

**Republic of Senegal
National Agency for Territory Planning (ANAT)**

**The Study on the Digital Topographic
Mapping Project
for
Northern Senegal**

Final Report

Summary

March 2013

Japan International Cooperation Agency (JICA)

**Aero Asahi Corporation
Asia Air Survey Co., Ltd.**

EI
JR
13-113

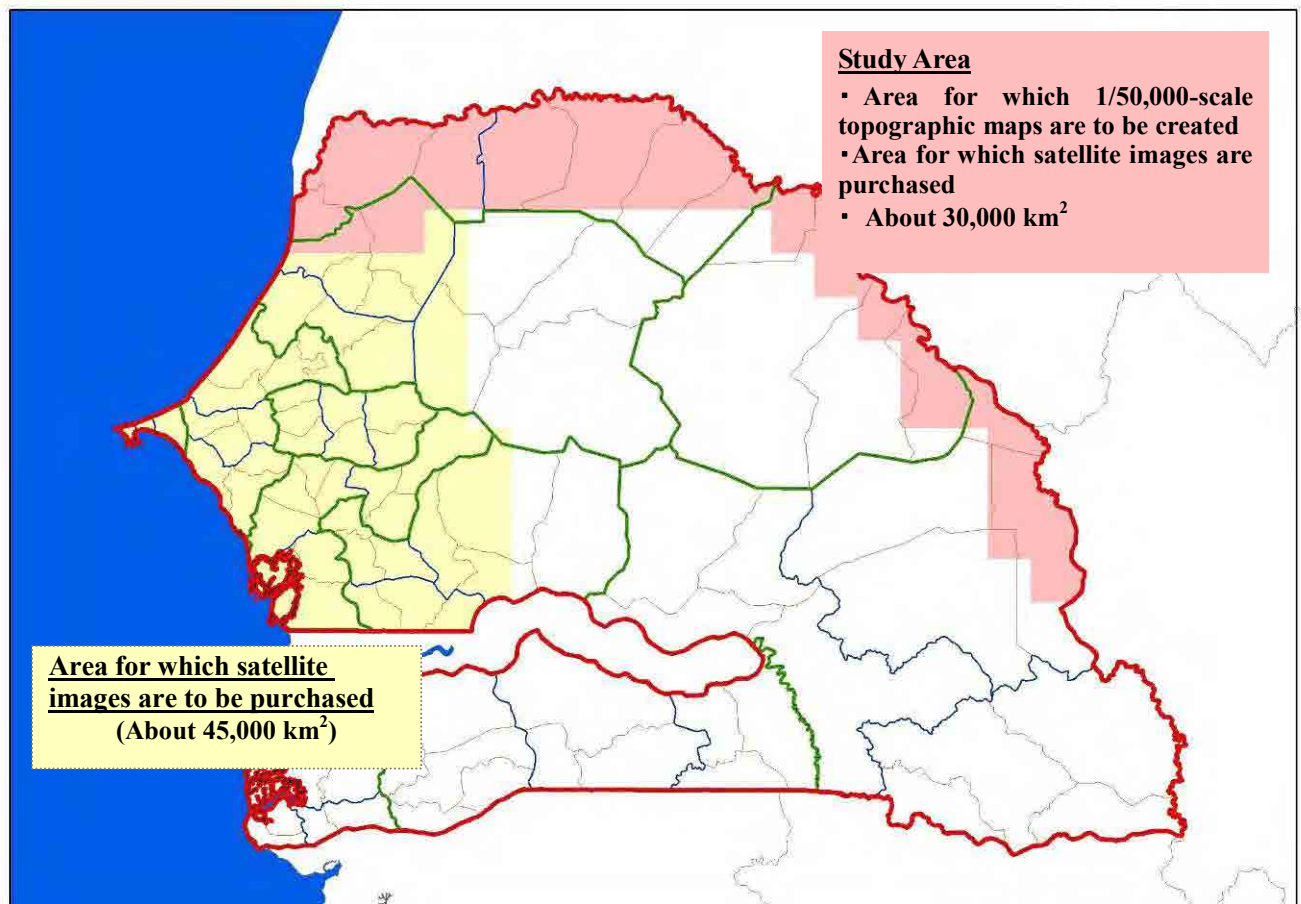
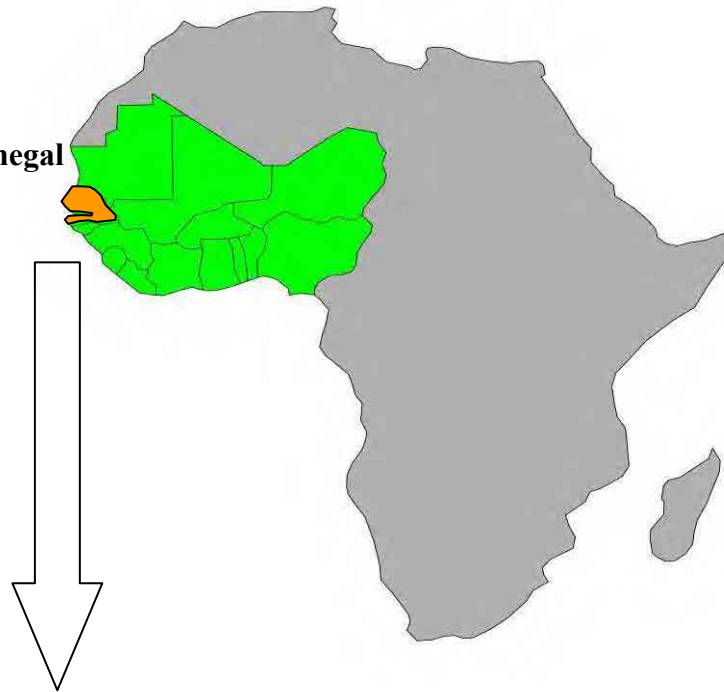
**The Study on the Digital Topographic Mapping Project
for
Northern Senegal**

Final Report



Study Area

Republic of Senegal



Study Area and Area for purchased satellite images

Photographs of Work in Senegal

April 2011 to February 2013

* **Start of project**



ANAT



Kick-off meeting



Discussion of Inception Report



Signing of meeting minutes



Opening Seminar



Consultation of specifications



Discussion about Website



Study team office

*** Ground control point survey**



Cars used in study: TOYOTA Land Cruisers Prado



Ground control point survey – Training for centering



GPS observation



Training in GPS data analysis

* **Field identification/field verification**



Acquisition of building data (using a GPS camera)



Recording of acquired data onto images



On site interview survey



Crossing a river by boat to reach a destination village

Abbreviations

ADIE	Agence de l'Information de l'Etat
ALOS	Advanced Land Observing Satellite
ANAT	Agency of National Land Management
ARTP	Autorité de Régulation des Télécommunications et des Postes
AVNIR-2	Advanced Visible and Near Infrared Radiometer type 2
CCD	Charge Coupled Device
CEDT	Centre d'Entrepreneuriat et de Développement Technique
CSE	Centre de Suivi Ecologique
DEM	Digital Elevation Model
DGID	Direction Générale des Impôts et des Domaines
DMG	Direction of Mines and Geology
DTGC	Direction des Travaux Géographiques et Cartographiques
DUA	Direction de l'Urbanisme et de l'Architecture
FAO	Food and Agriculture Organization
GCP	Ground Control Point
GICC	Inter-institutional Consultation and Coordination Group
GIS	Geographic Information System
GLONASS	Global Navigation Satellite System
GNI	Gross National Income
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRS	Geodetic Reference System 1980
HDD	Hard Desk Drive
IMF	International Monetary Fund
INP	Institut National de Pédologie
ISO	International Organization for Standardization
ITRF	International Terrestrial Reference Frame
JSMAP	Japan, Senegal Mapping Project
KML	Keyhole Markup Language
KMZ	Keyhole Markup Zip
LERG	Laboratoire d'Etude et de Recherches en Géomatique
LGO	Leica Geo Office
LPS	Leica Photogrammetric Suits
NSDI	National Spatial Data Infrastructure
OGC	Open Geospatial Consortium
OJT	On the Job Training
OLAG	Office du Lac de Guiers

OMVS	Organisation pour la mise en valeur du fleuve Senegal
PDF	Portable Document Format
PDOP	Position Dilution of Precision
PRISM	Panchromatic Remote-sensing Instrument for Stereo Mapping
RPC	Rational Polynomial Coefficients
SAED	Société d'Aménagement et d'Exploitation des terres du Delta et du fleuve Sénégal et de la Falémé
SHP	SHAPE File
UTM	Universal Transverse Mercator
WFP	World Food Program
WGS84	World Geodetic System 1984

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Photographs of Work in Senegal

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Chapter 1 Overview of the Study

1.1 Background to the Study

The Republic of Senegal (hereinafter referred to as “Senegal”) introduced various structural reforms such as the privatization of state-run industries and the liberalization of import prices as part of an action adjustment plan implemented under the guidance of the IMF and the World Bank, which has put the economy on an upward trend and has caused the GNI to continue growth since 1994. On the other hand, there is no agriculture to ensure continuous economic growth, so that the poverty rate of the population as a whole is still as high as 57% (65% in rural areas).

Senegal also suffers from other problems, such as population growth, population inflow into the cities, an expanding disparity in wealth, desertification and a high unemployment rate, and the economic, social, and environmental structures of the country remain weak. Under these circumstances, in 2006 Senegal adopted the Secondary Poverty Reduction Strategy Paper, with its four main pillars: (1) “Creation of wealth,” (2) “Basic social services,” (3) “Good governance and rural development,” and (4) “Social protection and disaster prevention and management.” Regarding (1) “Creation of wealth,” in particular, the priority development areas were determined to be the northern and western areas of the country. In the former area conditions are generally underdeveloped despite the growth potentials, such as food production and trade with neighboring countries; and in the latter area the basic infrastructure for transportation such as roads and railways, communication, energy, etc. is inadequate in view of the concentration of population in the capital city, which will undergo intensive development in the future.

Under these circumstances, the establishment of wide-area plans and prioritization of various policies has become more important than ever before to enhance the effectiveness and efficiency of development. Although the 1/50,000-scale topographic map information is most appropriate for the consideration of wide-area plans, the 1/50,000-scale topographic maps developed so far cover only 45% of the national land. In addition, the latest maps for the western and northern areas were created in 1991 and 1955, respectively, and contain significant discrepancies from current conditions. This state of affairs is obstructing the implementation of public works and the establishment of policies.

For the northern area, in particular, it is recognized that the development of digital geospatial information is urgently required for the sake of (1) the regional plan for the improvement of agricultural productivity (management of agricultural water, rural development, and readjustment of agricultural land divisions), (2) management of the Senegal River Basin (flood disaster management, coordination of water use with neighboring countries, and the repair and maintenance of cross-border bridges), and (3) the improvement of the traffic and physical distribution infrastructure (development of road and railway networks, communication infrastructure, and power-transmission networks).

Since at present there are no engineers with the skills needed to create or update 1/50,000-scale digital topographic maps, there is also a clear need to train up engineers with the ability to create or update geospatial information.

Against such a background, in October 2010 JICA dispatched a study team to draw up a detailed plan in accordance with a request from the government of Senegal. The creation of topographic maps of the northern area of Senegal was discussed with the said government, and the S/W for this project was signed on December 24, 2010.

