handy GPS unit. Many of the objects for field completion were geographic names, roads and bridges.

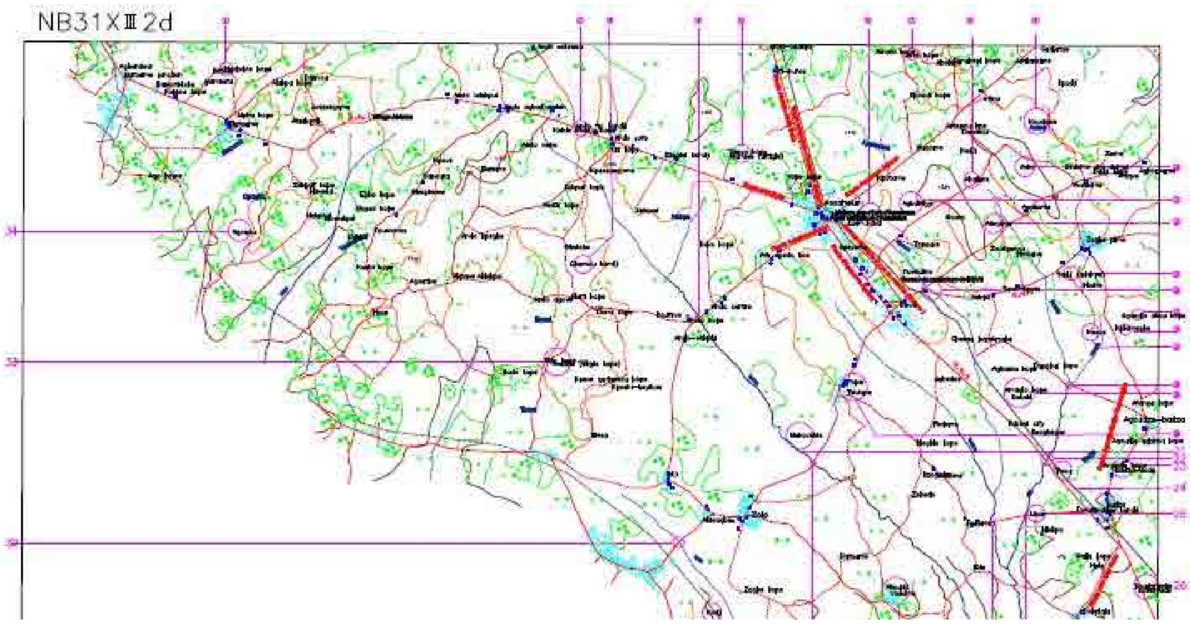


Figure 34 Field Completion Map (showing ambiguities identified in digital plotting)

3) Filing of the Results of the Field Completion

The participants entered the results of the field completion systematically on new 1/50,000-scale printout maps.

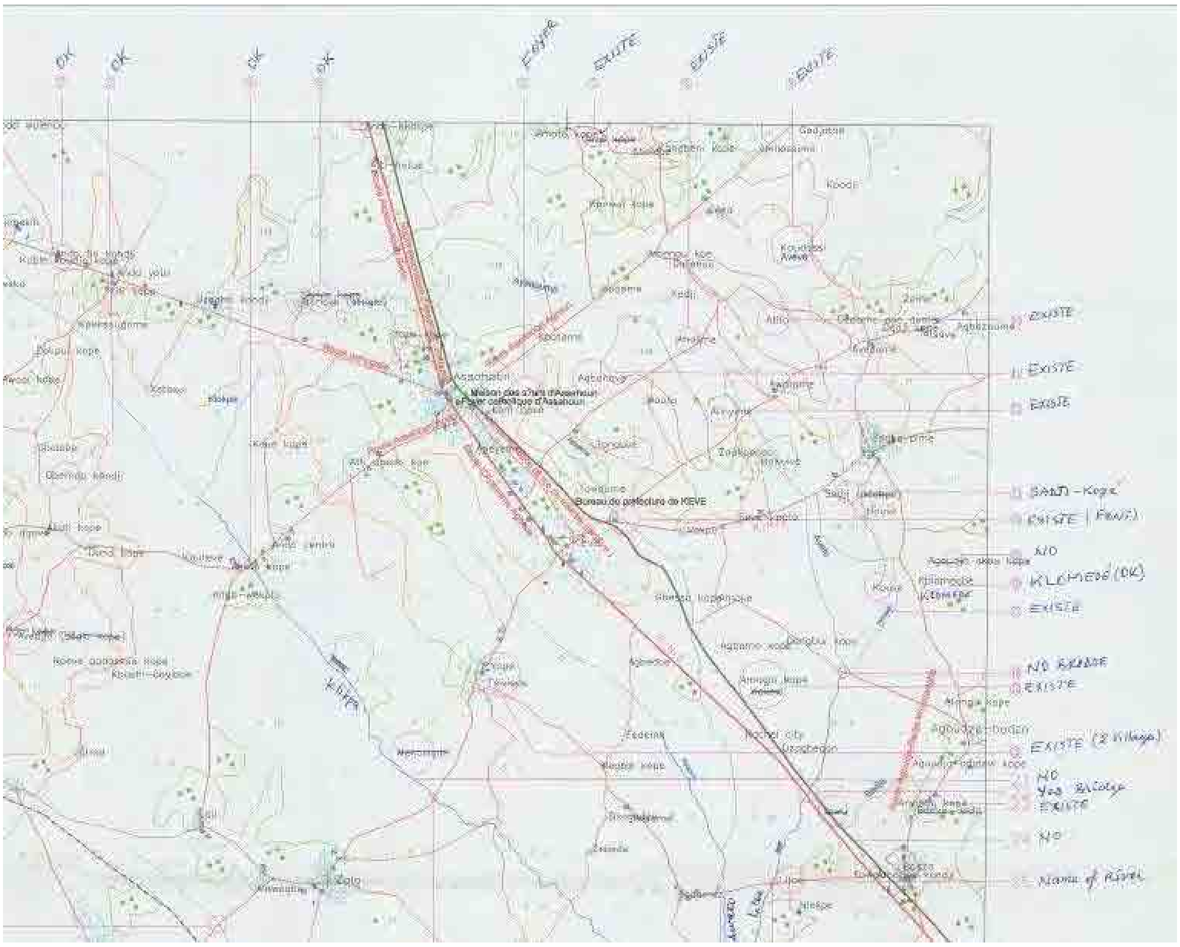


Figure 35 Map on which the results of field completion have been entered systematically

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

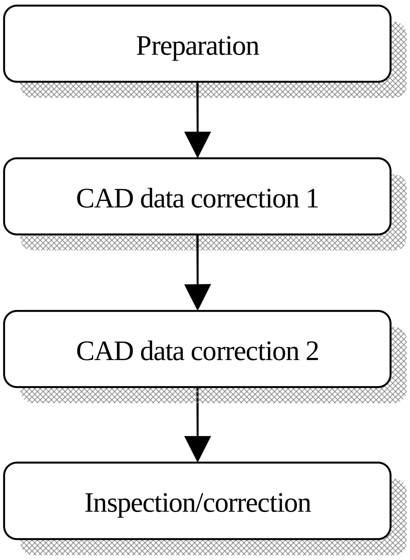
3-19. Field Completion in Northern Area [Work in Togo]

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.



Required data are selected and the coordinate system for data import is standardized with use of the results of field completion and new reference materials.

Required data mentioned above (data related to point, line and polygon data) are imported.

New data cleaning and/or polygon topology creation is carried out if the status of the imported data requires such a procedure.

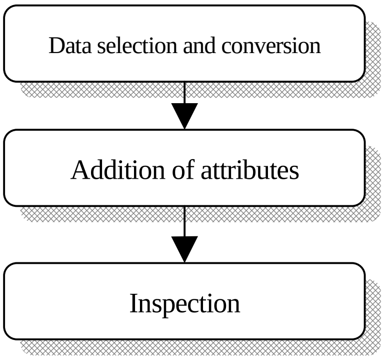
Visual and automatic inspection is carried out to confirm whether there are data with inappropriate shapes or unnecessary data and whether the necessary polygon data have been created.

Figure 36 Workflow of Digital Compilation after Field Completion

Technology transfer in digital compilation after field completion was carried out in June – July 2013. The contents and target area of the technology transfer were decided during discussions between the DGC and the Study Team. CAD was used in the technology transfer. (See Chapter 4.)

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.



Required data are selected from the data created in the digital compilation after field completion and converted into a data format compatible with GIS software.

Attributes required for GIS analysis are added to the data using GIS software.

Visual and automatic inspection is carried out to confirm whether the data contain all the information required for GIS basic data or not.

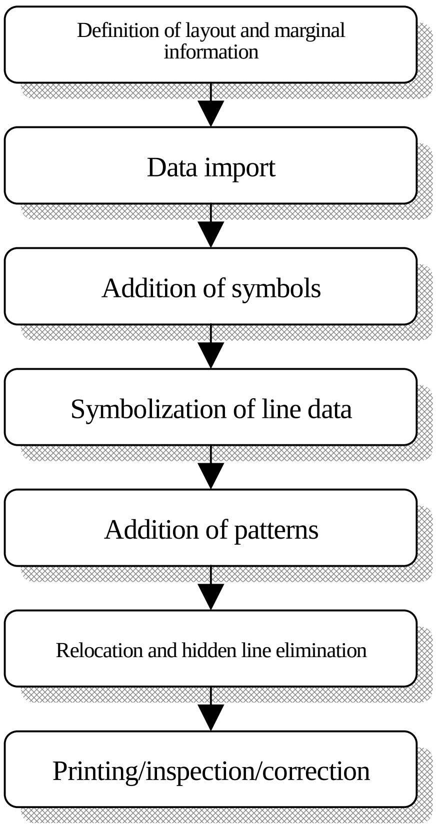
Figure 37 Workflow of Data Structurization

Figure 38 Structured data

Technology transfer in data structurization was carried out twice, in July – August 2012 and June – July 2013. The contents and target area of the technology transfer were decided during discussions between the DGC and the Study Team. The topographic map data created in the digital compilation after field completion and GIS software were used in the technology transfer. (See Chapter 4.)

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.



Layout and marginal information of topographic maps are defined as agreed upon between the DGC and Study Team

The data created in the digital compilation after field completion are imported using Illustrator.

Plotted point data are converted, with symbols for point data created and registered in accordance with the map specifications.

Line data are converted, with colors, styles and widths of line data created and registered in accordance with the map specifications.

Polygon data are converted, with patterns (filing colors and patterns) created and registered in accordance with the map specifications.

Relocation and hidden line elimination of data are carried out in order to make overlapping or juxtaposing data easily distinguishable on printouts.

Output proofs of the symbolized data are inspected visually to confirm whether the data conform to the specifications for 1/50,000-scale topographic maps or not.