1.2 Overview of the Agency of National Land Management (ANAT)

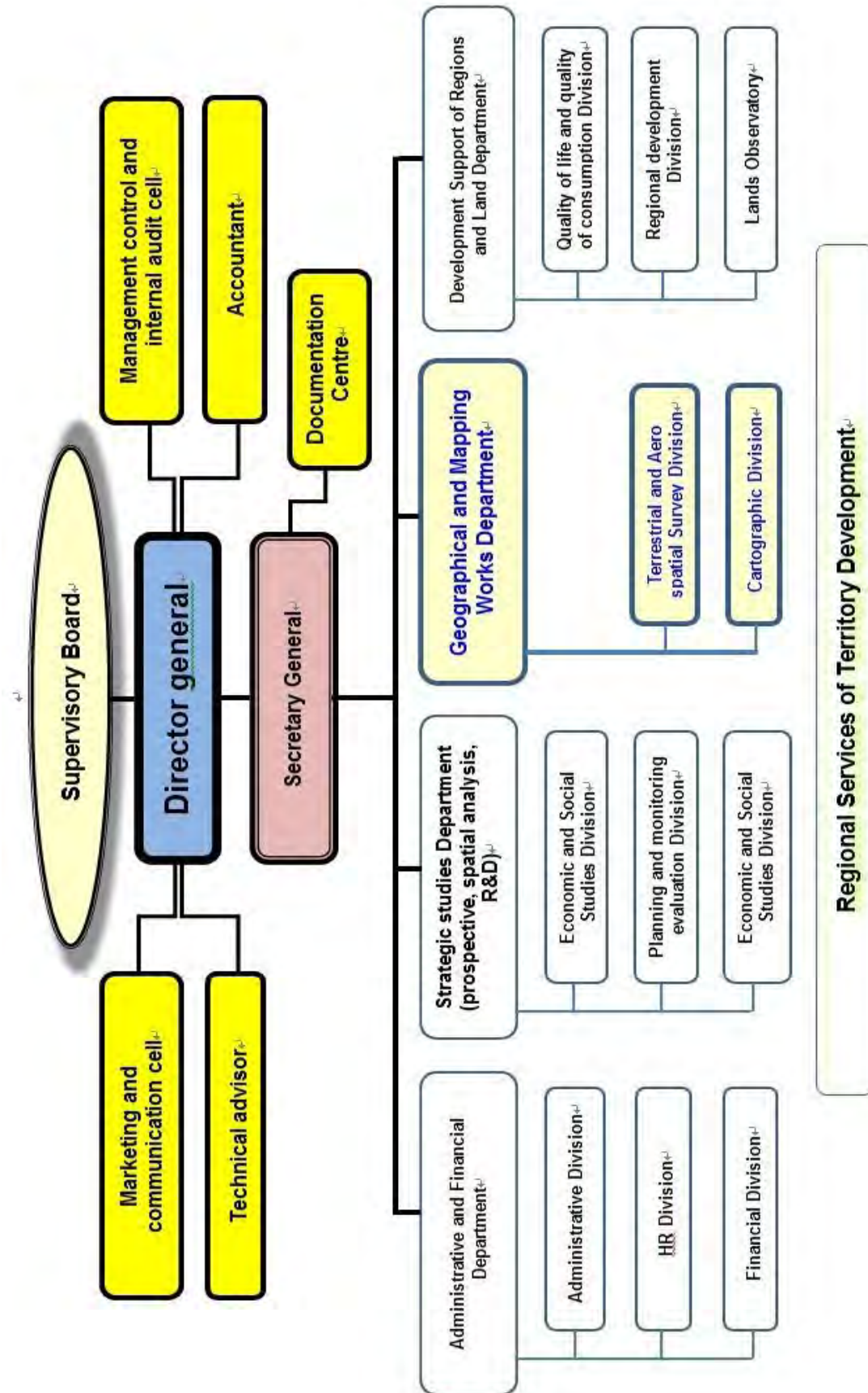
The National Agency for the Territory Development (ANAT) was created by presidential decree having an independent management and is engaged in public service mission on November 20, 2009. The Agency, which replaces the Department of Territory Development, carries out the powers formerly vested to Geographical and Mapping work Department and the National Agency of Quality of Life and Quality of consumption. It has its headquarters in Dakar and is under the technical supervision of the Minister in charge of Territory Development and Minister in charge of Finance.



Photo 1-1 Office building of ANAT

1.2.1 Organizational Structure of ANAT

The current organizational structure of ANAT is shown in the figure below.



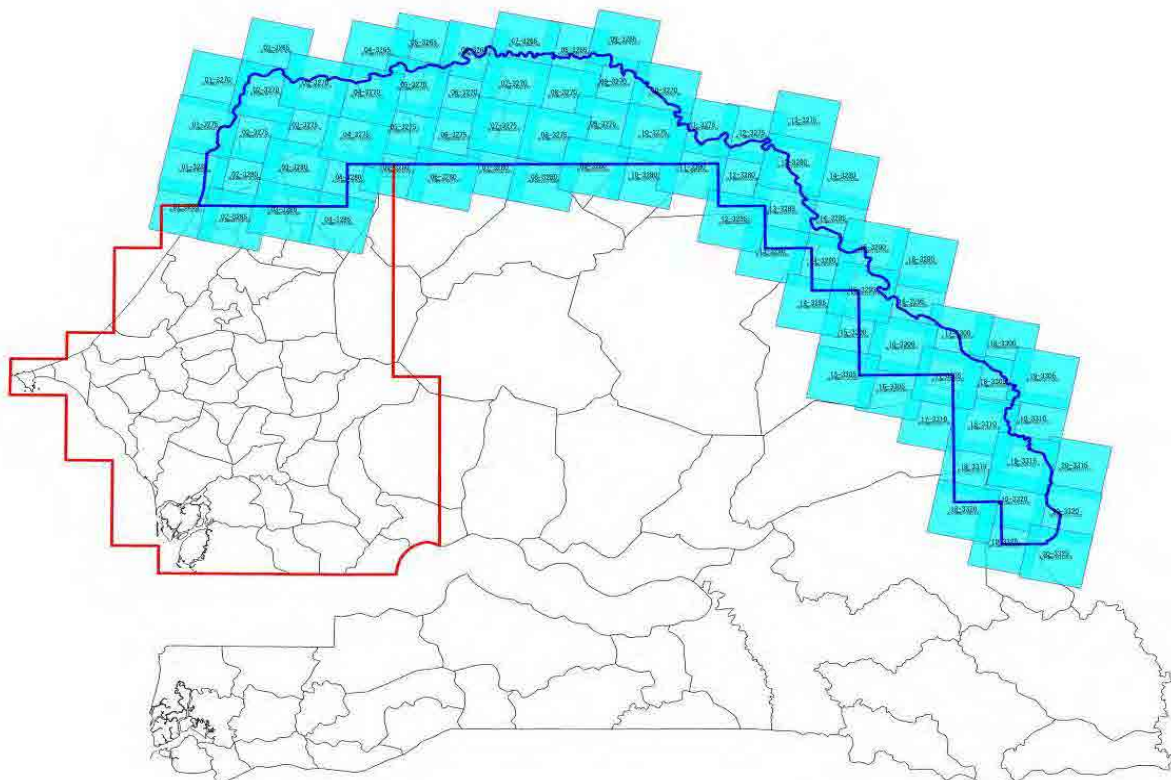
1.3 Objective of the Study

The study has the following two objectives:

- (1) The creation of 1/50,000-scale digital topographic maps of the northern part of Senegal (About 30,000 km² in the Senegal River Basin)
- (2) Technology transfer in the creation of digital topographic maps, with the following two goals:
 - ① To provide the Agency of National Land Management (ANAT) of Senegal with the ability to create by itself topographic maps of the area outside the scope of the project after completion of the project.
 - ② To provide the ANAT with the ability to update by itself the topographic maps which have been created in the project.

1.4 Study Area and Satellite Images

This study was carried out over an area of about 30,000 km² in the Senegal River Basin, including the Saint Louis. The Study Team also supplied satellite images only for an area of about 45,000 km² including Dakar, for which Senegal would create and update topographic maps by itself using the outputs of the technology transfer implemented in this study. Figure 1-2 shows the study area and the area for which satellite images are to be purchased.



**Figure 1-2 Study Area for the Topographic Mapping
Area for the satellite images to be purchased**



1.5 Basic Policies of the Project

1.5.1 Basic Technical Policies

Based on the background and objectives of this study and points to note in its implementation, the technical considerations of particular importance were as follows:

Basic technical policy 1: Technology transfer

ANAT, the mapping organization, did not have any experience in creating medium-scale topographic maps on its own accord, but had a certain level of knowledge in creation of topographic maps and utilization of GIS database. Therefore, technology transfer was implemented with particular focus on the acquisition of skills and capabilities relating to the actual creation of topographic maps.

The goals of the technology transfer are to ensure that, after the completion of this study, using the supplied ALOS images of the western area, the ANAT members

1. -can create topographic maps following the standard specifications created in this study,
2. -understand the inspection methods to be used in each process, and
3. -can create and update topographic maps by themselves while also achieving the above two goals.

Since the technology transfer training was to be implemented in a short period of time, a follow-up was implemented after the technology transfer (such as the exchange of questions and answers via e-mail). ANAT was encouraged to make about four sheets of maps through OJT. As a result, four sheets of topographic map data will be created as the output of the technology transfer.

Basic technical policy 2: Survey criteria

The survey part of this project was implemented using the following survey criteria. The details were determined in the consultation of specifications after the start of the project.

- Map projection UTM (Universal Transverse Mercator)
- Geographic coordinate system ITRF2000
- Reference ellipsoid GRS80
- Altitude reference Based on the existing benchmarks
- Annotation The data files and the marginal information plates should indicate the following annotation:

This digital map was prepared jointly by Japan International Cooperation Agency (JICA) under the Japanese Government Technical Cooperation Program and the Government of Senegal.

Basic technical policy 3: Compliance with the Overseas Mapping (National Base Map) Standard Specifications

The work related to the creation of digital topographic maps in this study was carried out in

compliance with the Overseas Mapping (National Base Map) Standard Specifications. Senegal has the “Senegal Map Symbol Specifications” which are compliant with the “African Mapping Standards” The “Senegal Map Symbol Specifications” were created in a period when the creation of analog topographic maps was still the mainstream. After consultation with ANAT, therefore, we edited the standard specifications to include the creation of digital topographic maps, which will be the mainstream in the future, and proposed new standard specifications and symbol specifications to ensure the efficient progress of the project.

Basic technical policy 4: Acquisition of satellite images

This project created topographic maps using high-resolution satellite images with a ground resolution of 2.5 m or higher (compliant with stereoscopic view). In addition, satellite images (compliant with stereoscopic view) covering the range shown in the study area (Figure 1-2) were acquired.

Basic technical policy 5: Utilization of existing maps

This study adopted the method of carrying out plotting work for the area covered by the maps that were created in 1991. The existing maps were used as reference materials for the plotting work.

Basic technical policy 6: Quality management

Discussions were held with ANAT at the start of the study regarding the quality of the output (such as the accuracy and completeness of information acquisition). With regard to quality control, a “report on quality control” was prepared after the completion of the work, to summarize the process and results of the quality control implemented in accordance with the “Overseas Mapping (National Base Map) Standard Specifications”.

Basic technical policy 7: Promotion of the utilization of project outputs

In an effort to ensure widespread utilization of the data, the utilization of the project output was promoted by means of a project-opening seminar, lessons given at educational institutes, and the provision of data to organizations intending to construct sample GIS systems. At the end of the project, a seminar was again held as a public-relations vehicle targeting the utilization of the project outputs. Additionally, to promote sustainability, ANAT was encouraged to plan and implement the seminar by itself.

Existing committees consisting of the members of the relevant government organizations of Senegal were used to promote widespread utilization of the outputs of this study and to provide assistance for the formation of a committee viewing local information.

Basic technical policy 8: Work plan taking the climate of the study area into consideration

In Senegal where there are a rainy season and a dry season, planimetric features can be identified in

vastly different ways, depending on when the satellite images were acquired. Therefore, the characteristics of features, for cultivated land in particular, were carefully examined in the rainy season and the dry season for interpretation of satellite images, with full use being made of the crop calendar and other information.

1.5.2 Basic Management Policies

Basic management policy 1: General

As a basic policy, this study was to be implemented on the premise that all the members of the Study Team should fully understand and recognize that the study was being implemented with the technical cooperation of the Japanese government; and, to ensure this, that all members should maintain regular communications.

Basic management policy 3: ANAT management

In January 2011, the 1/2,000-scale map project covering seven major cities implemented by the EU (EU2000 project) was started. Since ANAT was also participating in the EU2000 project to work on topographic maps and receive technology transfer, we shared our schedule with the Senegalese side and paid attention to the management of ANAT staff assignments so that there would be no interference with the technology transfer in this project with respect to the personnel plan, assignments, etc.

Basic management policy 4: Appropriate organization of study team

Since the purposes of this study are to create a geospatial information database and to carry out a study and technology transfer in this field, we selected engineers who have abundant overseas experience and excellent skills in creating geographic data. Since the work also included the use of digital data and maps and the effective utilization and popularization of GIS, we selected engineers who are familiar with these fields and engineers who have skill and experience in promoting the use of WebGIS and data.

Basic management policy 5: Holding of seminars

At the start of this project, we held a seminar to overview the project. At the end of the project, we will hold a seminar to disclose the results of the technology transfer for the purpose of promoting the popularization, utilization, and secondary use of the GIS database that has been created. Additionally, the Study Team assists ANAT to take the initiative in managing these seminars, for the purpose of technology transfer in digital data disclosure methods, etc.

Basic management policy 6: Safety management

Safety management for the Study Team and ANAT was ensured by having the members strictly

observe the safety standards of the Japan International Cooperation Agency.

Since the study area in the Senegal River Basin is an area where yellow fever is common, the safety of the team members was ensured by making vaccination or other appropriate measures obligatory.

1.6 Study Team Members

The following table shows the Study Team members and their principal duties.

Table 1-1 Study Team members and their principal duties

Name	Charge	No.	Description of duties
Takashi Harada	Team leader	(1)	Collection, Sorting, Analysis of Relevant Materials and Information
		(2)	Preparation of Inception Report
		(3)	Explanation and Discussion of Inception Report
		(4)	Discussion of Specifications
		(5)	Collection and Sorting of Existing Materials
		(6)	Purchase of Satellite Images
		(7)	Ground Control Point Survey
		(8)	Aerial Triangulation
		(9)	Field Identification and Verification
		(10)	Digital Plotting and Compilation
		(11)	Preparation of Interim Report
		(12)	Explanation and Discussion of Interim Report
		(13)	Structurization of Digital Data
		(14)	Map Symbolization of Topographic Maps
		(15)	Creation of Data Files
		(16)	Construction of Website
		(17)	Construction of System of Usage
		(18)	Promotion of Utilization (Seminar, etc.)
		(19)	Preparation of Draft Final Report
		(19)	Explanation and Discussion of Draft Final Report
		(20)	Preparation of Final Report
(21)	Technology Transfer (⑨ Quality Control of All Processes, ⑩ Partial Correction, Seminar Evaluation)		
Takao Ikeda	Consultation of Specifications	(1)	Collection, Sorting, Analysis of Relevant Materials and Information
		(2)	Preparation of Inception Report
		(3)	Explanation and Discussion of Inception Report
			Creation of Map symbol Specifications (Example)
			Creation of Marginal Information Plate (Example)
		(4)	Discussion of Specifications
	(19)	Preparation of Draft Final Report	

Hiromichi Maruyama	Data Usage Planning	(1)	Collection and Analysis of Existing Materials and Information
		(2)	Preparation of Inception Report
		(11)	Promotion of Utilization
		(12)	Preparation of Interim Report
		(17)	Construction of System of Usage
		(19)	Explanation and Discussion of Interim Report
		(19)	Preparation of Draft Final Report
		(20)	Explanation and Discussion of Draft Final Report
		(21)	Preparation of Final Report
Kazuhiro Ishizuka	Ground Control Point Survey 1	(2)	Preparation of Inception Report
		(7)	Ground Control Point Survey
		(11)	Preparation of Interim Report
		(19)	Preparation of Draft Final Report
		(21)	Technology Transfer (①Ground Control Point Survey, ⑨ Quality Control)
Masanori Teshima	Ground Control Point Survey 2	(7)	Ground Control Point Survey
		(21)	Technology Transfer (①Ground Control Point Survey, ⑨ Quality Control)
Takao Ikeda	Aerial Triangulation	(2)	Preparation of Inception Report
		(8)	Aerial Triangulation
		(11)	Preparation of Interim Report
		(19)	Preparation of Draft Final Report
		(21)	Technology Transfer (② Aerial Triangulation, ⑨ Quality Control)
Mitsuo Iwase	Field Identification	(2)	Preparation of Inception Report
	/Field Verification 1	(9)	Field Identification (Creation of Interpretation Key)
		(11)	Preparation of Interim Report
		(9)	Field Verification
		(19)	Preparation of Draft Final Report
		(21)	Technology Transfer (④Field Identification/ Verification, ⑨ Quality Control)
Hirokazu Morita	Field Identification	(5)	Field Identification (Creation of Interpretation Key)
	/Field Verification 2	(9)	Field Verification
		(21)	Technology Transfer (④Field Identification/Verification, ⑨ Quality Control)
Kazuhiro Arataki	Digital Plotting	(2)	Preparation of Inception Report
		(10)	Digital Plotting
		(11)	Preparation of Interim Report
		(19)	Preparation of Draft Final Report
		(21)	Technology Transfer (③ Digital Plotting, ⑨ Quality Control, ⑩ Partial Correction)

		(22)	Creation of Orthophoto Data
Jun Hoshino	Digital Compilation/ Digital Compilation after Field Verification	(2)	Preparation of Inception Report
		(10)	Digital Compilation/Digital Compilation after Field Verification
		(11)	Preparation of Interim Report
		(15)	Creation of Data Files
		(19)	Preparation of Draft Final Report
		(21)	Technology Transfer (③ Digital Compilation, ⑨ Quality Control, ⑩ Partial Correction)
Yoshimitsu Fukumoto	Map Symbolization	(2)	Preparation of Inception Report
		(10)	Map Symbolization
		(11)	Preparation of Interim Report
		(15)	Creation of Data Files
		(19)	Preparation of Draft Final Report
		(21)	Technology Transfer (⑥ Map Symbolization, ⑨ Quality Control)
Junko Yamashita	Digital Data Structurization	(2)	Preparation of Inception Report
		(11)	Preparation of Interim Report
		(13)	Digital Data Structurization
		(15)	Creation of Data Files
		(19)	Preparation of Draft Final Report
		(21)	Technology Transfer (⑤ Digital Data (GIS) Structurization, ⑨ Quality Control)
Naoki Goto	Construction of Website	(2)	Preparation of Inception Report
		(3)	Explanation and Discussion of Inception Report
		(11)	Preparation of Interim Report
		(16)	Construction of Website
		(19)	Preparation of Draft Final Report
		(19)	Explanation and Discussion of Draft Final Report
		(21)	Technology Transfer (⑦ Construction of Website, ⑨ Quality Control, Seminars)
Naomi Tamura	Coordinator/Digital Plotting Assistance	(1)	Collection, Sorting, Analysis of Relevant Materials and Information
		(3)	Explanation and Discussion of Inception Report
		(5)	Collection and Sorting of Existing Materials
		(6)	Purchase of Satellite Images
		(12)	Explanation and Discussion of Interim Report
		(19)	Explanation and Discussion of Draft Final Report
		(21)	Technology Transfer (Seminars)

1.7 Staffing Plan

Table 1-3, “Staffing Plan” shows the staffing plan for implementation of the study. The column on the right shows changes to the plan due to a delay in the procurement of equipment and materials, revision of the vehicle use plan, and other reasons.

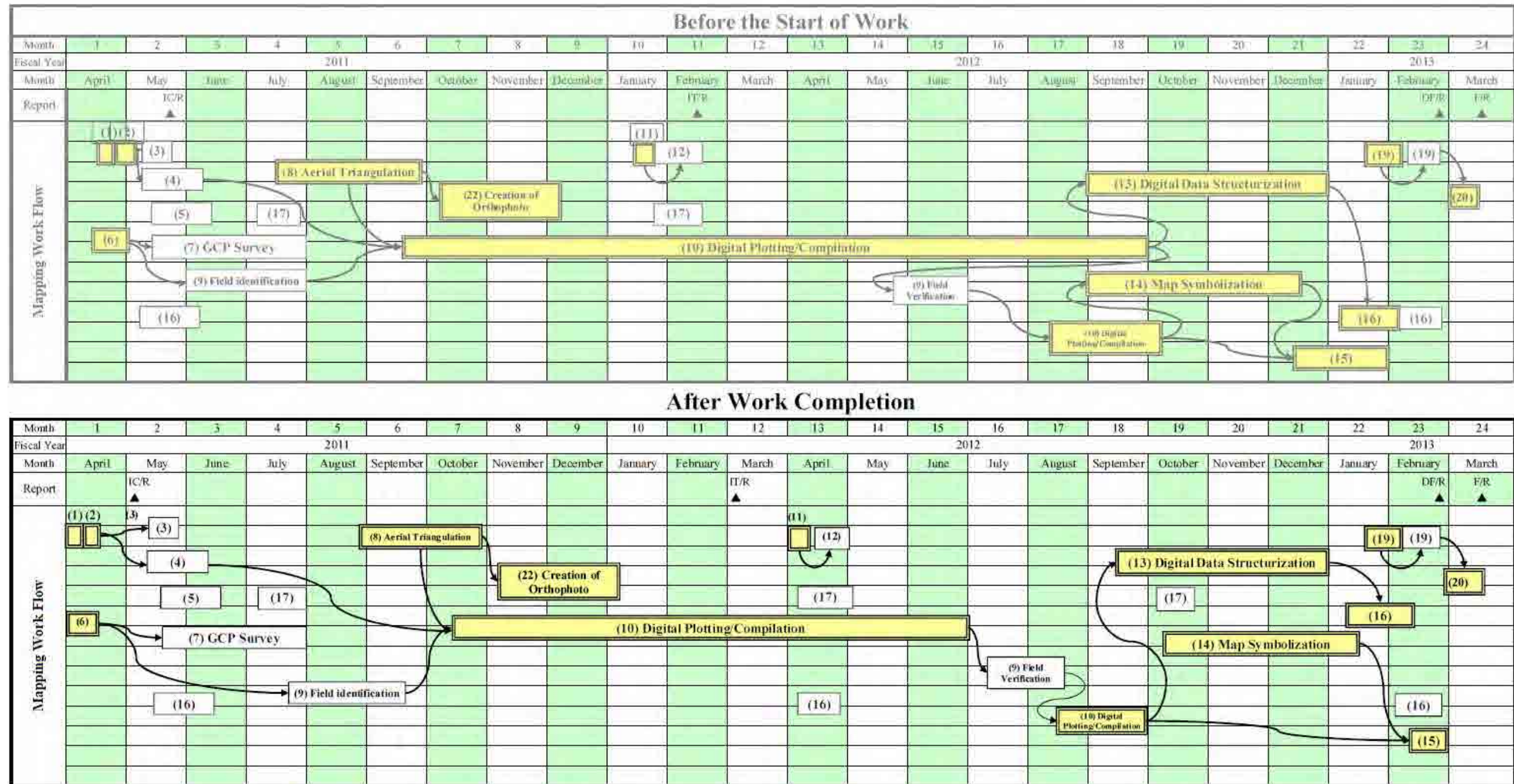
Table 1-2 Staffing Plan

		Before the Start of Work																									
Administrator	Name	Affiliation	grade	2011												2012						2013					
				1 APR	2 MAY	3 JUN	4 JUL	5 AUG	6 SEP	7 OCT	8 NOV	9 DEC	10 JAN	11 FEB	12 MAR	13 APR	14 MAY	15 JUN	16 JUL	17 AUG	18 SEP	19 OCT	20 NOV	21 DEC	22 JAN	23 FEB	24 MAR
Work in Senegal	Team Leader	Takashi HARADA	AAC	2																							
	Data Usage Planning	Hiromichi MARUYAMA	AAC/IDI	3																							
	Consultation of Map Symbol Specifications	Takao IKEDA	AAC	4																							
	GPS survey 1	Kazuhiro ISHIZUKA	AAC/KKC	3																							
	GPS survey 2	Masanori TESHIMA	AAC	4																							
	Field Identification/Verification1	Mitsuo IWASE	AAC/IDI	3																							
	Field Identification/Verification2	Hirokazu MORITA	AAC	4																							
	Aerial Triangulation	Takao IKEDA	AAC	4																							
	Digital Plotting	Kazuhiro ARATAKI	AAS	4																							
	Digital Compilation after Field Verification	Jun HOSHINO	AAC	5																							
	Symbolization	Yoshimitsu FUKUMOTO	AAC/Digi-Sho	3																							
	Digital Data Structurization	Junko YAMASHITA	AAC	4																							
	Construction of Website	Naoki GOTO	AAC	4																							
	Coordinator	Naomi TAMURA	AAC	5																							
Interpreter	Tomoyuki OTANI	AAC/Techno Staff																									
		After Work Completion																									
Administrator	Name	Affiliation	grade	2011												2012						2013					
				1 APR	2 MAY	3 JUN	4 JUL	5 AUG	6 SEP	7 OCT	8 NOV	9 DEC	10 JAN	11 FEB	12 MAR	13 APR	14 MAY	15 JUN	16 JUL	17 AUG	18 SEP	19 OCT	20 NOV	21 DEC	22 JAN	23 FEB	24 MAR
Work in Senegal	Team Leader	Takashi HARADA	AAC	2																							
	Data Usage Planning	Hiromichi MARUYAMA	AAC/IDI	3																							
	Consultation of Map Symbol Specifications	Takao IKEDA	AAC	4																							
	GPS survey 1	Kazuhiro ISHIZUKA	AAC/KKC	3																							
	GPS survey 2	Masanori TESHIMA	AAC	4																							
	Field Identification/Verification1	Mitsuo IWASE	AAC/IDI	3																							
	Field Identification/Verification2	Hirokazu MORITA	AAC	4																							
	Aerial Triangulation	Takao IKEDA	AAC	4																							
	Digital Plotting	Kazuhiro ARATAKI	AAS	4																							
	Digital Compilation after Field Verification	Jun HOSHINO	AAC	5																							
	Symbolization	Yoshimitsu FUKUMOTO	AAC/Digi-Sho	3																							
	Digital Data Structurization	Junko YAMASHITA	AAC	4																							
	Construction of Website	Naoki GOTO	AAC	4																							
	Coordinator	Naomi TAMURA	AAC	5																							
Interpreter	Tomoyuki OTANI	AAC/Techno Staff																									

Chapter 2 Project Implementation Status and Results

The workflow of the project as it was implemented is shown in the table below.