Figure 39 Workflow of Map Symbolization

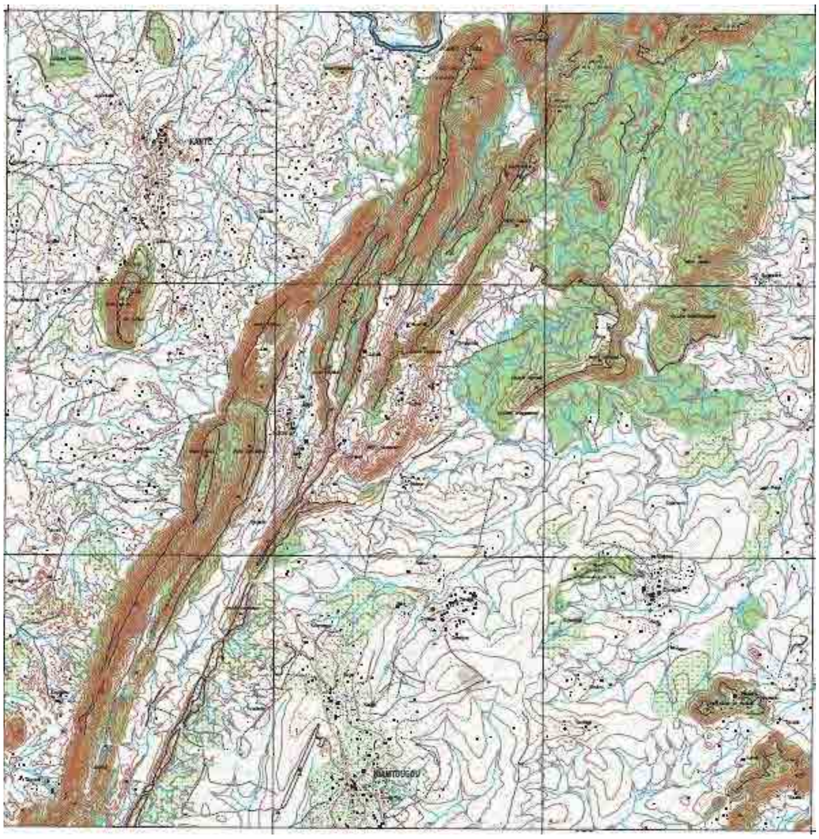


Figure 40 Map-symbolized Data

Technology transfer in map symbolization was carried out in June – July 2013. The contents and target area of the technology transfer were decided during discussions between the DGC and the Study Team. Topographic map data created in the digital compilation after field completion by DGC personnel and software for graphic design were used in the technology transfer. (See Chapter 4.)

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. Here is the list of participants in the seminar.

Table 28 List of Participants at the Seminar

	Type	Number of invited organizations	Number of participants
1	Administrative institutions (Office of the President, Ministry of Urban Planning and Housing, etc.)	20	46
2	Professional associations in various areas (Association of Surveyors of Togo, etc.)	4	6
3	Private sector (Togo Telecom, etc.)	7	11
4	Research institutions (University of Lomé, etc.)	5	21
5	International organizations (the World Bank, etc.)	3	4
6	Local governments (of five regions and 21 prefectures)	23	28
7	JICA Côte d'Ivoire Office	1	1
8	JICA Expert	1	1
9	JICA Study Team	1	4
10	Others		3
			Total 125

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. (For the Minutes of Meeting, please refer to Appendix 16.)

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.　The Study Team concluded from the results of the evaluation that the technical capacities of the counterparts were either at "Level 1" or "Level 2" in the table below.

Table 29　Technical Level Categories of Counterparts

Category	Experience of Counterparts	Goals
Level 1	No experience in the target work and no knowledge of computers	Understanding of basic theories Basic operation of equipment Improvement of working speed and accuracy by repeated practice
Level 2	No experience in the target work, but with knowledge of computers	Improvement in the capacity to organize data by documentation or as digital data

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 30 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	
			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. Participants in the Technology Transfer

The technology transfer in control point survey was conducted for eight survey engineers of DGC and locally-employed survey assistants under the guidance of the member of the Study Team in charge of the technology transfer in control point survey. The engineers and assistants worked in four work groups, each group consisting of two DGC survey engineers and two survey assistants.

Table 31 Participants in the Technology Transfer

Name		Organization	Technical level	Notes
1	HOUEDAKOR Anoumou Mario	DGC	Level 2	Group 1
2	ADJOH Mawussi	Private organization outsourced by DGC	Level 1	
3	PAKOUN Léma	DGC	Level 2	Group 2
4	GUEGUE Diwèfé-Esso	Directorate General of Equipment	Level 1	
5	SODAGNI Yawo	Directorate General of Equipment	Level 2	Group 3
6	ADJATI Amèvi Agossi		Level 1	
7	AGBOFOATI Kudzo	Private organization outsourced by DGC	Level 1	Group 4
8	KPODZRO Kwami Valentin	DGC	Level 2	

4-1-3. Schedule and Contents of the Technology Transfer

The table below shows the schedule of the technology transfer.

Table 32 Schedule of the Technology Transfer in Control Point Survey

Term		Contents/Activity	Expected outcome
Southern Area June – September 2011	Week 1	Briefing and joint training	Standardization of work procedures Safety control procedures
	Week 2	Training in reconnaissance, point selection and equipment	Understanding of basic manipulation of the equipment Understanding of allocation of points for aerial triangulation Interpretation of satellite images
	Week 3	GPS observation (Lomé)	Repeated exercises in manipulation of the GPS equipment
	Week 4	GPS observation (Lomé - Notsé)	
	Week 5	GPS observation (Notsé)	
	Week 6	GPS observation (Notsé - Atakpamé)	
	Week 7	GPS observation (Atakpamé)	Preparation of control point details register
	Week 8	Leveling (Atakpamé)	Repeated exercises in manipulation of the leveling equipment and handy GPS unit Methods for verification and evaluation of the observation results
	Week 9	Leveling (Notsé)	
	Week 10	Leveling (Lomé)	Preparation of benchmark details register
	Week 11	Establishment of control point origins, 48-hour observation	
	Week 12	GPS analysis, maintenance of control	Understanding of the basic theory of network

Term		Contents/Activity	Expected outcome
		points	adjustment Manipulation of the software
Northern Area October – December 2011	Week 1	Procurement of materials and equipment, travel, courtesy visits to security institutions in the Northern Area and establishment of a safety control system	Safety control procedures
	Week 2	GPS observation/leveling (Sokodé)	Repeated exercises in manipulation of the handy GPS unit Repeated exercises in manipulation of the GPS equipment Repeated exercises in manipulation of the leveling equipment
	Week 3	GPS observation/leveling (Kara)	
	Week 4	GPS observation/leveling (Mango)	
	Week 5	GPS observation/leveling (Dapaong)	
	Week 6	GPS observation/leveling (Atakpamé)	
	Week 7	Establishment of control point origins, 48-hour observation	
	Week 8	GPS analysis, maintenance of control points	Manipulation of the software Evaluation of the outputs, preparation of the quality control table

Figure 41 Technology Transfer in Control Point Survey (Top left: Joint training, Top right: Field reconnaissance for selection of control points, Bottom left: Leveling, Bottom right: Network adjustment)

4-1-4. 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.

Table 33 Impact and Evaluation of the Technology Transfer in Control Point Survey

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future
Control point survey	Field reconnaissance for selection of control points	Basic concepts of GPS (Understanding of control point allocation, image interpretation and positional correlations)	The C/Ps are able to use the handy GPS units to reach their destination quickly.	While the C/Ps have mastered the method to select candidate control points appropriately by themselves, they will require more experience in order to be able to select points under other conditions.
	GPS survey	Installation of the devices Manipulation of the devices	The C/Ps can install the devices and enter data in the master observation sheets without problems.	Improvement in the capacity to use the devices for purposes other than those of this Study
		Preparation of control point details register	The C/Ps can prepare it without problems.	Improvement in the capacity to use various types of software for the preparation of the description
	GPS analysis	Data download from the devices Basic manipulation of the software	Although the participants were not able to fully master the data download and basic manipulation during the technology transfer in the Southern Area, they mastered them fully during the technology transfer in the Northern Area.	Improvement in applied use of the GPS analysis technology
		Confirmation and understanding of the observation results (Preparation of the quality control tables)	The counterparts acquired the capacity to prepare and evaluate the quality control table (Appendix-14_1) independently during the technology transfer in the Northern Area.	Preparation of reports which can be used for the evaluation of the results of the analysis
	Leveling	Quick and accurate installation of the devices Understanding of how to manipulate the devices Data download from the device	The C/Ps can install the devices and enter data in the master observation sheets without problems.	Improvement of safety measures and the capacity to adjust the devices
		Confirmation and understanding of the observation results (Preparation of the quality control tables)	The counterparts acquired the capacity to prepare and evaluate the quality control table (Appendix-14_2) independently during the technology transfer in the Northern Area.	Improvement in efficiency of the preparation of the quality control tables with the effective use of various types of software
	Control point maintenance procedure	Methods to file the records of the state of maintenance and use of national benchmarks (Preparation of benchmark control tables)	The C/Ps can file the records without problems.	Establishment of a maintenance system including creation of awareness of the people living near the control points on their importance for their consistent maintenance

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 34 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. Participants in the Technology Transfer

DGC selected eight people, shown in the table below, as the participants in the field identification. The Study Team evaluated their technical levels as shown below from interviews conducted before the work.

Table 35 Participants in the Technology Transfer

	Name	Organization	Technical level	Notes
1	HOUEDAKOR Anoumou Mario	DGC	Level 2	Group 1
2	ADJOH Mawussi	Private organization outsourced by DGC	Level 1	
3	PAKOUN Léma	DGC	Level 2	Group 2
4	GUEGUE Diwèfé-Esso	Directorate General of Equipment	Level 1	
5	SODAGNI Yawo	Directorate General of Equipment	Level 2	Group 3
6	ADJATI Amèvi Agossi		Level 1	
7	AGBOFOATI Kudzo	Private organization outsourced by DGC	Level 1	Group 4
8	KPODZRO Kwami Valentin	DGC	Level 2	

4-2-3. Schedule and Contents of the Technology Transfer

The table below shows the schedule of the technology transfer in field identification.

Table 36 Schedule of the Technology Transfer in Field Identification

Term		Contents/Activity	Expected outcome
Southern Area August – October 2011	Week 1	Briefing and joint training in manipulation of equipment and field identification	Study of existing reference materials, standardization of the work procedures Safety control procedures
	Week 2	Preliminary survey Field training (Lomé)	Preliminary survey methods, interpretation of images and maps Manipulation of the equipment (handy GPS unit), method for the acquisition of ground photographs
	Week 3	Field identification (Atakpamé)	Method for storage of the results of identification Interview survey method Acquisition of efficient work procedures
	Week 4	Field identification (Atakpamé - Notsé)	
	Week 5	Field identification (Notsé)	
	Week 6	Field identification (Notsé - Lomé)	
	Week 7	Field identification (Lomé)	
	Week 8	Inspection and filing of the results of the field identification	Acquisition of the procedures for quality control and understanding of the importance of the quality control procedures
Northern Area January – February 2012	Week 1	Procurement of materials and equipment, travel, courtesy calls to security institutions and establishment of safety control system	Safety control procedures
	Week 2	Field identification (Dapaong)	Repeated exercises in manipulation of the handy GPS unit Repeated exercises in interpretation of images and topographic maps Repeated exercises in data acquisition
	Week 3	Field identification (Bassar)	
	Week 4	Field identification (Kara)	
	Week 5	Field identification (Sokodé, Atakpamé)	
	Week 6	Inspection and filing of the results of the field identification	Acquisition of the procedures for quality control and understanding of the importance of the quality control procedures

Figure 42 Technology Transfer in Field Identification (Top left: Preliminary survey, Top right: Manipulation of equipment, Bottom left: Interview survey, Bottom right: Filing of the results)

4-2-4. 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.

Table 37　Evaluation of the Results of the Technology Transfer in Field Identification

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future
Field identification	Preliminary work	Outline of the survey Explanation of the map symbols Methods to collect existing reference materials Interpretation of satellite images	The C/Ps have fully understood the outline of the survey, map symbols and existing maps and required documents.	Improvement in the capacity to interpret ALOS satellite images
	Field identification	Manipulation of the devices	The C/Ps have learned how to use the handy GPS units and GPS cameras and become able to use them effectively	Improvement in the capacity to manipulate the devices
		Recognition of objects interpreted on ALOS images in the field	C/Ps' achievement is to be re-evaluated during the field identification in the Northern Area.	Improvement in the capacity to interpret ALOS satellite images
	Filing of the identification results	Methods to file the survey results on printed maps and images	The C/Ps can file data in such a way that anyone can find easily	Improvement in the capacity to file survey results
		Preparation of result filing sheets	The C/Ps can file data in such a way that anyone can find easily	Improvement in the capacity to file survey results
		Filing of the data on printed maps	C/Ps' achievement is to be re-evaluated during the field identification in the Northern Area.	Improvement in the capacity to inspect data
		Creation of data of the result filing sheet	C/Ps' achievement is to be re-evaluated during the field identification in the Northern Area.	Improvement in the capacity to inspect created data

	A	B	C	D	E	F	G	H	I	J
1	Date	Numero d'equipe	Numero de feuille	No.	Designation	Code	Numero de GPS	Numero de photo	Numero de photo	Description
32	2011/9/13	1	NB31XX2c		Bridge	5201		4041	4043	Bridge
33	2011/9/13	1	NB31XX2c		Village			4045	4046	Mama-Kopé (village)
34	2011/9/13	1	NB31XX2c		Bridge	5201		4047	4048	Bridge
35	2011/9/13	1	NB31XX2c		Bridge	5201		4049	4051	Bridge over Bitoukpabè river
36	2011/9/13	1	NB31XX2c		Bridge	5201				Bridge
37	2011/9/13	1	NB31XX2c		Village			4052	4053	Nyawouta (village)
38	2011/9/13	1	NB31XX2c		Village			4054		Paris-Kopé (village)
39	2011/9/13	1	NB31XX2c		Village					Kékéwou (village)
40	2011/9/13	1	NB31XX2c		Market	3112		4055	4056	Kékéwou (market)
41	2011/9/13	1	NB31XX2c		School	3115		4057	4059	Public primary school of Afougbadjè
42	2011/9/13	1	NB31XX2c		Bridge	5201		4060		Bridge over Avégnivé river
43	2011/9/13	1	NB31XX2c		Bridge	5201		4061		Bridge over Ohoèga river
44	2011/9/13	1	NB31XX2c		Bridge	5201		4062		Bridge over Lihoué river
45	2011/9/13	1	NB31XX2c		Bridge	5201				Bridge
46	2011/9/13	1	NB31XX2c		Bridge	5201		4063		Bridge over Tokplala river
47	2011/9/13	1	NB31XX2c		Bridge	5201		4064	4066	Bridge over Sassa river
48	2011/9/13	1	NB31XX2c		Bridge	5201		4067	4068	Bridge over Sassa river
49	2011/9/13	1	NB31XX2c		Bridge	5201		4069		Bridge
50	2011/9/13	1	NB31XX2c		Bridge	5201		4072		Bridge
51	2011/9/13	1	NB31XX2c		Bridge	5201		4070	4071	Bridge over Sassa river
52	2011/9/13	1	NB31XX2c		Bridge	5201		4073	4074	Bridge over Danyi river

Figure 43　Data of the Results of Field Identification

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 38 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. Participants in the Technology Transfer

The ten people mentioned in the table below participated in the technology transfer in aerial triangulation. A questionnaire survey of the participants conducted before the technology transfer revealed that, while one of them had studied the theory of aerial triangulation abroad, none had ever used software for aerial triangulation. (See Appendix-7 for the results of the questionnaire survey.)

Table 39 Participants in the Technology Transfer

Name		Organization	Technical level	Notes
1	PAKOUN Léma	DGC	Level 2 (He attended a training course on the theory of aerial triangulation in Germany.)	Team 1
2	SODAGNI Yawo	Directorate General of Equipment	Level 2	
3	GUEGUE Diwèfé-Esso		Level 1	
4	AGBOFOATI Kudzo	Private organization outsourced by DGC	Level 1	
5	KPODZRO Kwami Valentin	DGC	Level 2	
6	HOUEDAKOR Anoumou Mario	DGC	Level 2	Team 2
7	ESTEVE Moudjibou	Directorate General of Equipment	Level 2	
8	ADJATI Amèvi Agossi		Level 1	
9	ADJOH Mawussi	Private organization outsourced by DGC	Level 2	
10	BESSEH Koffitsè	DGC	Level 2	

4-3-3. Schedule and Contents of the Technology Transfer

On the basis of the results of the questionnaire survey, the Study Team decided to place emphasis on the concept of aerial triangulation and basic manipulation of the software (LPS: Leica Photogrammetry Suite) in the technology transfer. The table below shows the schedule of the technology transfer.

In order to improve their knowledge of the theory of aerial triangulation and skill in software manipulation from basic level through repeated practice, “analog photographs,” “digital photographs” and “satellite images” were used in this order in the technology transfer. The amount of work was also increased gradually from “single course/single model” to “multiple courses/multiple models” during the technology transfer.

Table 40 Schedule of the Technology Transfer in Aerial Triangulation

Term		Contents/Activity	Expected outcome
First session July 2012	Week 1	Briefing with C/Ps on the schedule of the technology transfer Questionnaire survey, team formation and preparation of materials and equipment	Establishment of individual goals
	Week 2	Orientation on the technology transfer Theory of aerial triangulation Basic manipulation of the software Creation of projects	Understanding of the basic theory of aerial triangulation Understanding of the outline of the digital photogrammetry system Understanding of the outline of the software
	Week 3	Creation of camera files and interior orientation Lecture on coordinate systems Photo interpretation (extraction of an identical location from different photographs) Theory of tie point observation	Understanding of the characteristics of analog cameras Understanding of coordinate systems Understanding of the method for accurate measurement of control points and number and allocation of tie points
	Week 4	Theory of control point observation, adjustment calculation and tolerance Comprehensive practice	Understanding of the workflow of aerial triangulation Understanding of the adjustment calculation
Second session May – June 2013	Week 1	Review of the first session	Understanding of the workflow of aerial triangulation Understanding of the adjustment calculation
	Week 2	Block adjustment with analog aerial photographs	Setting of the orientation of images in the case of multiple course aerial triangulation Automatic interior orientation Automatic tie point observation
	Week 3	Aerial triangulation with digital aerial photographs Aerial triangulation with ALOS images	Understanding of the characteristics of digital cameras Understanding of the characteristics of ALOS satellite images
	Week 4	Creation of DEMs and orthophotos Evaluation of the results of the aerial triangulation Creation of the quality control table	Acquisition of the method for automatic digital terrain model creation Acquisition of the method for orthophoto creation


Figure 44　Technology Transfer in Aerial Triangulation (Left: Lecture on theory, Right: Practice)

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

The participants often forgot how to manipulate the equipment and software and became confused when the conditions were changed during the first session. However, they 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.

Table 41 Activities Implemented during the Technology Transfer in Aerial Triangulation and the Results and Evaluation of the Technology Transfer

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future	Item
Basics of photogrammetric systems	Basic manipulation of the digital photogrammetric system	Project formulation Setting of various conditions (camera files and coordinate systems) Import of imagery data, control point data, etc. Creation of pyramid files Interior orientation	Implementation of a test Qualitative evaluation by members of the Study Team	Appendix 9-1	Deeper understanding of configurations of images and coordinate systems which have high potential for future use
	Basic methods of processing satellite imagery data	Search, selection and representation of the images Establishment of an appropriate condition for screen display Correction of tone and brightness of images	Implementation of a test Qualitative evaluation by members of the Study Team	Appendix 9-2	Search for a representation method suitable for the observation
Aerial triangulation	Basic manipulation of the software for aerial triangulation	Understanding of the theory of pass points/control points	Qualitative evaluation by members of the Study Team	Appendix 9-3	Acquisition of the understanding of efficient work with a shape of blocks and allocation of control points taken into consideration
		Pass point observation Observation using the description of control point details as reference	Qualitative evaluation by members of the Study Team	Appendix 9-3	Understanding of the advantages and disadvantages of the automatic processing
		Understanding of residuals and tolerances on pass points and control points Search for points with problematic observation results and correction of such results	Qualitative evaluation by members of the Study Team	Appendix 9-4	Institutionalization of strict enforcement of inspections at each stage
Filing of the results of the aerial triangulation	Filing and understanding of the results of the aerial triangulation	Understanding of the records of the results of the aerial triangulation created by the software Preparation of quality control tables using the results of the aerial triangulation	Evaluation of the quality control tables for completeness	Appendix 9-5	Institutionalization of the preparation of quality control tables and filing of the tables

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 42 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. Participants in the Technology Transfer

Ten DGC staff members participated in the technology transfer in digital plotting. In order to prepare an efficient plan for the technology transfer, the Study Team conducted a questionnaire survey of the participants mentioned in the table below. (See Appendix-7 for the results of the questionnaire survey.)

The results of the questionnaire survey (Appendix-7) revealed that, while a few participants had experience in working with CAD software used in drawing and compilation of vector data, as shown in the table below, none had experience in digital plotting including stereo plotting and head-up digitizing (two-dimensional digitizing).

The results also revealed that none had experience in manipulation of software for photogrammetry or interpretation of satellite images or black-and-white photographs.

Table 43 Participants in the Technology Transfer

Name		Organization	Technical level	Notes
1	PAKOUN Léma	DGC	Level 2 (with experience in using AutoCAD)	Team 1
2	SODAGNI Yawo	Directorate General of Equipment	Level 2 (with experience in using AutoCAD)	
3	GUEGUE Diwèfé-Esso		Level 1	
4	AGBOFOATI Kudzo	Private organization outsourced by DGC	Level 2	
5	KPODZRO Kwami Valentin	DGC	Level 2	
6	HOUEDAKOR Anoumou Mario	DGC	Level 2 (with experience in using AutoCAD)	Team 2
7	ESTEVE Moudjibou	Directorate General of Equipment	Level 2 (with experience in using AutoCAD)	
8	ADJATI Amèvi Agossi		Level 1	
9	ADJOH Mawussi	Private organization outsourced by DGC	Level 2 (with experience in using AutoCAD)	
10	BESSEH Koffitsè	DGC	Level 2	

4-4-3. Schedule and Contents of the Technology Transfer

The results of the questionnaire survey mentioned above led the Study Team to implement the technical transfer focused on basic matters required for plotting and basic manipulation of the software (LPS and MicroStation) and hardware. The table below shows the schedule of the technology transfer in digital plotting.