Table 2-1 Workflow



Work in Senegal Work in Japan

- | | | | |
|--|---------------------------------------|---|---|
| (1) Collection, Sorting of Relevant Materials | (7) Ground Control Point Survey | (12) Explanation and Discussion of Interim Report | (17) Construction of System of Usage |
| (2) Preparation of Inception Report | (8) Aerial Triangulation | (13) Digital Data Structurization | (18) Holding of Technology Transfer Seminar |
| (3) Explanation and Discussion of Inception Report | (9) Field Identification/Verification | (14) Map Symbolization | (19) Discussion of Draft Final Report |
| (4) Consultation of Specifications | (10) Digital Plotting/Compilation | (15) Creation of Data Files | (20) Preparation of Final Report |
| (5) Collection and Sorting of Existing Materials | (11) Preparation of Interim report | (16) Construction of Website | (22) Creation of Orthophoto |
| (6) Purchase of Satellite Images/Image Processing/Creation of Orthophoto | | | |

The implemented operations and the implementation statuses of these operations are described below.

2.1 (1) Collection, Sorting and Analysis of Relevant Materials and Information (Work in Japan)

Before the start of the Work in Senegal, the following tasks were carried out in Japan.

- Sorting and analysis of materials collected by Aero Asahi Corporation and the preliminary Study Team
- Creation of symbol specifications (examples) for consultation of map specifications
- Summary of basic policies, work methods, procedures, etc.

Furthermore, additional information available in Japan was collected, sorted, and analyzed.

2.2 (4) Consultation of Map Specifications (Work in Senegal)

At the start of the project, the inception report was discussed with regard to the map specifications of the topographic maps to be created, survey criteria, field survey methods, etc. and the results of the discussion were confirmed in the minutes of the meeting (Appendix 1, 2). Additionally, the basic specifications (map symbols, annotations, etc.) required for the creation of the 1/50,000-scale topographic maps in this study were discussed and approved (Appendix 4). Although in principle the work was based on the map specifications normally held by ANAT, the details were determined in discussions with ANAT in compliance with the “Overseas Mapping (National Base Map) Standard Specifications”.

The major discussion topics in the consultation of specifications are listed below. Appendix 3 shows the results of the discussions. See Appendix 5 for the other decisions made in the discussions on map creation.

1. Check of map symbol specifications – Topics discussed in Japan and confirmation of ANAT’s intentions
2. Check of survey criteria
3. Check of area to be mapped
4. Check of map sheets
5. Check of marginal information
6. Check of project outputs
7. Check and acquisition of existing materials
8. Technology transfer
9. Check of standard specifications to be used
10. Check of supplied equipment
11. Check items for field identification

2.3 (5) Collection and Sorting of Existing Materials (Work in Senegal)

In Senegal, the following existing data that can be utilized in this study, such as existing topographic maps and surveying results, were collected and sorted.

The topographic maps that were collected are shown in the table below.

Table 2-2 List of existing topographic maps

Map scale	Mapping rate	Year of mapping	Remarks
1/50,000-scale topographic maps	45%	1955 to 1991	137 sheets including 43 created by JICA in 1991.
1/200,000-scale topographic maps	100%	2008	27 sheets created in collaboration with the EU
1/500,000-scale topographic maps	100%	1966	2 sheets
1/1,000,000-scale topographic maps	100%	2010	1 sheets

2.4 (6) Purchase of Satellite Images (Work in Japan)

The satellite images of the study area that were acquired (about 75,000 km²) were ALOS/PRISM images with a resolution of 2.5 meters, for which stereoscopic images are available at all times.

Taking the quality of the final outputs into account the images acquired were in triplet imagery, and the images were used differently according to the processes.

2.5 (7) Ground Control Point Survey (Work in Senegal)

The ground control point survey was carried out as described below.

[Point Selection Plan]

Before the planning and implementation of the GCP survey, effective use was made of Google Earth images as a reference tools, 1/200,000-scale topographic maps and description of existing control points in selecting the approximate positions of the control points. In particular, 47 GCPs were planned at positions that facilitate pricking on ALOS images.

[Observation Plan]

After the GCPs had been selected on the images, a plan was made with reference to the specifications of three sets of dual-frequency GNSS receivers, existing topographic maps and the Overseas Mapping (National Base Map) Standard Specifications.

[Selection of GNSS Receiver and Procurement Process]

In Japan, the Study Team selected three sets of GNSS receiver (Leica GS10 system and accessories) and analysis software based on information from a sales representative in Senegal, and communicated with the sales representative in Senegal to go ahead with the procurement process.



Photo 2-1 Delivery of GNSS receivers for GCPs



Photo 2-2 Explaining of GNSS receivers to Mr. Ndong, director of DTGC

[Technical Consultation with ANAT (Surveying Specifications, Existing Control Points, Structure of Observation Team)]

The Study Team held discussions with ANAT and confirmed that the ground control point (GCP) survey should be conducted using the following survey criteria that have been adopted by Senegal:

- Geographic coordinate system: ITRF2000
- Projection method: UTM (Zone 28 North)
- Reference ellipsoid: GRS80
- Altitude reference: Existing control points and benchmarks

[Observation Specifications, Settings and Training]

In order to carry out the observation using the GNSS receiver, the observation conditions needed to set on the controller, and the following major observation specifications were used as the initial settings.

- Observation angle of elevation: 15 degrees
- Observation data acquisition interval: 15 seconds
- Type of satellite frequency to be acquired: GPS L1 / L2 GLONASS

[Net Adjustment] (see Appendix 7)

After the location accuracy check in the baseline analysis, the net adjustment was made for each session by fixing the coordinates and ellipsoidal heights in the known point outputs. The net adjustment was made using the LEICA LGO software. In the Chapter 3 “Technology Transfer”, Table 3-3 shows the results of GCP coordinates after net adjustment.

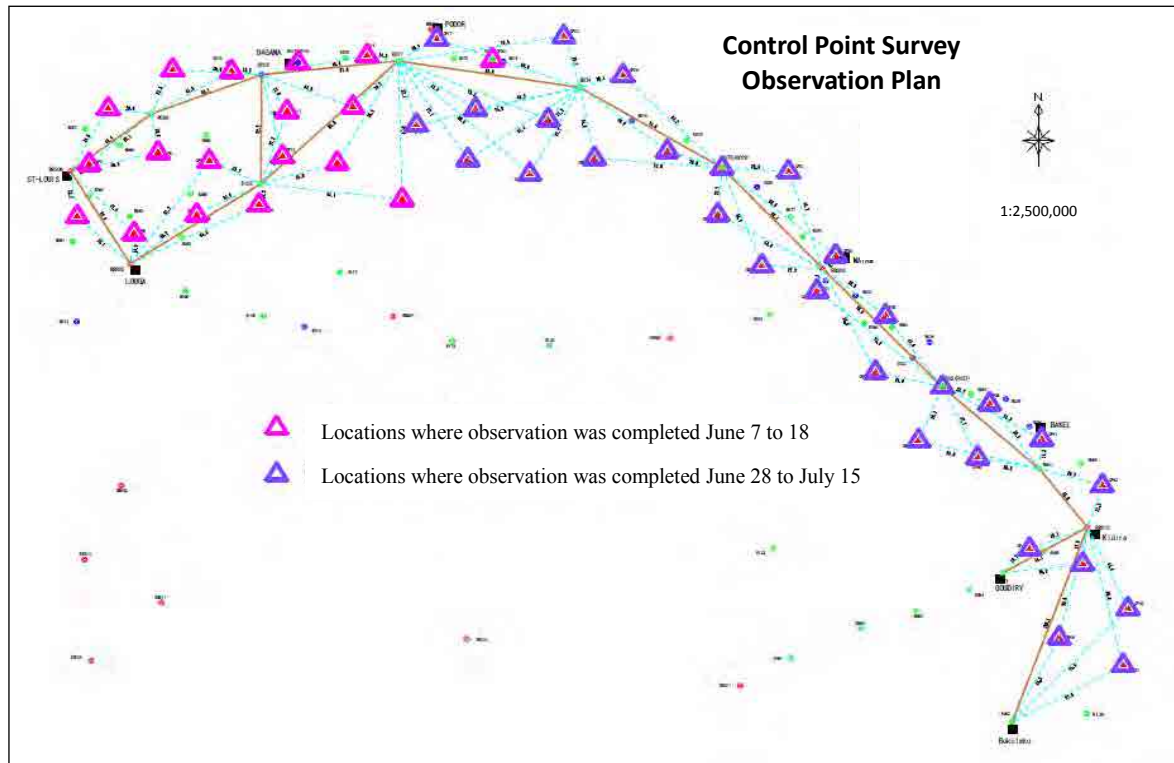


Figure 2-1 GNSS Observation map

[Pricking of GCPs]

The pricking of GCPs was done by outputting the ALOS image data in an enlarged form and checking it against the planimetric features in the field. In many cases the pricked GCPs turned out to be at the corners of hedges and fences, roads, and the corners of houses in and around villages. In areas without such planimetric features, small isolated trees were interpreted in the images and pricked. The pricked points in images, sketches of the surrounding areas and ground photographs were organized in the GCP pricking point detail register (see Appendix 8). At the GCPs pricked and observed in the field, an iron bar (50 cm in length and 1.2 cm in diameter) was laid flush with the ground.

2.6 (8) Aerial Triangulation (Work in Japan)

From the satellite images acquired as described in Item (6), “Purchase of Satellite Images,” those covering the area for which topographic maps were to be created (About 30,000 km² in the Senegal River Basin) were selected, and aerial triangulation was carried out on each of them using a digital plotting system on which aerial triangulation software had been installed. Below is an overview.

The ALOS/PRISM images provided by the data provider form what is called the exterior orientation model, also known as the RPC model. The RPC model consists of files that describe the rational polynomial coefficients connecting the satellite images with the ground space, similar to the exterior orientation parameters in aerial photos. The plotter can convert the RPC model associated with the satellite images (ALOS/PRISM) into a stereo model, allowing the measurement of the 3D coordinates of planimetric features in the images. However, RPC models generally include systematic errors so that the accuracy must be improved for the creation of topographic maps. Therefore, the RPC model was readjusted through adjustment calculation using the image coordinates of tie-points and GCPs, the RPC model, and the GCP outputs (3D coordinates). The results of this process are described below.

[Period of Implementation]

Aerial triangulation was carried out over a period of three months, from August to October 2011.

[Scope of Implementation]

The scope of implementation is as shown below. For a plotting range covering about 30,000 km², 234 ALOS/PRISM images (78 scenes x triplets) were used.