In order to familiarize the participants gradually with manipulation of the equipment, the focus of the technology transfer was placed on basic manipulation of the relevant software, including software for the acquisition of two-dimensional data from satellite images and existing topographic maps. In order to familiarize the participants with interpretation of images, the technology transfer began with relatively easy subjects such as stereo interpretation of color aerial photographs and gradually moved on to more difficult tasks.

Table 44 Schedule of the Technology Transfer in Digital Plotting

Term		Contents/Activity	Expected outcome
First session July 2012	Week 1	Briefing with C/Ps on the schedule of the technology transfer Questionnaire survey, team formation and preparation of materials and equipment	Establishment of individual goals
	Week 2	Basic manipulation of the digital plotter and associated software Practice in stereoscopic viewing (moving the cursor to the height of a subject) Interpretation, acquisition of data and explanation of road layer codes	Understanding of the outline of the digital photogrammetry system Understanding of the outline of the software Acquisition of stereoscopic viewing skills
	Week 3	Interpretation, acquisition of data and explanation of layer codes of rivers, vegetation and contour lines	Understanding of the map symbols Understanding of the characteristics of features Interpretation of ALOS images
	Week 4	< Interpretation and acquisition of various types of data from ALOS images > Outline of data acquisition Interpretation and acquisition of data on roads, rivers and vegetation Interpretation and acquisition of data on contour lines	Repeated exercises in interpretation of ALOS images Understanding of the draw-data function of the software
Second session May – June 2013	Week 1 Week 2	< Interpretation and acquisition of various types of data from ALOS images > Outline of data acquisition Interpretation and acquisition of data on roads, rivers and vegetation Acquisition of spot elevations, interpretation and acquisition of data on contour lines	Repeated exercises in interpretation of ALOS images Understanding of the draw-data function of the software
	Week 3	Edge matching	Acquisition of data compilation techniques Acquisition of edge-matching techniques
	Week 4	Inspection and correction of the acquired data Preparation of the quality control table Partial correction	Acquisition of data inspection techniques Acquisition of data updating techniques

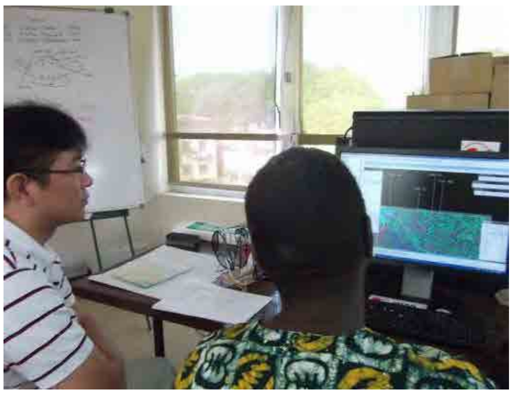


Figure 45 Technology Transfer in Digital Plotting (Left: Practice in contour lines, Right: Inspection and correction of data)

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

The member of the Study Team evaluated the technology transfer in digital plotting using a map (31B-XX-3a) on which the counterparts practiced digital plotting. One of the counterparts who was considered to have average capacity was selected for the evaluation described below. The results of the evaluation were compiled in the Evaluation Report on Technology Transfer (Appendix-10) in such a way that the progress made and problems to be solved in future were clearly described.

In the first session, the counterparts still had problems, *e.g.* inability to perform stereoscopic viewing for a long period of time and, in planimetric plotting, acquisition of data that were too large or too small to be represented on 1/50,000-scale topographic maps and inconsistency in accuracy of shapes, and problems in elevation plotting, *e.g.* inconsistency between spot elevations and contour lines and plotting of contour lines of tree-covered areas.

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.

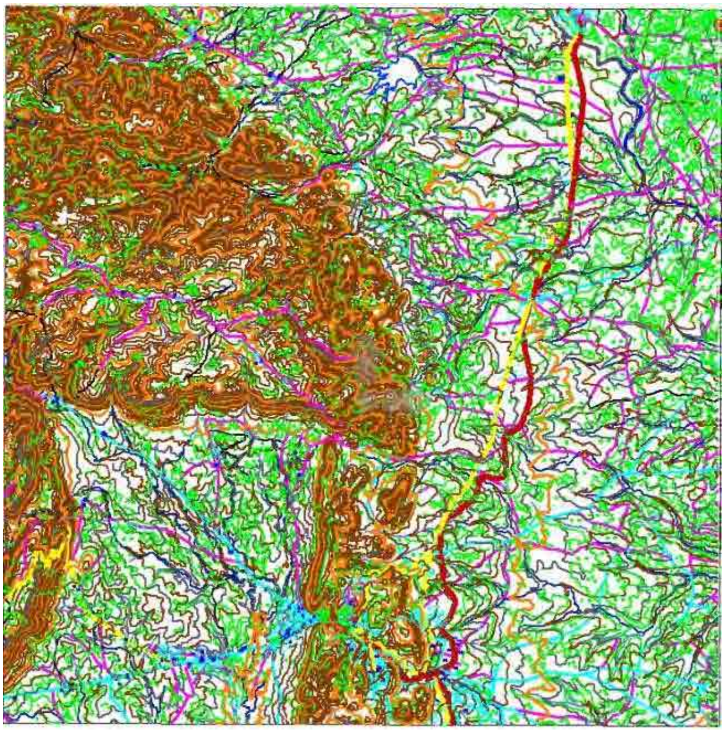


Figure 46 Output of Practice in Digital Plotting

Table 45 Evaluation of the Result of the Technology Transfer in Digital Plotting

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future	Item
Basics of the photogrammetric system	Basic manipulation of the digital photogrammetric system (for plotting)	Stereoscopic viewing of and introduction of heights to target features Understanding of the software Configuration with Pro600	Qualitative evaluation by members of the Study Team	Appendix 10-1	Some C/Ps become unable to perform stereoscopic viewing during continuous viewing work
	Basic manipulation of MicroStation	Manipulation for the code selection and drawing Manipulation of TopoMouse Transfer of plains and elevation	Qualitative evaluation by members of the Study Team	Appendix 10-2	Advanced use of the buttons on TopoMouse
Understanding of the map specifications	Understanding of map symbols	Understanding of the codes for major planimetric features Understanding of the data acquisition standards Data acquisition methods by code	Qualitative evaluation by members of the Study Team	Appendix 10-3	N/A
	Understanding of data acquisition methods for map at different scales	Shapes of linear objects on 1/50,000-scale topographic maps Understanding of the standards for the acquisition of size data Selection of buildings and other landmarks to be represented on the maps	Evaluation of the printed 1/50,000-scale topographic maps Qualitative evaluation by members of the Study Team	Appendix 10-4	Selection of features for representation on the 1/50,000-scale maps
Plotting	Understanding of the planimetric feature plotting	Understanding of the order of works in the plotting Acquisition of the data of planimetric features Verification of the data acquisition standards by feature	Scoring with the comparison with a model data	Appendix 10-5	Standardization of the road and vegetation data
	Understanding of the contour plotting	Contour plotting of bare land Understanding of how to represent shapes of ridges and valleys Acquisition of the data of spot heights Shapes and elevation of contour lines on the 1/50,000 topographic maps Contour plotting of areas covered with trees and other obstacles	Scoring with the comparison with a model data	Appendix 10-6	Contour plotting of areas covered with trees and other obstacles
	Data update	Updating plotting at a hypothetical location	Implementation of a test Qualitative evaluation by members of the Study Team	Appendix 10-7	N/A
Work Manual	Preparation of a Work Manual	Understanding of the basic issues required for the plotting Understanding of the details of filing corresponding to users	Scoring with the comparison with a model data	Appendix 10-8	Update of the manual when there is feedback that contributes to the improved efficiency of the subsequent processes

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 46 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. Participants in the Technology Transfer

The ten people listed in the table below participated in the field completion. All of them had participated in the field identification.

Table 47 Participants in the Technology Transfer

Name		Organization	Technical level	Notes
1	PAKOUN Léma	DGC	Level 2	Team 1
2	SODAGNI Yawo	Private organization outsourced by DGC	Level 2	
3	GUEGUE Diwèfé-Esso	Directorate General of Equipment	Level 1	
4	AGBOFOATI Kudzo		Level 1	
5	KPODZRO Kwami Valentin	DGC	Level 2	
6	HOUEDAKOR Anoumou Mario	DGC	Level 2	Team 2
7	ESTEVE Moudjibou	Directorate General of Equipment	Level 2	
8	ADJATI Amèvi Agossi		Level 1	
9	ADJOH Mawussi	Private organization outsourced by DGC	Level 1	
10	BESSEH Koffitsè	DGC	Level 2	

4-5-3. Schedule and Contents of the Technology Transfer

The table below shows the schedule of the technology transfer in field completion.

Table 48 Schedule of the Technology Transfer in Field Completion

Term		Contents/Activity	Expected outcome
Southern Area November – December 2012	Week 1	Safety briefing	Standardization of the work procedures Safety control procedures
	Week 2	Preparation of plans, sharing of responsibilities Field completion (Atakpamé)	Understanding of completion maps Review of the technology transfer in plotting
	Week 3	Field completion (Atakpamé - Notsé)	Acquisition of efficient work procedures
	Week 4	Field completion (Notsé)	
	Week 5	Field completion (Lomé)	
	Week 6	Inspection and filing of the results of field completion	Efficient filing method Acquisition and understanding of the importance of quality control procedures
Northern Area January – February 2013	Week 1	Safety briefing	Safety control procedures
	Week 2	Preparation of plans, sharing of responsibilities Field completion (Dapaong)	Acquisition of efficient work procedures
	Week 3	Field completion (Bassar)	
	Week 4	Field completion (Kara)	
	Week 5	Field completion (Sokodé, Atakpamé)	
	Week 6	Inspection and filing of the results of field completion	Efficient filing method Acquisition and understanding of the importance of quality control procedures

Figure 47 Field Completion (Left: Interview survey, Right: Filing of the results)

4-5-4. 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.

Table 49 Evaluation of the Results of the Technology Transfer in Field Completion

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future
Field Completion	Field Completion	Understanding of the details of the completion represented on the completion maps Identification of the objects of field completion based on interpretation of the completion maps	The participants acquired the capacity to conduct the activities by themselves more smoothly than at the time of field identification.	Feedback to plotting (Creation of completion maps which facilitate field completion in the field)
	Filing of survey results	Method for entry of the results on maps	The participants acquired the capacity to enter the results in a way comprehensible to everyone.	Improvement in the capacity to enter the results of the completion
		Preparation of the result filing sheet	The participants acquired the capacity to enter the results in a way comprehensible to everyone.	Improvement in the capacity to enter the results of the completion
		Method for entry of the results in map data	Although the participants were not able to carry out the work smoothly and they occasionally made errors during the field completion in the Southern Area, they acquired the capacity to carry out field completion by themselves during the field completion in the Northern Area.	Entry and filing of the inspected results
		Creation of data from the result filing sheet	Although the participants were not able to carry out the work smoothly and they occasionally made errors during the field completion in the Southern Area, they acquired the capacity to carry out field completion by themselves during the field completion in the Northern Area.	Feedback to the subsequent processes

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 50 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. Participants in the Technology Transfer

There were ten participants in the first session. In the second session, three persons from organizations other than DGC, two from the Directorate of State-owned and Cadastral Affairs and one from the Ministry of Urban Planning, in addition to the ten mentioned above, participated in the second session. The results of the questionnaire survey on digital compilation/map symbolization (Appendix-7) revealed that, while a few of the participants had experience in working with CAD software which was used in drawing and compilation of vector data, none had ever used the software procured by the Study Team for this Study.