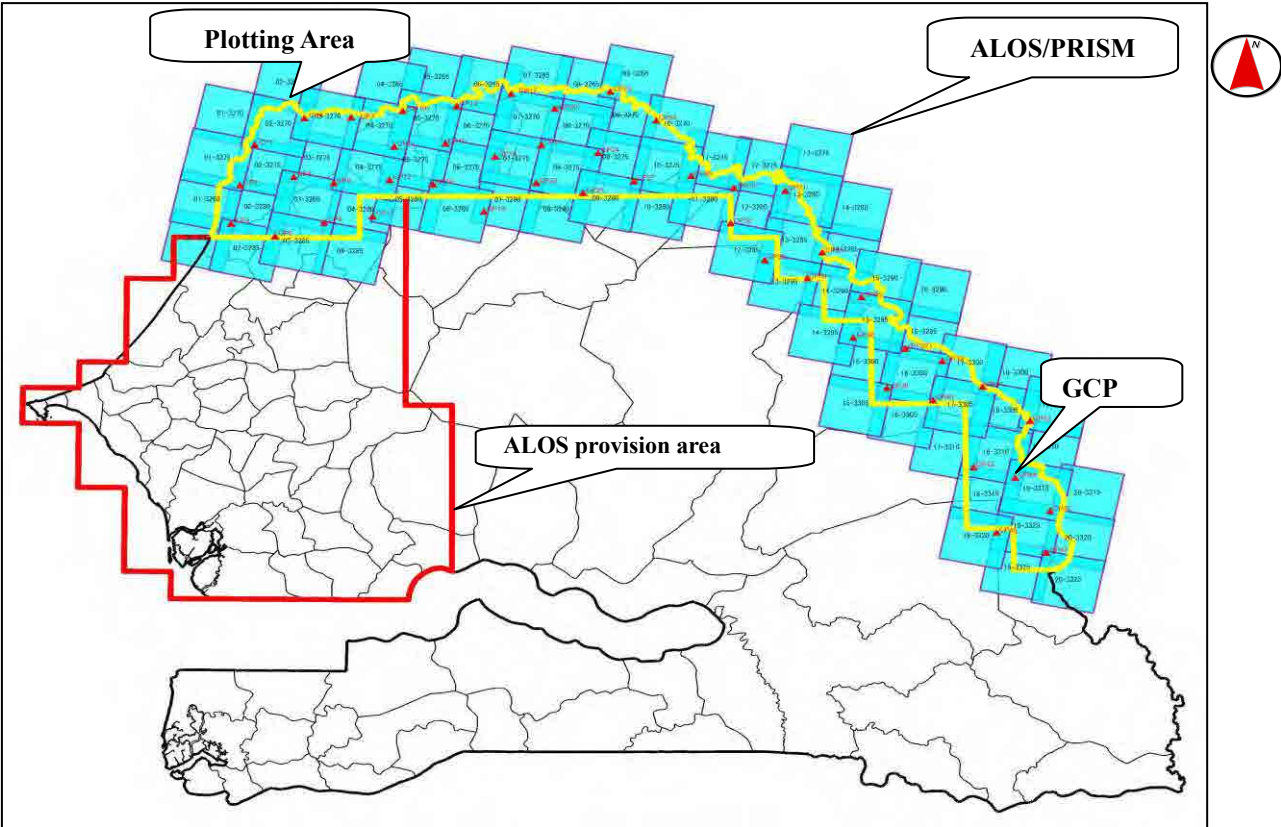


Figure 2-2 Layout of ALOS/PRISM scenes

[Data Used]

The data used is as follows:

- Satellite images: ALOS/PRISM, Level 1B1, CEOS format
- Orientation model: RPC model
- GCPs: 47 points in total
- Reference coordinate system
 - Projection information: UTM 28 System North
 - Reference ellipsoid: GRS80
 - Geodetic coordinate system: ITRF2000

[Software Used]

The following software was used:

- LPS by Intergraph Corp.

[Work Flow]

Aerial triangulation was carried out following the workflow shown below:

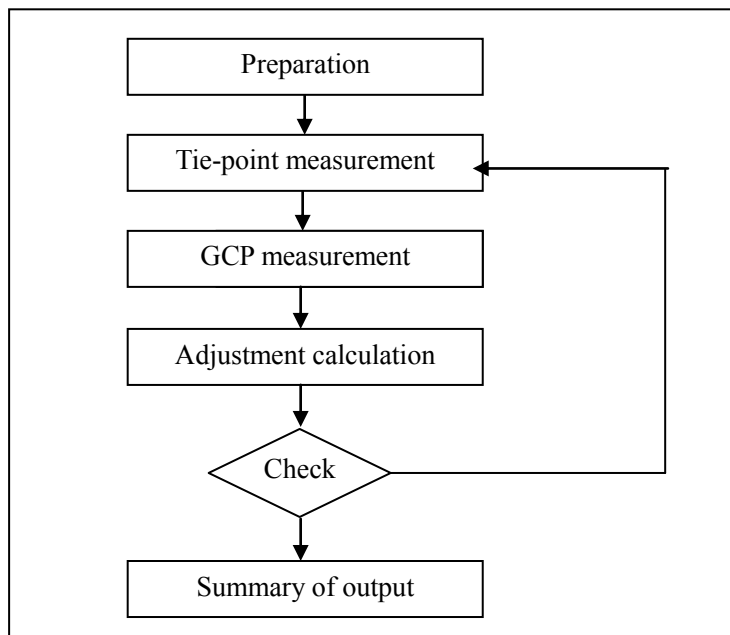


Figure 2-3 Flow of technology transfer in aerial triangulation

a) Adjustment Calculation and Results

Adjustment calculation was carried out using the image coordinates of the tie-points and GCPs, GCP outputs (3D coordinates), and the RPC model. Additional parameters used in the adjustment calculation were the shift term and the drift term. The limit values used to determine the conformance of results were the following values specified in the “Guidelines for the Creation of 1/50,000-scale Topographic Maps Using ALOS Optical Images” created by the Geospatial Information Authority of Japan.

➤ Limit values

- Control point residual error: Planimetric location: Standard deviation 5.0 m
Maximum 10.0 m
Height: Standard deviation 3.3m
Maximum 10.0m
- Intersection residual error: Standard deviation 1.0 pixel
Maximum 2.0 pixels

When the adjustment calculation was first carried out using all the scenes, the control point residual errors satisfied the limit values, but there were 32 points at which the maximum value for the intersection residual error exceeded the limit. When a recalculation was done excluding the forward views with large residual errors that had been identified during the tie-point measurement, the results obtained satisfied the limit values at all points. Although digital plotting is possible without using forward view images if stereo pairs of nadir and backward views are used, adjustment calculation was carried out on the paths including the excluded scenes as a single block, so as to use all the scenes. The following Table 2-6 shows the calculated intersection residual errors and control point residual errors.

Table 2-3 Control point residual errors

Block	Intersection Residual Error (unit: pixel)		Ground Control Point Residuals (unit: m)				Remarks
			Planimetric Location		Height		
	Standard deviation	Maximum	Standard deviation	Maximum	Standard deviation	Maximum	
all	0.20	1.85	1.361	3.173	0.882	2.157	Ignore Forward view image of even No. Path
02	0.39	2.54	1.500	3.169	2.447	5.390	
04	0.46	2.41	2.230	4.624	1.763	4.050	
06	0.52	2.48	2.139	3.097	0.964	2.027	
08	0.45	1.99	1.012	2.061	1.665	3.251	
10	0.43	2.13	0.008	0.010	1.220	2.267	
12	0.48	2.89	1.367	2.246	1.974	4.920	
14	0.48	2.71	0.569	0.706	2.376	5.934	
16	0.47	2.97	1.138	1.284	2.569	6.551	
18	0.49	1.97	1.394	2.118	2.599	6.179	
20	0.43	1.71	0.313	0.369	1.357	1.847	

Although some blocks were found to have a maximum intersection residual error in excess of the limit value of 2.0 pixels, they were deemed permissible because they were all GCPs and the error was less than 3.0 pixels at most, not a huge deviation from the limit values. Therefore, they were not excluded from the calculation but used as is.

b) Summary of Outputs

The RPC models after adjustment were stored in the format of LPS, the supplied software, so that they can be used by ANAT in the future. At the same time, they were also stored scene by scene in text format for the sake of versatility.

2.7 (9) Field Identification and Field Verification (Work in Senegal)

2.7.1 Field Identification

The field identification was carried out under the conditions described below. The field identification was started after the completion of the GCP survey on account of the lack of vehicles: four vehicles were loaned by JICA for the identification but three vehicles were used at all times in the GCP measurement, so that it was not possible to secure the number of vehicles (four) needed for the field identification.

The initial plan was to survey for all 54 map sheets, but the identification ended with approximately 80% completed in the designated field identification period, the work being time-consuming due to the many villages scattered over the area, the time spent travelling the long distances between them, etc. The remaining maps were surveyed by ANAT alone in coordination with the Japanese Study Team.

[Work Area and Amount of Work]

- Senegal: Saint Louis, Louga, Matam, and Tambacounda regions
- Total of 54 maps (30,000 km²: See attached Work Area)

[Work Period]

From July 25, 2011 to September 22, 2011: 60 days in total

From December 13, 2011 to December 23, 2011: 11 days in total



Photo 2-3 Training in study team office



Photo 2-4 Practical training involving all the ANAT participants

➤ Field Identification

The field identification and the following work were carried out using satellite image photos for which preliminary photo interpretation had been completed.

- Creation of interpretation key
- Technology transfer

➤ **Organization of Survey Items**

The planimetric features collected during the field work were organized as shown below to be used as reference for subsequent compilation work.

- Locational information acquired using GPS-enabled digital cameras: HDD filing
- Scanning (digitalization of photos for field work): HDD filing

➤ **Implementation Report**

Reports on the field identification were submitted to the JICA Senegal Office.

➤ **Map Symbols Used**

The map symbols used in the field were the “Senegal Map Symbol Specifications” (Draft) created in advance in discussions of the specifications in compliance with the “African Mapping Standards” and the survey covered about 200 items.

➤ **Summary of Survey Results**

In order to provide locational information for the subsequent work, the images taken using GPS-equipped digital cameras were printed out as enlarged photos for use in the field identification, and marked with the planimetric feature code numbers on the acquisition positions.

➤ **Creation of Interpretation Key** (see Appendix 9)

For the creation of the interpretation key, for the most part the Japanese side selected interpretation key items in advance during the preliminary photo interpretation process and also implemented the process in the field identification. Data for the items listed below was acquired.

Table 2-4 List of items for an interpretation key

No.	Acquisition item	No.	Acquisition item	No.	Acquisition item
1	Track	2	Footpath	3	Electric transmission line
4	End of transmission line	5	Deep ditch	6	Fence or barrier
7	Building (square symbol)	8	Object (round symbol)	9	Aerodrome
10	Fountain or well	11	Irrigation canal	12	Pond, swamp, or lake
13	Marshland	14	Flood plain	15	Mangrove
16	Orchard	17	Savanna	18	Scrub
19	Farm	20	Cultivated land (rice paddy, etc.)	21	Other: grassland, palm trees, baobab