Against this background and at the request of the participants, the team member in charge provided guidance focused on basic manipulation of the software in the technology transfer in digital compilation/digital compilation after field completion.

Because none of the participants had experience in using design software or in map symbolization itself, the team member in charge decided to give them a lecture on the theories including the theory of map adjustment before practice in basic manipulation of the software.

Table 51　Participants in the Technology Transfer

	Name	Organization	Technical level	Notes
1	PAKOUN Léma	DGC	Level 2 (with experience in using AutoCAD)	Team 1
2	SODAGNI Yawo	Private organization outsourced by DGC	Level 2 (with experience in using AutoCAD)	
3	GUEGUE Diwèfé-Esso	Directorate General of Equipment	Level 1	
4	AGBOFOATI Kudzo		Level 2	
5	KPODZRO Kwami Valentin	DGC	Level 2	
6	BOURAIMA Soumaila	Directorate of Territorial Affairs and Cadastre	Level 2 (with experience in using AutoCAD)	
7	Georges Laté LAWSON-BETUM		Level 2 (with experience in using AutoCAD)	
8	HOUEDAKOR Anoumou Mario	DGC	Level 2 (with experience in using AutoCAD)	Team 2
9	ESTEVE Moudjibou	Directorate General of Equipment	Level 2 (with experience in using AutoCAD)	
10	ADJATI Amèvi Agossi		Level 1	
11	ADJOH Mawussi	Private organization outsourced by DGC	Level 2 (with experience in using AutoCAD)	
12	BESSEH Koffitsè	DGC	Level 2 (with experience in training in Japan)	
13	FAGBEDJI John	Ministry of Urban Planning	Level 1 (with experience in using AutoCAD)	

4-6-3.　Schedule and Contents of the Technology Transfer

The focus of the first session was on digital compilation and digital compilation after field completion. For the purpose of increasing the knowledge of the participants by adding knowledge of the compilation function MicroStation through correction of data shapes to basic knowledge of the draw function, the main tool used in digital plotting, the training began with compilation of the data acquired in digital plotting.

This training was then followed by a lecture on the correct point, line and plane structures required in map symbolization and data structurization, and then by training in the compilation of each type of data (*e.g.* sorting of each type of data by attribute, correction and determination of data errors, and creation of polygon topology).

In the second session, the focus of the technology transfer was on digital compilation and map symbolization.　The OJT area was used as the object of the technology transfer.　The team member in charge first of all evaluated the level of the participants' understanding of the lecture contents in the first session so that he could provide them with training focused on the subjects which they had not understood sufficiently. Then, he carried out the work from digital compilation to creation of GIS data/data for symbolization to make the counterparts aware that a data source which could be used in GIS and symbolization could not be created unless the digital compilation had been performed appropriately.

The team member in charge provided the participants with instruction in how to create final CAD data by importing the results of the field completion into the CAD data by source of data and reference system and re-compiling the data where necessary. With regard to the interpolation and conversion required when data acquired in different geographic coordinate systems were used, he taught them how to define the plane rectangular coordinate system to be used for the creation of large-scale maps which were to be used in urban planning.

In the technology transfer in map symbolization, training in symbolization using Illustrator was provided. The team member gave a lecture including an explanation of the map specifications to be used before the symbolization and the fact that each symbol was handed down from the preceding stage and that map data for plotter outputs and offset printing were created in this symbolization process.

In the actual training, the participants first developed an overall image of the map and, later, practiced automation as a means of reducing the load of repetitive work. In order to prevent representation such as overlapping and overcrowding of symbols and inconsistent texture and to realize appropriate topographic map representation, they translocated and generalized symbols in accordance with the concept of map adjustment.

Table 52 Schedule of the Technology Transfer in Digital Compilation/Digital Compilation after Field Compilation/Map Symbolization

Term		Contents/Activity	Expected outcome
First Session July – August 2012	Week 1	< Basic manipulation of MicroStation > How to use mouse Function to modify shapes of features On classes of features (point, line, smartline, shape and text) Reference files Creation of hatching, text and polygon elements	Acquisition of basic manipulation of the software
	Week 2	Attribute data, method to change attribute and sorting of data by attribute selection Layer manipulation, reference data (vector and raster data) Data conversion (batch processing, DWG files)	
	Week 3	Initial configuration of files < Data cleaning > Types of data cleaning functions Detection and types of errors Points to be noted in error detection using tolerances Practice on the manipulation of the software for the correction of data cleaning errors	Acquisition of data cleaning techniques
	Week 4	< Polygon topology > Practice of the manipulation of the software for the correction of polygon topology errors Creation of polygon topologies with Bentley Map/Creation and creation of polygons Joint practice of Team A and Team B Method to create polygons by importing polygon topologies into ArcGIS	Acquisition of polygon creation techniques

Term		Contents/Activity	Expected outcome
Second Session, June – July 2013	Week 1	< Review of the first session/GIS data creation with practice > Data cleaning for re-compilation of the OJT data into data compatible with GIS data (point, line, polygon and text data) (including basic manipulation of MicroStation)	Acquisition of techniques to correct complex data Recognition of processes essential for the creation of GIS data
	Week 2	Creation of polygon topology from the OJT data, integration and sorting of various data, correction of three-dimensional data (including basic manipulation of Bentley Map), correction of contour line data, conversion of geographic coordinates	Acquisition of techniques to correct complex data, recognition of processes essential for the creation of GIS data, correction of inappropriate contour line elevations, acquisition of coordinate conversion techniques
	Week 3	< Basic manipulation of Illustrator > Importance of map symbols and specifications, structure of map symbols and manipulation of layers, smoothing of line symbols, application of point symbols, application of “filling and lines” to polygons	Acquisition of procedures for symbolization from independent skeleton data to interlinked map data
	Week 4	Types of polygon symbols and methods for their representation, manipulation and processing of overlaps and translocation, inspection and correction of outputs	Acquisition of techniques for translocation and generalization of data in accordance with the concept of map adjustment
	Week 5	Preparation of the quality control table through the inspection/correction process	Acquisition of techniques for the preparation of the quality control table

Figure 48 Digital Compilation and Map Symbolization (Left: Practice in digital compilation, right: Lecture on map symbolization)

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

One of the participants in the technology transfer who was considered to have average capacity was selected for the evaluation. The results of the evaluation were compiled in the Evaluation Report on Technology Transfer (Appendix-11) to clarify the progress and problems to be solved in future.

In the first session, although the participants fully understood the concept of digital compilation and basic manipulation of the software, they had some difficulty in combining the commands in the compilation, setting the tolerance for the detection of logical errors and creating polygons where various elements co-existed.

They were able to overcome the problems that remained unsolved after the first session through repeated exercises in the OJT in the second session.

Since different tolerance values for the detection of logical errors and different procedures for the selection of data have to be used for the creation of data of different specifications and scales, the Study Team recommends that the counterparts should continue repeated self-exercises with different conditions. If there is feedback from the subsequent stages of symbolization and structurization which would lead to improvement in the efficiency of data creation in these stages, such feedback should be incorporated in the digital compilation and the manual should be revised accordingly.

The team considers that DGC will have to carry out calculation of the coordinates in the existing data required by the conversion of datum from that based on Clarke 1880 ellipsoid to ITRF and establish zones of plane rectangular coordinate systems for the development of large-scale topographic maps required for detailed urban planning.

Table 53 Evaluation of the Results of Technology Transfer in Digital Compilation/Digital Compilation after Field Completion

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future	Item
Basics of digital compilation	Basic manipulation of the CAD software	Understanding of the manipulation of MicroStation required for digital compilation Practice aiming at accurate and efficient performance of digital compilation	Qualitative evaluation by members of the Study Team	Appendix 11-1	N/A
Data Cleaning	Understanding and implementation of data cleaning	Outline of data cleaning Understanding of the features for data cleaning Understanding of the types of errors created by data cleaning and methods to correct them	Qualitative evaluation by members of the Study Team	Appendix 11-2	Continuation of repeated exercises with data on map areas other than that used in OJT
	Understanding and implementation of polygon creation	Understanding of the method to create polygons Understanding of the types of errors created during the creation of polygons and the method to correct them	Qualitative evaluation by members of the Study Team	Appendix 11-3	Continuation of repeated exercises with data on map areas other than that used in OJT
Basics of the digital compilation after field completion	Import of the results of field identification/ completion	Understanding of the contents of the results of field identification/completion Search for the locations for the completion Practice of the completion	Qualitative evaluation by members of the Study Team	Appendix 11-4	N/A
Application of digital compilation and digital compilation after field completion	Data update	Updating plotting at a hypothetical location	Implementation of a test Qualitative evaluation by members of the Study Team	Appendix 11-5	N/A

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future	Item
Work Manual	Preparation of a Work Manual	Understanding of the basic issues required for the plotting Understanding of the details of filing corresponding to users	Scoring with the comparison with a model data	Appendix 11-6	Update of the manual if there is feedback contributing to improvement of the efficiency of the subsequent processes

The Study Team evaluated the technology transfer in map symbolization as described in the table below. The results of the evaluation were compiled in the Evaluation Report on Technology Transfer (Appendix-12) to clarify the progress and problems to be solved. Since different judgment criteria are used for the adjustment of maps of different scales and for different uses, the criteria should be standardized among symbolization operators prior to symbolization. Therefore, DGC will have to prepare specifications including all the criteria and familiarize symbolization operators with the specifications.