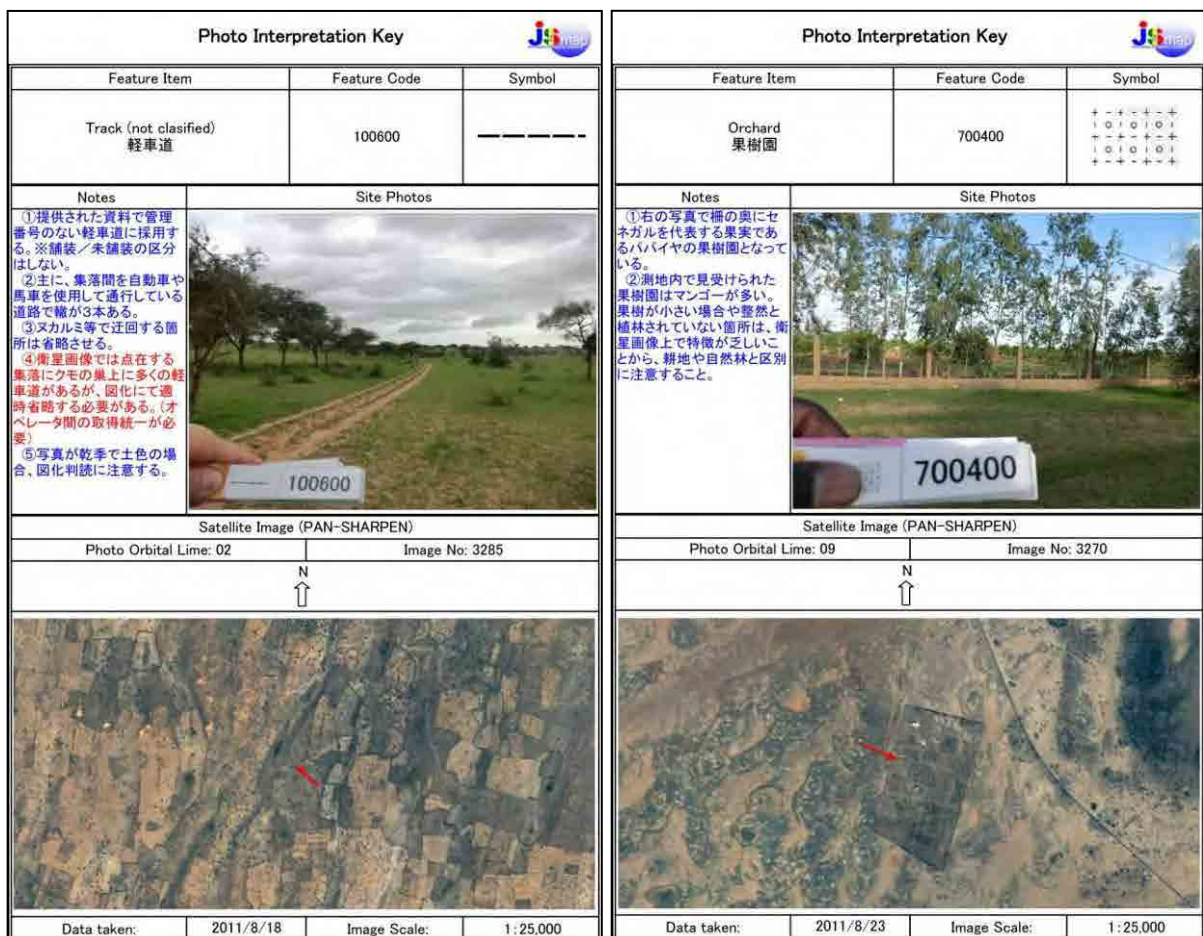


Figure 2-4 Examples from the interpretation key

2.7.2 Field Verification

Unclear points found during plotting were verified in the field. The details of the field verification are shown below.

[Preparation]

➤ Field Verification Map

- (1) Detailed check of field verification map data
- (2) Release of field verification maps (printed on waterproof paper) + PDF (spare; assumed to be map output from ANAT)
- (3) DGN + PDF data is stored on HD and then brought into Senegal (Orthophotos are also stored on HD)

➤ Annotation Check Map

- (4) Field verification map on which unclear locations and unclear annotations have been indicated

➤ **Road Type Classification Check Map**

(5) Map on which plotted roads and road data from 1/200,000-scale topographic maps are output overlaid on each other

[Work Area and work volume]

- Saint Louis, Louga, Matam, and Tambacounda regions
- Total of 54 maps (30,000 km², Approx. See attached Work Area)

[Work Period (including period of visit to Senegal)]

40 days in total (From Monday, July 9, 2012 to Friday, August 17, 2012)

[Work Schedule]

The work schedule was as follows

First field verification work

From July 16, 2012 to July 27, 2012 12 days in total

Saint Louis, Louga, Richard Toll, and Ndioum regions

Second field verification work

From August 1, 2012 to August 12, 2012 12 days in total

Tambacounda, Kidira, and Matam regions

[Purpose of the Work]

The purpose of the field verification work was as follows.

- 1) In the digital plotting work based on the field identification work data, to supplement and verify the items that occurred (map symbols, annotations, etc.).
- 2) To organize and store the field verification data for supply to subsequent work, to improve map accuracy.
- 3) To enable the staff of ANAT to understand and master the technology for creating and correcting topographic maps independently, to aid the continued development of geographic information in Senegal.

2.8 (10) Digital Plotting and Compilation (Work in Japan)

The following digital plotting and compilation work was implemented in Japan to produce the outputs shown below.

- Digital plotting and compilation sheets 54
- Field verification sheets 54
- Road map for verifying roads 54

2.8.1 Digital Plotting Work

Stereo plotting work was implemented using control data from satellite images acquired as a result of aerial triangulation, in accordance with the specification criteria shown below. All the images used were pan-sharpened and the plotting work was conducted in stereoscopic view to improve readability.

[Plotting Specifications]

- Satellite images: ALOS (forward, backward, and nadir views)
- Ground resolution: 2.5 m
- Plotting scale: 1/50,000
- Plotting area: Approx. 30,000 km²
- Number of maps to be plotted: 54 maps (not including extended parts)
- Contour interval: 10 m for main contour lines
50 m for index contour lines
- Map projection: UTM (Zone 28 North)
- Map framework: Latitude 15', longitude 15'

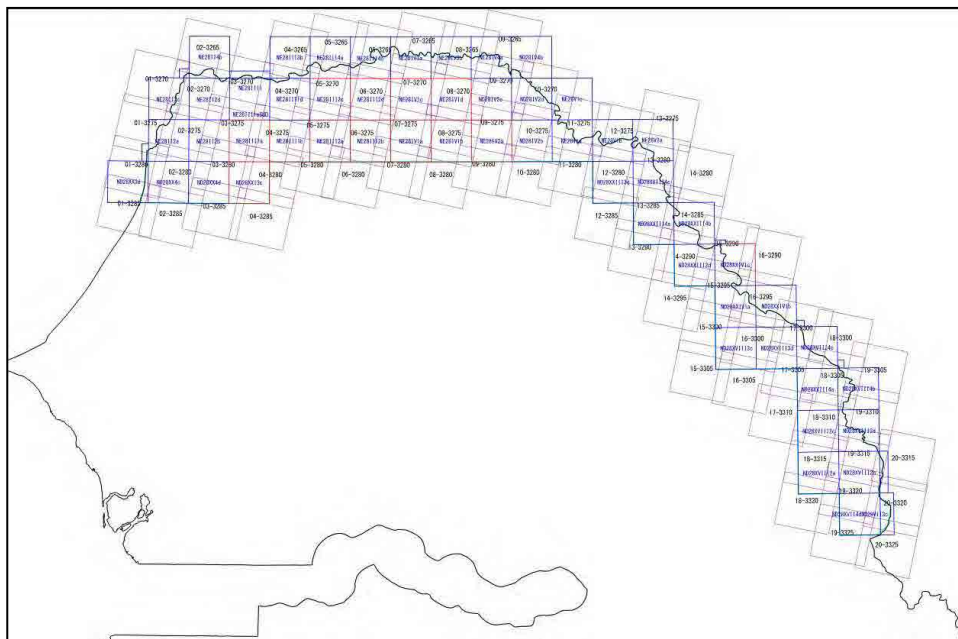


Figure 2-5 Index map for digital plotting and compilation sheets

[Materials Used]

The data and materials used for the plotting work are shown below.

- Interpretation key
Created in the field identification and compiled into the interpretation key register
- Pan-sharpened ortho images
Pan-sharpened color ortho images on a scale of 1/50,000

- Collected materials
Existing 1/50,000-scale topographic maps, 1/200,000-scale existing map data crop calendar, etc. Since satellite images are archived data, vegetation information matching the timing of the image acquisition was acquired and used to facilitate interpretation.
- Field identification photos
Field identification photos annotated with field identification information and converted into image data through scanning in the field
- Map symbol specification (Criteria for acquiring planimetric features)
Summary of specification discussions and meetings with ANAT up to the present
- Resource files, etc. defining line types
- Photos of local conditions
- Map framework data

2.8.2 Digital Compilation Work

Digital compilation was performed using the specifications shown below.

- Specifications
 - Compilation scale: 1/50,000
 - Compilation area: About 30,000 km²
 - Number of maps to be compiled: 54
 - Map framework: East-west 15' (about 26.8 km), north-south 15' (about 27.7 km)
- Digital Compilation Work
Using the digital plotting results, digital compilation was done by entering annotations, administrative boundaries, etc. with reference to the materials listed below.
 - 1) Field identification photos (including the kmz data of photos of features in the field)
 - 2) Existing maps (1/50,000)
 - 3) Existing data (SHP files)
 - 4) Road type data
 - 5) Range and names of villages
 - 6) Field verification items

➤ Digital Compilation Results

The digital compilation data was created in the Bentley MicroStation V8 (DGN format).

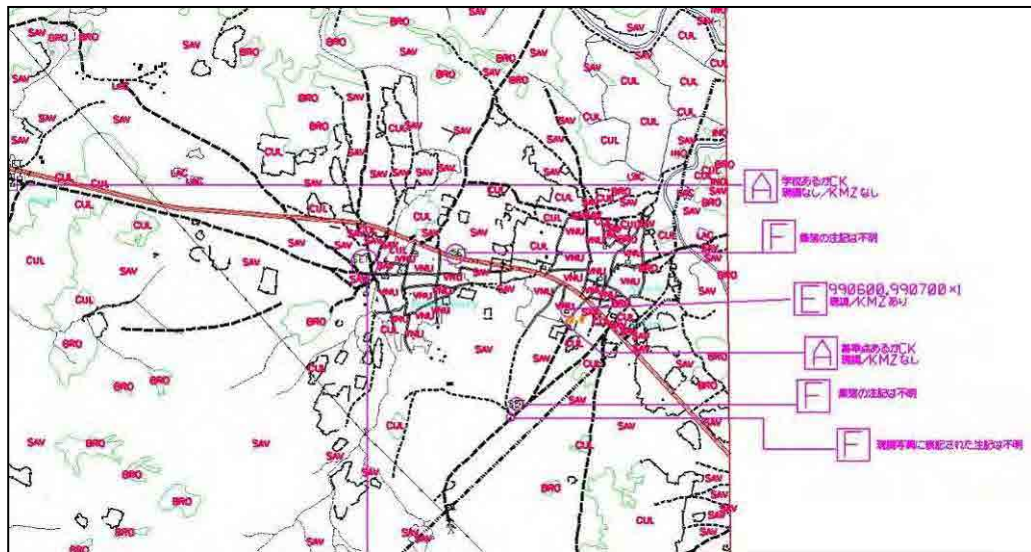


Figure 2-6 Digital Compilation Results

[Digital Compilation after Field Verification]

The digital compilation after field verification was carried out using the field verification and based on the following specifications.

- Compilation scale : 1/50,000
- Compilation area : 29,477 km²
- Number of maps to be compiled : 54
- Map framework : East-west 15' (about 26.8 km), north-south 15' (about 27.7 km)

2.9 (13) Digital Data Structurization (Work in Japan)

Data Transformation from compiled data referred field compilation to data format which have ability to be used for GIS and compilation works for its data transformation was carried out.

[Data Structurization and Compilation]

In the Data Structurization and Compilation, logical checking and data amendment for compiled data referred field compilation and compatible data structurization about the geometry and topology was carried out. CAD software, Bentley Map was used for the Data Structurization and Compilation. In addition, the data after Structurization and Compilation was used as original data for Symbolization Data Structuring.

a) Logical Checking

Logical checking was conducted for the following items by using of logical checking function of software and processed for the creation of data polygon as well.

b) Phase Structurization

By using of structured and compiled data, phase structurization was carried out for the data classification such as point, line and polygon of all field objects based on the symbol specification.

[GIS data creation]

Data after the Structurization a Compilation was transformed to SHAPE file format based on the following specification. As a rule, attribute information of each data are name and classification code. Regarding the data with height information such as contour lines is expressed with altitude value. The detail of added attribute information is stated in symbol specification.

2.10 (14) Map Symbolization (Work in Japan)

➤ Specifications

- Map symbolization scale: 1/50,000
- Map symbolization area: About 30,000 km²
- Number of maps symbolized: 54 sheets
- Map framework: East-west 15' (about 26.8 km), north-south 15' (about 27.7 km)

➤ Map symbolization of topographic maps

Map symbolization was carried out using the results of the digital compilation after field verification.

- 1) Structurization for map symbolization
- 2) Creation of marginal information plates
- 3) Map symbolization

➤ Map Symbolization Results

The map symbolization data was created in Adobe Illustrator (ai) format.