Table 54 Evaluation of the Results of the Technology Transfer in Map Symbolization

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future	Item
Introduction to the theory of map symbolization	Understanding of map adjustment	Understanding of the creation of final outputs through map adjustment Understanding of the meaning of various types of marginal information and the method of its creation Creation of marginal information	Qualitative evaluation by members of the Study Team	Appendix 12-1	Identification of items which require data update, such as the magnetic north indicator
	Understanding of different symbolization procedures for maps of different scales	Understanding of the details and types of map symbols Understanding of the design and placement of symbols (point data) Understanding of thicknesses, colors and styles of lines Understanding of planimetric patterns	Qualitative evaluation by members of the Study Team	Appendix 12-2	Application of different symbolization procedures for different scales to other software
Software for map symbolization	Basic manipulation of the software for symbolization	Creation of designs of symbols (points) Creation of thicknesses, colors and styles of lines Creation of planimetric patterns Symbolization appropriate for 1/50,000-scale printout maps	Qualitative evaluation by members of the Study Team	Appendix 12-3	Feedback to preceding processes
Advanced map symbolization	Data update	Plotting for data update of an assigned area	Qualitative evaluation by members of the Study Team	Appendix 12-4	Self-practice in data update of features other than roads and vegetation
Work manual	Preparation of a work manual	Understanding of essential matters Understanding of the need to organize the contents for users with different intentions	Scoring with the comparison with a model data	Appendix 12-5	Revision of the manual as the need arises

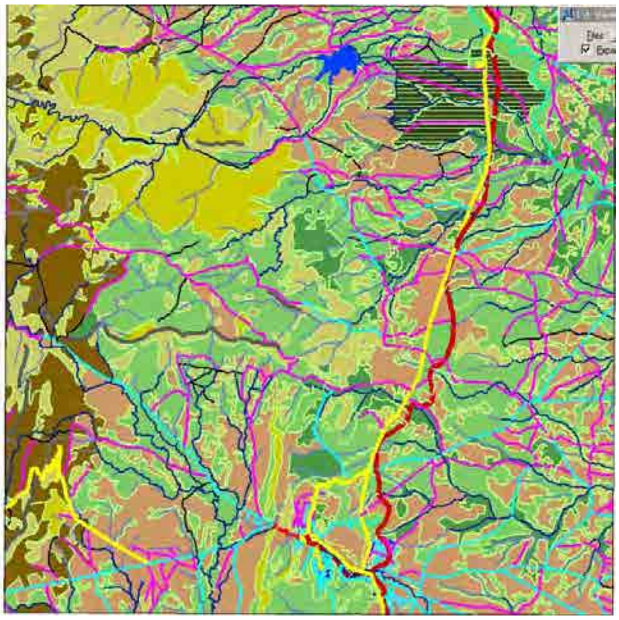


Figure 49 Results of Digital Compilation (excluding contour lines) of the OJT Area by the Staff Members of DGC

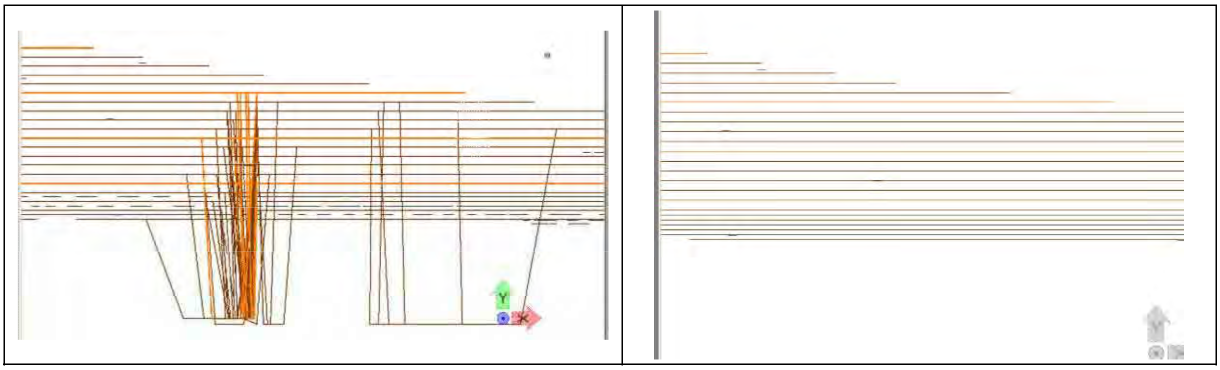


Figure 50 Results of Digital Compilation (contour lines) of the OJT Area by the Staff Members of DGC

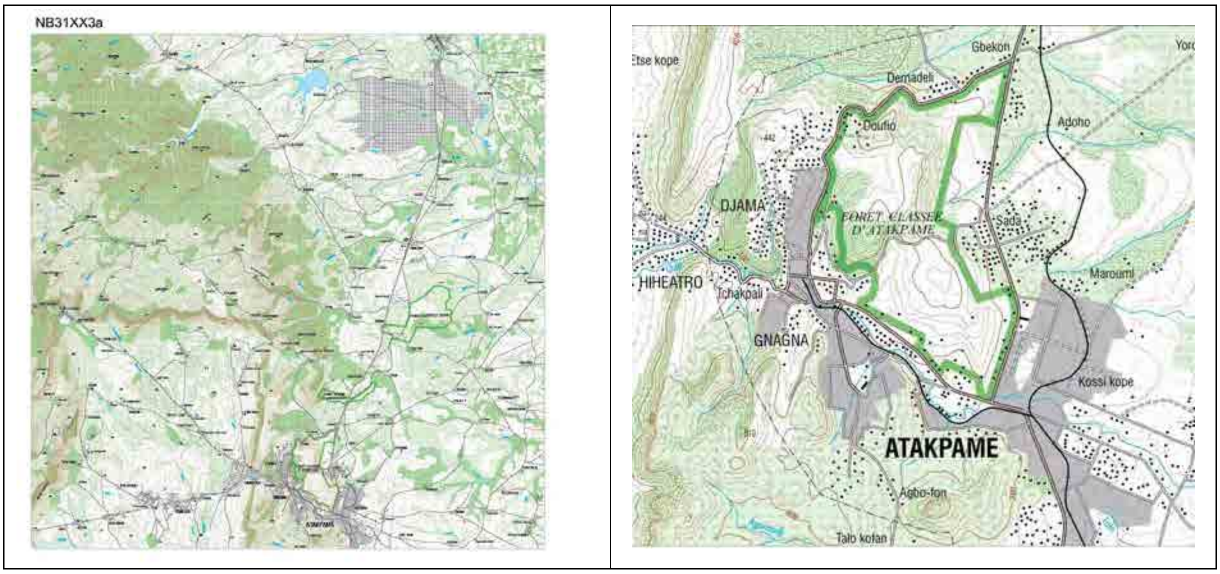


Figure 51 Results of Map Symbolization in the OJT Area by the Staff Members of DGC

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 55 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. Participants in the Technology Transfer

The 13 people listed in the table below participated in the technology transfer in data structurization. The results of the questionnaire survey on "Data structurization" (Appendix-7) revealed that none of them had any experience in using the software to be used in this technology transfer and little idea about the concept of structurization or GIS. Therefore, the Study Team member in charge decided to put emphasis on basic manipulation of the software in the training.

Table 56 Participants in the Technology Transfer

	Name	Organization	Technical level	Notes
1	PAKOUN Léma	DGC	Level 2	Team 1
2	SODAGNI Yawo	Private organization outsourced by DGC	Level 2	
3	GUEGUE Diwèfé-Esso	Directorate General of Equipment	Level 1	
4	AGBOFOATI Kudzo		Level 1	
5	KPODZRO Kwami Valentin	DGC	Level 2	
6	BOURAIMA Soumaila	Directorate of Territorial Affairs and Cadastre	Level 2	
7	Georges Laté LAWSON-BETUM		Level 2	
8	HOUEDAKOR Anoumou Mario	DGC	Level 2	Team 2
9	ESTEVE Moudjibou	Directorate General of Equipment	Level 2	
10	ADJATI Amèvi Agossi		Level 1	
11	ADJOH Mawussi	Private organization outsourced by DGC	Level 1	
12	BESSEH Koffitsè	DGC	Level 2 (with experience in training in Japan)	
13	FAGBEDJI John	Ministry of Urban Planning	Level 2	

4-7-3. Schedule and Contents of the Technology Transfer

Since the training had to begin from basic manipulation of ArcGIS as mentioned above, the first session of the technology transfer began with basic processes such as launch of the software and setting of the display. The subjects in the first session included launch of the software, creation, drawing and addition of attributes to shape data and changes in display method.

In the second session, the technology transfer in data analysis, map representation and three-dimensional bird's-eye view representation with ArcGIS was implemented following a review of the first session. Technology transfer in data conversion with ArcGIS as a procedure for the creation of structured data from digitally compiled data was also implemented.

Table 57 Schedule of the Technology Transfer in Data Structurization

Term		Contents/Activity	Expected outcome
First Session July – August 2012	Week 1	Starting-up of and data import to ArcGIS Change in the configurations of data representation (symbol configurations) Representation of data attributes (color, symbol size, line width and texts)	Basic manipulation of ArcGIS Manipulation for the representation of data
	Week 2	Creation of new line, point and polygon data Designation of coordinate systems to new and existing data Creation of the river centerline data Creation of polygon data on city areas Creation of point data from the polygon data	Manipulation for data creation and drawing Manipulation for the establishment of a coordinate system
	Week 3	Selection of graphic representations by attribute value Spatial search of existing data with the polygon data	Search manipulation
	Week 4	Lecture and practice on the BUFFER analysis and verification of the results of the practice Lecture and practice on CLIP, INTERSECT, UNION, etc. with the polygon data created in the practice and existing data and verification of the results of the practice	Manipulation for basic data analysis
Second Session, June – July 2013	Week 1	Review of the first session	Manipulation of the software
	Week 2	Compilation of attributes, analysis of line data Analysis of polygon data, visualization of the analysis results Creation of graphs	Analysis procedures and manipulation Manipulation for visualization
	Week 3	Display of map representation, creation of legend Creation of three-dimensional models, three-dimensional representation of orthophotos	Procedures for map representation Procedures for three-dimensional representation
	Week 4	Explanation of the outline of the creation of structured data Creation of line data, entry and compilation of attributes Creation of polygon data	Creation of structured data
	Week 5	Creation of point data Creation of annotation data Procedures for quality control and partial correction	Creation of structured data Quality control of structured data

Figure 52　Data Structurization (Left: Data analysis, Right: Creation of structured data)

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

The member of the Study Team evaluated the technology transfer in digital structurization using a map on which the counterparts had conducted digital plotting after field completion, as described in the table below. One of the participants in the technology transfer who was considered to have average capacity was selected for the evaluation. The results of the evaluation were compiled in the Evaluation Report on Technology Transfer (Appendix-13) to clarify the progress made and problems to be solved.

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.

Table 58 Evaluation of the Results of the Technology Transfer in Data Structurization

Item	Work	Transferred Technology	Evaluation Method	Expectations toward DGC in Future	Item
Basis for the theory of data structurization	Understanding of GIS (understanding of the standard data structure)	Understanding of the outline of GIS Understanding of the outline of the GIS analysis Understanding of the structures of point data, line data, polygon data, etc.	Qualitative evaluation by members of the Study Team	Appendix 13-1	Preparation of an original work manual and workflow
GIS	Basic manipulation of the GIS software	Creation of shape files Addition of attributes to the shape files Understanding of the types of attributes and data types Definition and change of map symbols	Qualitative evaluation by members of the Study Team	Appendix 13-2	Utilization of the outcome of this training in the creation of various GIS sample models
	Recommendation for the use for GIS data	Theme setting Data creation with applied use of the transferred technologies Visualization of the analysis results	Qualitative evaluation by members of the Study Team	Appendix 13-3	Creation of various GIS models applicable to various purposes on the basis of the data developed in this Project
Creation of structured data	Conversion to SHP data and data compilation	Conversion from CAD data to SHP data Compilation of SHP data Compilation of attribute data	Implementation of a test Qualitative evaluation by members of the Study Team	Appendix 13-4	Self-practice with map areas other than those used in the technology transfer
Quality control	Preparation of the quality control table	Logical inspection Visual inspection Preparation of the quality control table	Scoring with the comparison with a model data	Appendix 13-5	Maintenance and improvement of the quality of the created 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 59 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	Procedures for preparation of the inspection lists
	After completion of leveling	Verification of the observation results	
	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

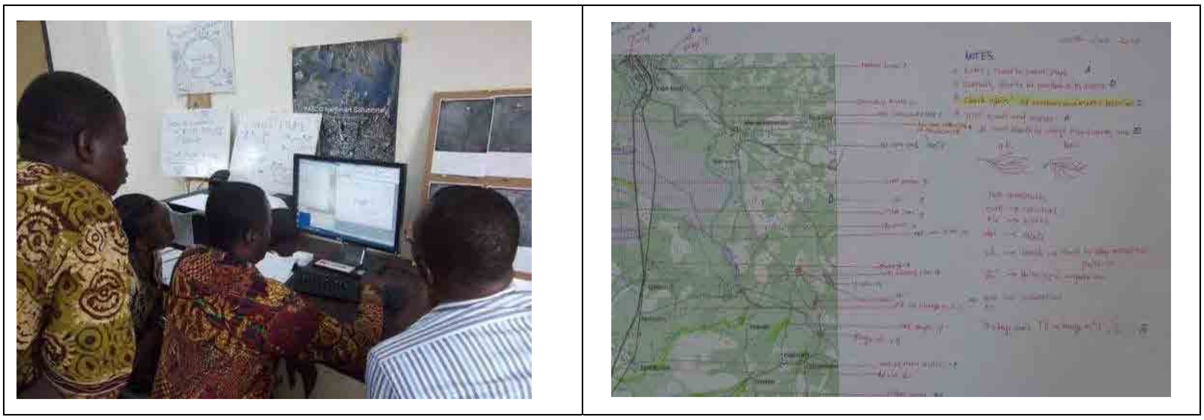


Figure 53 Technology Transfer in Quality Control (Left: Preparation of quality control table of the results of aerial triangulation, Right: Symbolization composition chart)

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.