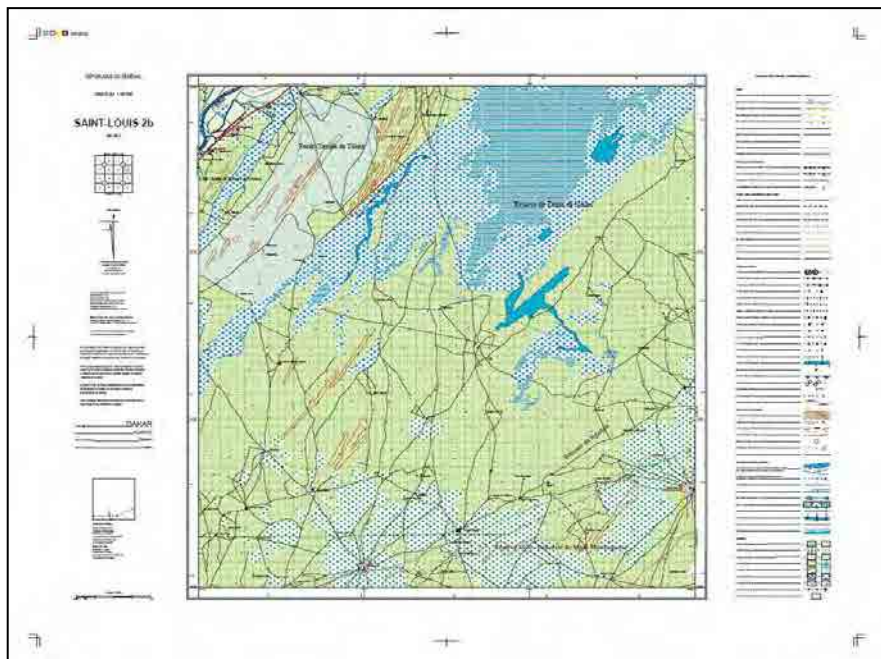


Figure 2-7 Topographic map with symbolization completed

[Quality Control]

For each sheet, an inspection was carried out for each of the processes listed below, and a quality control sheet was created.

- Digital plotting
- Digital compilation
- Map symbolization

Table 2-5 Quality Control Sheet

Sample quality control sheet Digital plotting, Data compilation/Symbolization Quality control sheets Checked Date : 13/Apr/2012

Project Name	Sheet Name/No.	Mapping Scale	Volume			Executive Organization			Chief Engineer	Checked by	
The Project of National Map Infrastructure of the Republic of Senegal	NE28H2a	50,000	619.605Km ²			AERO ASAHI CORPORATION ASIA AIR SURVEY CO., LTD.			Harada Takashi	Arataki Kazunori	
Item	Missing	Error	Item	Missing	Error	Item	Missing	Error	Item	Missing	Error
Roads			Building symbols			Vegetation			Marginal information		
Classification	1	2	Classification	21	3	Form of boundary	2	8	Sheet Name/No.		
Form	0	1	Position	5	4	Classification of symbol	6	14	District name		
Road institutions			Accessory objects			Annotation			Neat & Grid Line		
Tree row	0	0	Classification of symbols	3	0	Administration name			Coordinates Value, etc.		
Railways			Position of symbols			Park name			Scale Bar/Map symbol		
Classification	0	0	Form of lines	0	4	River, Lake name			Sheet index		
Form	0	0	Geodetic points			Building name			Sheet History		
Electric, Telephone supply			Value			Place ground name			Planning / Executing Org.		
Classification	2	0	Contour Lines			Road name			Others		
Form	0	3	Classification	0	3	Railway name			Connection between adjacent sheets	1	3
Administrative Boundaries			Value			Geodetic points name					
Classification			Natural features			Government office name					
Form			Form			School name					
Fences			Form			other annotation					
Classification	0	0	Water features								
Form	3	4	Classification of symbol items								
Buildings			Position of symbol items								
Classification	2	14	Form of line items								
Form	2	3	Flow direction								

For each of the planimetric features, the number of omissions, misentries, etc. were recorded. Any feature omitted or entered incorrectly was corrected in each process before the next process was started.

2.11 (15) Creation of Data Files (Work in Japan)

Structured data and Symbolized data was created following data format as Topographic map data and GIS basic data. Unit of file separation is summarized in each sheet individually as DWG and DGN data format, taking into consideration using for the map up-dating work expected from now on in future. The topographic map data, structured and compiled data were created by AI, DGN file format but DPF and DWG data file format also created for taking into consideration of general data versatility. These data file were stored in HDD and/or DVD media as following manner.

- Topographic map Data : PDF and AI data format, map sheet unit
- GIS basic Data : SHAPE data format, Department unit
- Structured compilation data : DGN and DWG data format, map sheet unit

2.12 (16) Structuring of Website (Work in Japan and Senegal)

The Study Team has implemented the work required for the structuring of a Website for downloading and browsing the digital topographic maps using the WebGIS technology for the purpose of promoting the utilization of the outputs of this study.

In the third Field Work, the Study Team carried out a final review of the website that had been created in accordance with the required specifications.

After the final review, in the final seminar the ANAT engineer in charge of the website gave a presentation regarding the website.

2.13 (17) Structuring of System of Usage (Work in Senegal)

To allow a wide range of users to make effective use of the 1/50,000 scale digital topographic maps that are the outputs of this project, it will be necessary to

- Inform as many persons and organizations as possible of the existence of the topographic maps, with details;
- Ensure that the topographic maps are readily available to the persons and organizations intending to acquire them;
- Make the process of creating new products easier and more transparent for persons or organizations intending to use or convert the acquired topographic maps for that purpose; and
- Explain in an easy-to-understand manner any restrictions on such actions that may be required.

Therefore, the Study Team constructed a system for the usage of digital topographic maps and carried out activities to promote utilization. Since the range of map users must be expanded over the long term, it was determined that the activities should include the spread of map use among ordinary citizens and young people. Seminars for promoting the use of digital topographic maps are described in Section 2.14, “(18) Seminars to Promote Utilization.”

[Study Plan]

Before the start of the study, the goals and the outputs required to achieve those goals were determined as shown below.

a. Goals

- (1) The system to promote secondary use shall be established by the ANAT by means of, for example, clarification of the fee structure and management of copyright.
- (2) The wide-scale demand for the 1/50,000-scale topographic maps to be created in the project shall be revealed and effective use made of the topographical maps and data.

- (3) Activities shall be undertaken to identify the demand and connect it to practical applications. In addition, the system for secondary use shall be operated and maintained smoothly.
- (4) Interest in and understanding of geospatial information shall be promoted among the ordinary citizens and young people.

b. Outputs

- (1) Rules relating to secondary use licenses and the collection of fees shall be drawn up.
- (2) A list of the demands for the application of the 1/50,000-scale topographic maps to be created in this project shall be drawn up. Examples of actual use shall be gathered and made public.
- (3) A compilation of case studies relating to secondary use licenses and the collection of fees shall be compiled and a report on meeting the demand for the use of topographic maps shall be prepared.
- (4) Public relations on geospatial information aimed at ordinary citizens and young people shall be carried out regularly.

Item (3) in the above list involves technology transfer, and is detailed, including the progress status, in Section 3.1.8 ⑧, “Promotion of Utilization/Construction of System of Usage.”

To achieve outputs (1), (2) and (4) above, it was determined that the activities listed in Table 2.6 should be carried out.

Table 2-6 Outputs and corresponding activities relating to the construction of a system of usage and the promotion of utilization

Output	Activities
1. Rules relating to secondary use licenses and the collection of fees shall be drawn up.	1-1 Survey of copyright-related laws in Senegal, current pricing and handling of maps and other products supplied by the C/P organization
	1-2 Survey of the handling of the copyright of information such as statistics, cadastral data and weather supplied by Senegalese government organizations and the current situation with regard to the collection of fees for the information, if any
	1-3 Explanation to the C/P organization and Senegalese government staff of the concept of copyright and pricing in Japan and other countries, and a survey of their opinions regarding their applicability in Senegal
	1-4 Analysis of the economic effects according to conditions in Senegal based on the existing results of investigations of the economic effects of topographic maps, and a raising of the awareness of the C/P organization
	1-5 Based on the results of Items 1-1 to 1-4, the creation of draft rules relating to secondary use licenses and the collection of fees; Consultation with GICC* about overseeing of the rules wherever possible in line with the intentions of the C/P organization
	1-6 The results of all the items above to be incorporated in the rules
2. A list of the demands for the application of the 1/50,000-scale topographic maps to be created in this project shall be drawn up.	2-1 Survey of the demand for 1/50,000-scale topographic maps in the relevant government organizations, etc.; In particular, a detailed survey of the agriculture-related organizations that are the main target of this project, not yet surveyed at the time of the detailed planning survey
	2-2 Selection of organizations strongly motivated to make use of the 1/50,000-scale topographic maps to be created in the project, and coordination of the case studies with these
	2-3 Provision of assistance for the creation and implementation of a program for GICC to stimulate activities to promote the use of 1/50,000-scale topographic maps
	2-4 Meetings with the C/P to discuss the outline of workshops to be held
	2-5 Report on interim outputs of the project to GICC* and raising of expectations relating to

Examples of actual use shall be gathered and made public.	the use of project outputs by relevant organizations
	2-6 Provision of interim outputs to promote the creation of examples of use by the organizations identified in Activity 2-2, with comments on the specific content of the examples and the work required to achieve them
	2-7 Survey of the organizations (private, etc.) not found in the 1/50,000-scale topographic map needs survey of the relevant government organizations in Activity 2-1, and of organizations that need supplemental survey to promote utilization
	2-8 Holding of workshops
	2-9 Addressing the demand found
4. Public relations on geospatial information aimed at ordinary citizens and young people shall be carried out regularly.	4-1 Survey of the interest in maps among ordinary citizens and young people and ANAT's public relations activities towards them
	4-2 Study and preparation for activities to attract the interest of ordinary citizens and young people
	4-3 Activities such as visiting workshops and open days to attract the attention of ordinary citizens and young people

*: Groupe Interinstitutionnel de Concertation et de Coordination: A group aimed at coordinating discussion among relevant organizations (for the implementation and monitoring of the geospatial information plan). The chairperson is the head of the State Agency of Informatics (ADIE), and the secretary general is Mr. Ndong, the director of the Geographic and Cartographic Works Department of the Agency of National Land Management (ANAT).

For the activities shown in Table 2-6, the work in Senegal was implemented in four phases, in accordance with the schedule shown in Table 2-7.

Table 2-7 Schedule of work in Senegal

Work in Senegal	Schedule
First phase	Saturday, June 18 to Sunday, July 10, 2011
Second phase	Tuesday, April 10 to Friday, May 4, 2012
Third phase	Saturday, October 6 to Thursday, November 1, 2012
Fourth phase	Friday, January 31, 2013 to Sunday, February 24, 2013

[Overview of Outputs Obtained]

The major outputs obtained as a result of implementing the work in Senegal in accordance with the schedule shown above are shown below.

Output 1:

- The supply forms and prices (proposed) for the 1/50,000-scale digital topographic maps and digital orthophotos (the outputs of this project) have been determined.
- The rules relating to secondary use licenses for the digital topographic maps (Document 5) and digital orthophotos mentioned above have been determined.

Output 2:

- The demand for 1/50,000-scale topographic maps and digital orthophotos in the relevant

government organizations, etc. was surveyed and listed.

- Organizations strongly motivated to make use of the 1/50,000-scale topographic maps and digital orthophotos were identified, and encouraged to provide study cases and speak about the results at the project-end seminar.
- The status of this project was widely notified via visiting surveys, seminars, etc. to uncover the demand for digital topographic maps and digital orthophotos.

Output 4:

- Since the school curriculum includes map study, map education is being given although it is not sufficient. However, it turns out that maps are not used in everyday life.
- Secondary schools were visited to provide lessons on maps, thereby getting the C/P to recognize the importance of awareness activities about maps for young people, and marking the start of specific activities.

[Implementation Status: (Output 1) Creation of Rules Relating to Secondary Use Licenses and Fee Collection]

The activities related to Output 1 were carried out according to the plan described below. Note that Activity 1-4 shown in Table 2-6 was cancelled in view of the state of progress and circumstances relating to the C/P.

(1) Situation Relating to Copyright in Senegal, Map Supply and Secondary Use Licensing by ANAT (Activity 1-1)

- Copyright in Senegal

With regard to copyright in Senegal, the “Law No. 2008-09 of January 25, 2008 on Copyright and Related Rights” (LOI n° 2008-09 du 25 janvier 2008 portant loi sur le Droit d’Auteur et les Droits voisins) was downloaded from the legal site of Senegal (<http://www.jo.gouv.sn/>) (Document 1).