Table 60 Evaluation of the Results of the Technology Transfer in Quality Control

Stage	Contents/activity	Evaluation method	Result of evaluation	Problems
Control point survey	Inspection of equipment	Can the participants inspect the equipment and its quantity in accordance with the list? (Qualitative evaluation by the Study Team member in charge)	The participants were able to inspect the equipment correctly.	N/A
	GPS observation GPS analysis	Can the participants inspect the calculation results, detect errors and correct them? (Evaluation of the quality control table)	The participants were able to prepare the quality control table (Appendix 14-1).	N/A
	Leveling	Can the participants inspect the calculation results, detect errors and correct them? (Evaluation of the quality control table)	The participants were able to prepare the quality control table (Appendix 14-2).	N/A
Aerial triangulation	GCP and tie point observation	Can the participants perform visual inspection after the observation？(Qualitative evaluation by the Study Team member in charge)	The participants were able to perform visual inspection after every observation.	N/A
	Adjustment calculation	Can the participants inspect the calculation results, detect errors and correct them? (Evaluation of the quality control table)	The participants were able to prepare the quality control table (Appendix 14-3).	Area division to facilitate quality control when a huge number of photographs are used.
Field identification/Field completion	Inspection of preliminary survey maps	Can the participants perform visual inspection, detect erroneous data and correct them? (Evaluation of completeness)	The participants were able to prepare corrected documents.	N/A
	Inspection of the results of identification/completion	Can the participants perform visual inspection, detect erroneous data and correct them? (Evaluation of completeness, positional accuracy and thematic accuracy).	The participants were able to prepare corrected documents.	N/A
Digital plotting	Inspection of planimetric features Inspection of contour lines	Can the participants perform the inspection by manipulating the software or on output maps and detect and correct erroneous data? (Evaluation of completeness using the quality control table, positional accuracy appropriate for map scales and thematic accuracy of attributes, etc.)	The participants were able to prepare the quality control table (Appendix 14-4).	Standardization of outputs among operators
Digital compilation Digital compilation after field completion	Edge matching between maps	Can the participants perform the inspection of output maps and detect and correct erroneous data? (Evaluation of completeness with the quality control table)	The participants were able to prepare the quality control table (Appendix 14-5).	N/A
	Inspection and correction of logical errors Topology check	Can the participants perform the inspection of output maps and detect and correct erroneous data? (Evaluation of logical consistency with the quality control table.)		Improvement in work efficiency with a large amount of data in a large number of types
Map symbolization	Inspection of data conversion (CAD → Illustrator)	Can the participants perform the inspection by manipulating the software and confirm the successful data conversion? (Evaluation of completeness)	The participants were able to convert data without making errors.	N/A
	Inspection of the output maps (1/50,000) of symbolized data	Can the participants perform the inspection of output maps and detect and correct erroneous data? (Evaluation of the quality control table)	The participants were able to prepare the quality control table (Appendix 14-6).	Standardization of outputs among operators
Digital data structurization	Inspection of data conversion (CAD → Illustrator)	Can the participants perform the inspection by manipulating the software and confirm the successful data conversion? (Evaluation of completeness)	The participants were able to convert data without making errors.	N/A
	Inspection of attributes	Can the participants perform the inspection of output maps and detect and correct erroneous data? (Evaluation of thematic accuracy)	The participants were able to convert data without making errors.	N/A

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 61 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 62 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

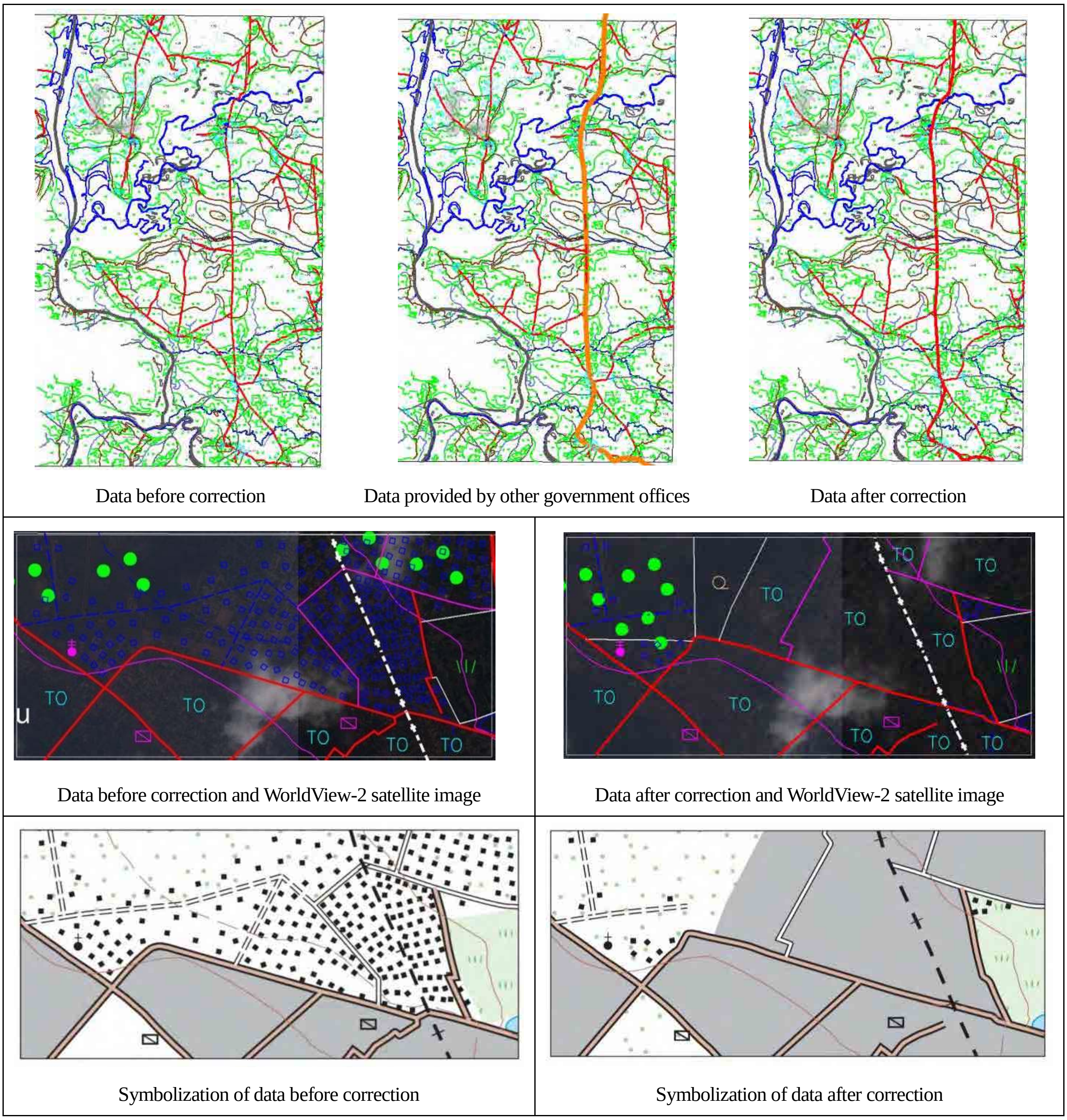


Figure 54 Partially Corrected Data (Top: Roads and bridge, Bottom: Road, high-density residential area and vegetation)


Figure 55 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.

Table 63 Evaluation of the Results of the Technology Transfer in Partial Correction

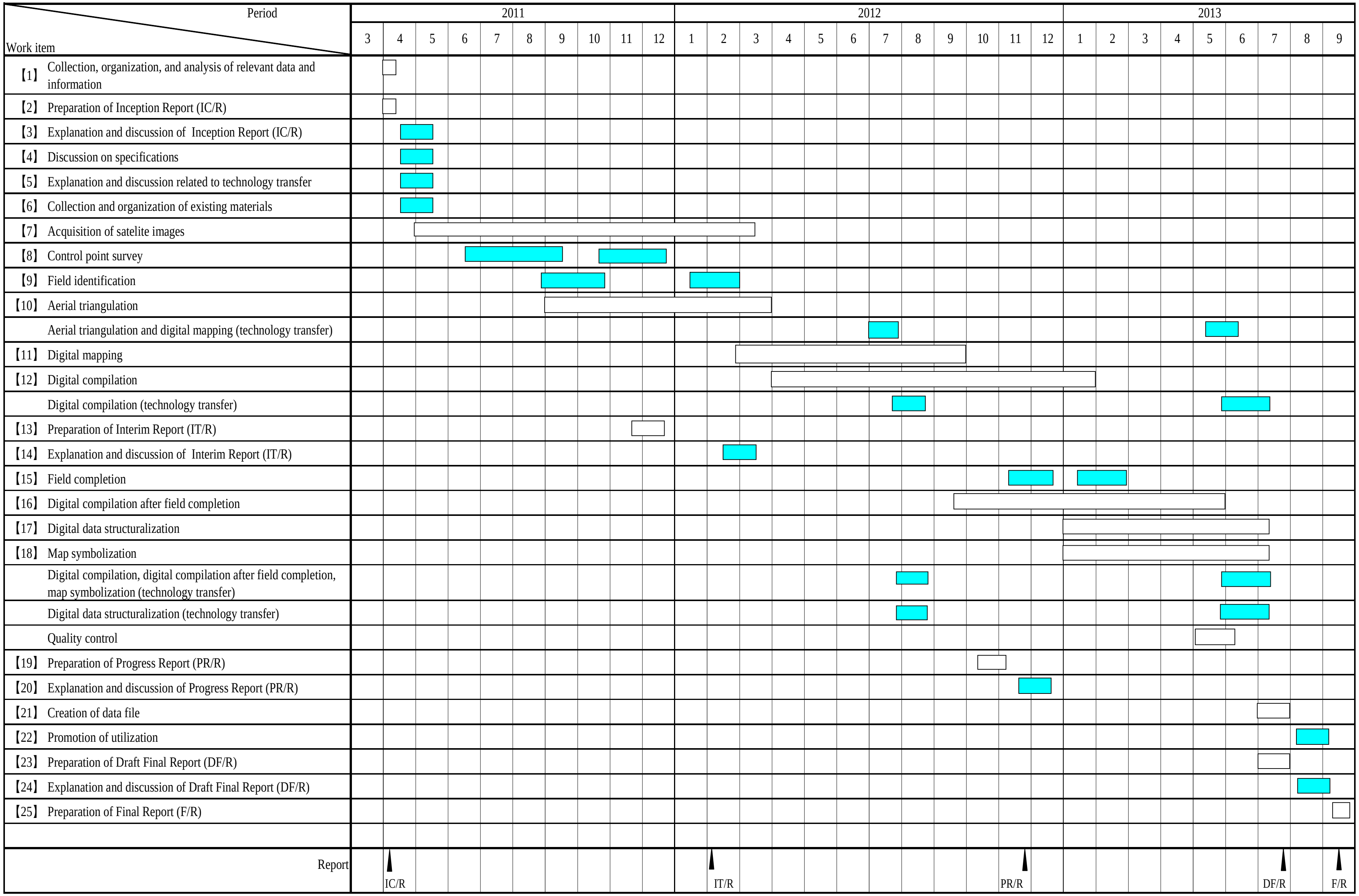
Stage	Activities	Evaluation method	Evaluation results	Problems
Digital plotting	Detection of areas requiring data correction by cause and scale of change over time	Visual inspection of the areas corrected by DGC staff members by the Study Team member	The participants were able to implement the work with an understanding of the scale of the areas affected by change over time.	Detection of areas with changes over time in the case of changes in topography
	Data update	Visual inspection by the Study Team member	The participants were able to select appropriate feature codes and implemented the work smoothly.	N/A
	Edge matching with the surrounding area	Inspection for completeness	The participants were able to match all the corrected line data.	N/A
Digital compilation Digital compilation after field completion	Data cleaning appropriate for the area requiring update	Inspection for completeness	The participants were able to correct all logical errors.	N/A
	Generalization of polygons	Visual inspection by the Study Team member	The participants were able to select polygons which had to be generalized and generalize them.	N/A
Map symbolization	Conversion of the data on the corrected area	Inspection for completeness	The participants were able to convert data without errors.	N/A
	Edge-matching with the surrounding area	Inspection for completeness	The participants were able to match all corrected line and polygon data.	N/A
Digital data structurization	Conversion of the data on the corrected area	Inspection for completeness	The participants were able to convert data without errors.	N/A
	Edge-matching with the surrounding area	Inspection for completeness	The participants were able to match all corrected line and polygon data.	N/A

Chapter 5 Work Process Schedule and Personnel Plan

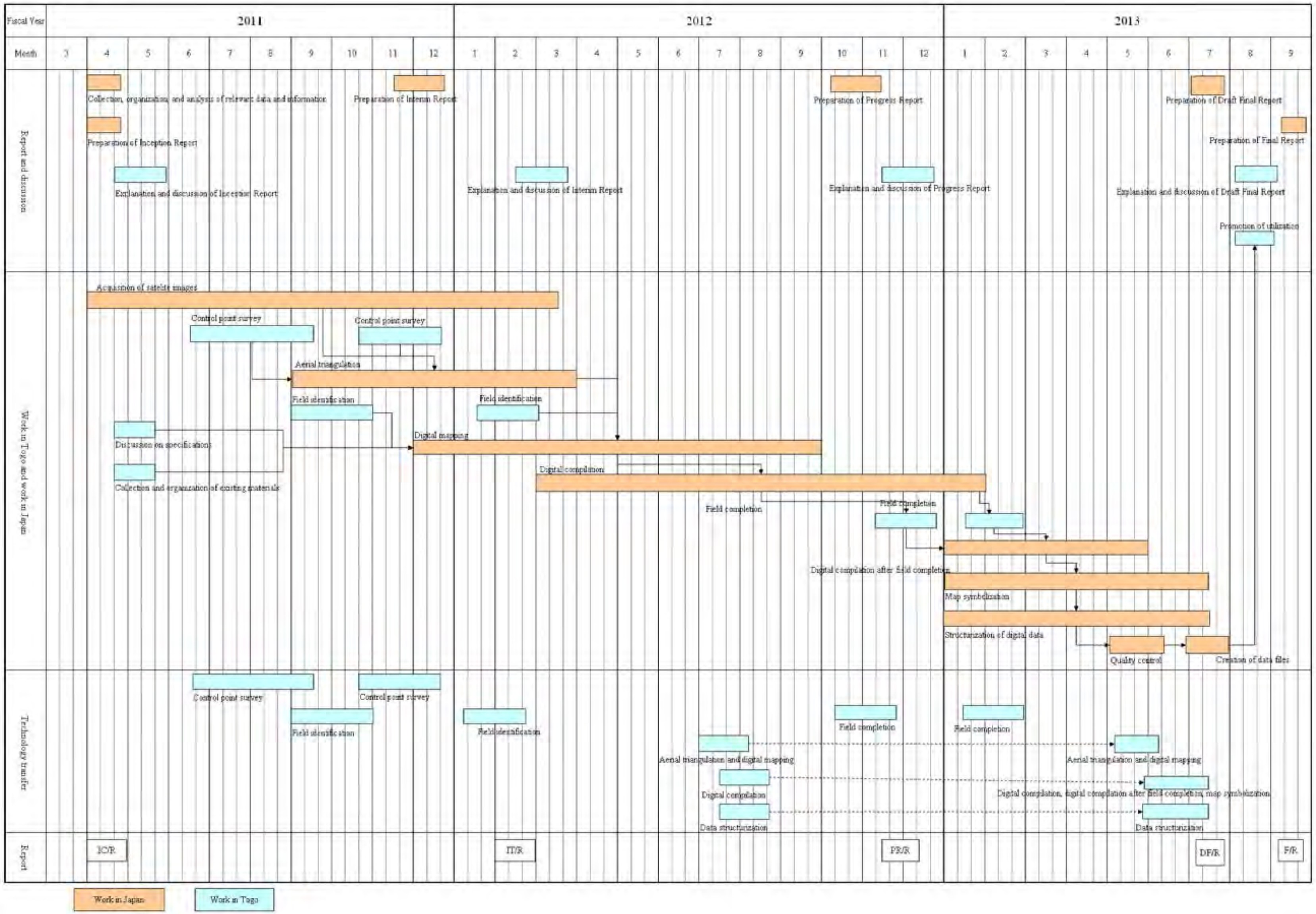
5-1. Work Process Schedule and Work Flowchart

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
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
Report and discussion
Collection, organization, and analysis of relevant data and information
Preparation of Interim Report
Preparation of Progress Report
Preparation of Draft Final Report
Preparation of Inception Report
Preparation of Final Report
Explanation and discussion of Inception Report
Explanation and discussion of Interim Report
Explanation and discussion of Progress Report
Explanation and discussion of Draft Final Report
Promotion of utilization
Work in Togo and work in Japan
Acquisition of satellite images
Control point survey
Control point survey
Aerial triangulation
Field identification
Field identification
Discussion on specification
Digital mapping
Collection and organization of existing materials
Digital compilation
Field completion
Field completion
Digital compilation after field completion
Map symbolization
Structuralization of digital data
Quality control
Creation of data files
Technology transfer
Control point survey
Control point survey
Field identification
Field identification
Field completion
Field completion
Aerial triangulation and digital mapping
Aerial triangulation and digital mapping
Digital compilation
Digital compilation, digital compilation after field completion, map symbolization
Data structurization
Data structurization
Report
IC/R
IT/R
PR/R
DF/R
F/R
Work in Japan
Work in Togo

5-2. Personnel Plan

The personnel plan is as follows:

	Operation	Name	Organization	Rating	2011												2012												2013									Total	
					1	2	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	Togo	Japan
Work in Togo	Study Team Leader / Discussion on specifications	Akira SUZUKI	PASCO CORPORATION	2				30							15				31									28								30		4.47	
Work in Togo	Control point survey 1	Nobuhiro SATA	PASCO CORPORATION (DMS)	3							89				60																							4.97	
Work in Togo	Control point survey 2	Ken TAKANASHI	AERO ASAHI CORPORATION	4							89				60																							4.97	
Work in Togo	Field identification / field completion 1	Masakuni NAKAYAMA	PASCO CORPORATION	3									59																									1.97	
Work in Togo	Field identification / field completion 1	Nobuhiro SATA	PASCO CORPORATION (DMS)	3																							44											1.47	
Work in Togo	Field identification / field completion 2	Ryusuke NAKATANI	PASCO CORPORATION	4									59														44											3.43	
Work in Togo	Field identification / field completion 1 (In charge of Northern Area)	Nobuhiro SATA	PASCO CORPORATION (DMS)	3													47													43								3.00	
Work in Togo	Field identification / field completion 2 (In charge of Northern Area)	Hidemi IZUTSU	PASCO CORPORATION	4													47																					1.57	
Work in Togo	Field identification / field completion 2 (In charge of Northern Area)	Ryusuke NAKATANI	PASCO CORPORATION	4																										43								1.43	
Work in Togo	Aerial triangulation	Akira OTA	PASCO CORPORATION	4																			29										30					1.97	
Work in Togo	Digital mapping	Takashi KOGURE	PASCO CORPORATION	4																			29										30					1.97	
Work in Togo	Digital compilation / Map symbolization / Digital compilation after field completion	Takashi SHIMONO	PASCO CORPORATION (DMS)	4																			30											43				2.43	
Work in Togo	Data structuralization	Kenichi ARAI	PASCO CORPORATION	4																			30															1.00	
Work in Togo	Data structuralization	Ryusuke NAKATANI	PASCO CORPORATION	4																														43				1.43	
Work in Togo	Interpreter	Takashi SHIRANI	PASCO CORPORATION (TECHNO STAFF)	4				28							13				29																	28		(3.27)	
Work in Togo	Interpreter	Tomoyuki OTANI	PASCO CORPORATION (TECHNO STAFF)	4																								23										(0.77)	
Work in Togo	Project coordinator / Assistant in digital mapping	Akira OTA	PASCO CORPORATION	4				30		28			20						24									23								30		5.17	
Work in Togo	Subtotal for work in Togo																																					41.23	
Work in Japan	Study Team Leader/Discussion on specifications	Akira SUZUKI	PASCO CORPORATION	2				15								15											5								15		9		1.97
Work in Japan	Control point survey 1	****	***	3					9																														0.30
Work in Japan	Field identification / field completion 1	****	***	3									9																										0.30
Work in Japan																																							0.00
Work in Japan	Subtotal for work in Japan																																						2.57
Report	Submission schedule (Indicated with a triangle and a report name)							△ IC/R										△ IT/R									△ PR/R								△ DF/R		△ F/R		
Report	Work in Japan (Total man-months)																																						