Article 6 of the said law gives examples of copyrighted work covered by the Copyright Laws. Item 7 of this article lists “maps, ground plans, sketches, and plastic work related to geography, geology, architecture, and science,” and therefore topographic maps are subject to protection under the Copyright Law. According to Article 53 of the said law, the duration of copyright is 70 years.

- Situation Relating to Map Supply and Secondary Use Licensing by ANAT

The principal maps supplied by ANAT are available at the prices shown in Table 2-8. Any product created by a Senegalese government organization can commonly be supplied free of charge if a letter requesting it is sent to the head of the organization. However, ANAT is permitted to supply maps at a charge in accordance with an ordinance issued in 2000 (Document 2). Note that, after the establishment of ANAT in 2009, DTGC became a bureau of ANAT and the 2000 ordinance ceased to have effect. Instead, the ordinance for the establishment of ANAT (Document 3) specifies that

DTGC has jurisdiction over geospatial information, but does not specify anything about a charge being made for the supply of maps, and this remains an issue yet to be determined. The supply of maps for a fee is a continuation as a matter of practice of the method operating hitherto.

Table 2-8 Major maps supplied by ANAT, and their prices

Map name	Price (paper)	Price (CD)	Remarks
1/50,000-scale topographic maps	4,000	15,000	
1/200,000-scale topographic maps (new series)	5,000	20,000	
1/200,000-scale topographic maps (former series)	4,000	15,000	
1/500,000-scale maps	8,000	15,000	Price for one pair covering the country
1/1,000,000-scale road maps	2,500	15,000	
City schematic map	—	Available on order	Scale 1/50,000
Dakar ground plan	2,500	Available on order	
Aerial photographs	3,500	7,500	Digital photos are scanned at 150 dpi.

* Prices are in CFA francs (Fixed exchange rate of 1 Euro = 655.957 FCFA).

The price of a 1:50,000-scale topographic map (paper) is 4,000 FCFA. The price of a topographic map of the same scale in Japan (290 yen), works out at about 1,600 FCFA (assuming one yen to be 5.7 FCFA), making the Senegalese topographic map about 60% more expensive. The price of a 1/200,000-scale topographic map created with the assistance of the EU several years ago is 5,000 FCFA, even more expensive.

Table 2-9 shows the sales volume of topographic maps by type from January to June 2011. According to this data, the 1:200,000-scale new topographic maps (paper) sell the best, followed by 1:50,000-scale topographic maps (paper) and digital topographic maps, in that order. In January, the sales volume of the 1:200,000-scale new topographic maps (paper) was extraordinarily high but seems to have been bulk purchases by bookstores. The bookstores bulk-purchase maps at a discount price and sell them at a premium. In February there were no more bulk purchases because of a change in the system in January, in which the bulk purchase discount was discontinued.

The system of map pricing is to be determined by the governing minister based on the draft proposal made through consultation by the relevant executives. However, the draft proposal is not made according to any specific price calculation criteria.

Table 2-9 Sales volume of major maps provided by ANAT (January to June 2011)

Map type	Sales volume (2011)						
	January	February	March	April	May	June	Total
1/50,000-scale topographic maps (paper)	16	15	10	17	33	33	124
1/200,000-scale topographic maps (paper) (New series)	1,180	45	40	110	57	97	1,529
1/200,000-scale topographic	7					2	9

maps (paper) (Former series)							
1/500,000-scale maps (paper)	2	1			2	7	12
1/1,000,000-scale road maps (paper)		1	2			1	4
Dakar ground plan (paper)	3		2	1	10	13	29
Digital topographic maps (1/50,000-scale and 1/200,000-scale)		19	3	32	2		56

Generally, secondary use of any product created by a Senegalese government organization is permitted regardless of whether it is commercial or non-commercial use, as long as the source is acknowledged. Paper maps supplied by ANAT may be handled in the same way if sufficient editing is added. Digital maps must not be used unless the purchaser makes an agreement with ANAT in order to prevent illegal distribution, etc. Since one of the conditions for use is the prohibition of commercial use, applications for commercial use are handled on a case-by-case basis.

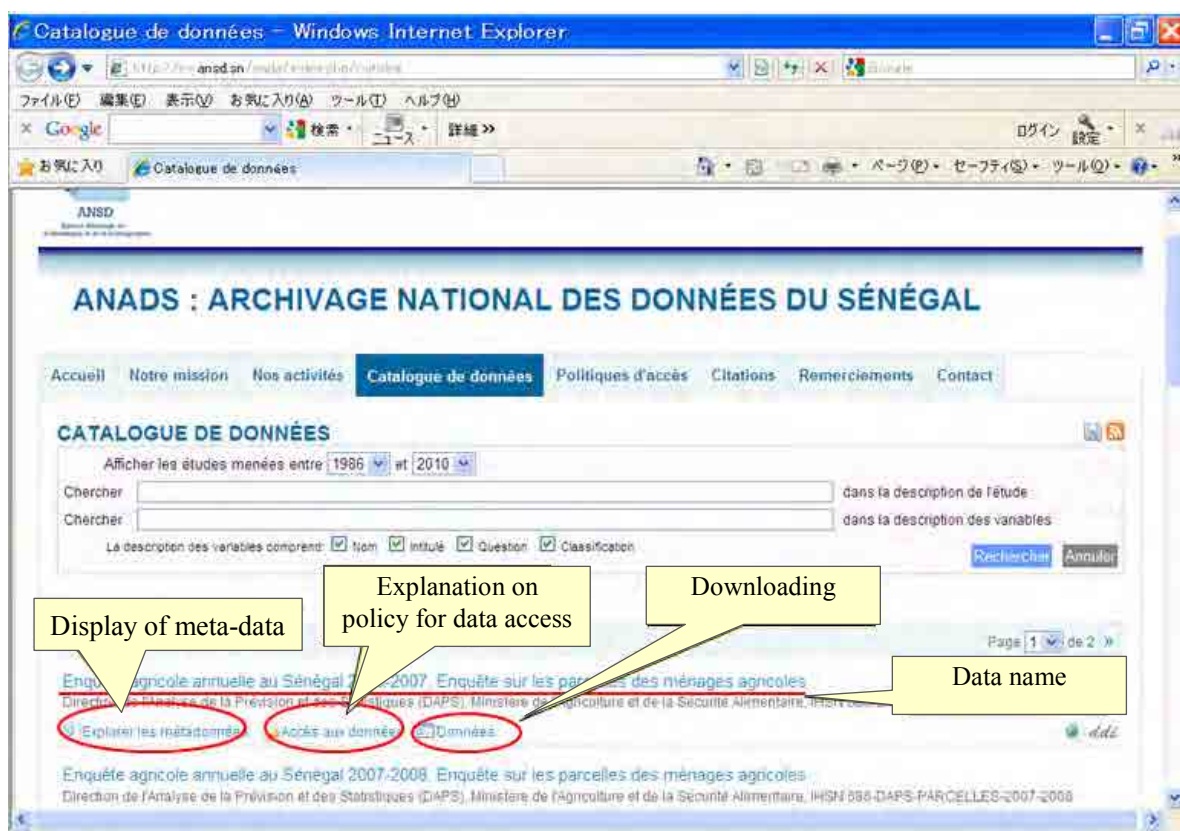
(2) Supply of Data by Government Organizations Other than ANAT (Activity 1-2)

As mentioned earlier, any product created by a Senegalese government organization can commonly be supplied free of charge if a letter requesting it is sent to the head of the organization. However, some government organizations such as the cadastral and statistics bureaus handle this matter in their own way.

The Directorate of Cadastre supplies cadastral maps, etc. at prices stipulated by law (Ministerial Ordinance, Document 4) in the same way as the former DTGC. It also supplies digital data but, unlike ANAT, no agreement needs to be exchanged for secondary use as long as the source is acknowledged. However, there are some data that cannot be supplied due to other laws. For example, the names of landowners are not supplied due to the personal information protection law.

The Statistics and Demography Agency supplies detailed data of the national census over the Internet and by other means (Figure 2-8). By agreeing over the Internet with the conditions of use displayed and applying for use specifying the name, address, purpose of use, etc., a user can download the data from the Internet or obtain it on a CD-ROM after passing the screening process. Access to the data may or may not be free of charge.

Figure 2-8 Statistical data archive site of the Statistics and Demography Agency



(3) Handling of Copyright and Pricing in Japan and Western Countries (Activity 1-3)

The handling of copyright and pricing of topographic maps created by the national mapping organizations in Japan, the U.S., the U.K., France and Germany are unique to those particular countries, as shown in Table 2-10. As a global trend, however, free supply of data and simplification of copyright handling can be observed, such as free downloading of some data or for some users in Japan, the U.K., and France, and simplification of copyright control in the U.K.

Table 2-10 Pricing and handling of copyright for maps created by national mapping organizations in major countries

Country	Pricing	Copyright handling	Recent changes
Japan	<ul style="list-style-type: none"> Amount equivalent to cost (printing and distribution) + copyright Free download of basic map information 	<ul style="list-style-type: none"> Copyright is claimed. Secondary use is permitted with the focus on application of the Survey Act. Secondary use is permitted free-of-charge if sufficient editing is added. 	<ul style="list-style-type: none"> Free supply of basic map information was started in 2008.
U.S.	<ul style="list-style-type: none"> Free download of digital maps Supply of paper maps for the amount equivalent to cost (printing and distribution) 	<ul style="list-style-type: none"> Products made by the federal government are copyright-free. No restriction is imposed on secondary use. 	

U.K.	<ul style="list-style-type: none"> ▪ Fair price setting according to the Competition Law 	<ul style="list-style-type: none"> ▪ Strict copyright control is imposed. ▪ Data is supplied and secondary use permitted by license agreement. 	<ul style="list-style-type: none"> ▪ Free supply of most data was started in 2010 (OS OpenData). ▪ The complex license agreement has been simplified.
France	<ul style="list-style-type: none"> ▪ Pricing taking into account the cost of information collection and creation, including an amount corresponding to intellectual property rights ▪ Pricing also takes into account market prices of equivalent products by private companies 	<ul style="list-style-type: none"> ▪ Aerial photos are copyright-free (but orthophotos are copyrighted). ▪ Data is supplied and secondary use is permitted by license agreement. 	<ul style="list-style-type: none"> ▪ Basic map information RGE is available for free download for public and educational purposes.
Germany	<ul style="list-style-type: none"> ▪ The federal government claims fees are charged appropriately to avoid conflict with the private sector. On the other hand, state organizations are expected to make a profit and therefore pricing guidelines have been established in coordination 	<ul style="list-style-type: none"> ▪ Data is supplied and secondary use is permitted by license agreement. 	

(4) Creation of Rules on Fee Collection and Secondary Use (Activities 1-5 and 1-6)

Based on the situation in Senegal and the global trends described in Sections (1) to (3), this operation was carried out to draw up rules on fee collection and secondary use of products derived from the 1:50,000-scale topographic maps and orthophotos that are the outputs of this project.

• Second Phase Work in Senegal (April and May 2012)

The Study Team drew up and explained to ANAT the “Rules on Secondary Use and Prices, Draft Framework Outline” and the “End User License Rough Draft” for products derived from the project outputs (referred to below as project outputs). The Draft Framework Outline puts forward the rough plan and its background with regard to possible points requiring regulation: the introduction of licenses, consideration of differences in conditions of use (internal use and supply of derived products), the concept of price components, consideration of user categories, purchase quantities and number of terminals on which the data is used, effective license periods, and the introduction of sales agents. The Draft Framework Outline was drawn up with reference to examples of topographic map data provided by the national mapping organizations, etc., of the U.K., France, Germany and Japan. The “End User License Rough Draft”, on the other hand, was drawn up with reference to the license for Japan’s artificial satellite images ALOS.

Next, the prices of the project outputs were estimated based on the assumption of the price components set out in the Draft Framework Outline. The details of the price calculation follow examples taken from Japan. The data required for price calculation, i.e., the time required for the work, material costs and personnel costs, was acquired with the help of the ANAT staff. Another

factor required for calculation, the estimated sales volume of project outputs, was set based on the figures for the sales volume of the ANAT 1/200,000-scale topographic maps that were acquired in the first phase work in Senegal.

- Third Phase Work in Senegal (October 2012)

In the second phase work in Senegal, four documents were created: Rules on Secondary Use and Prices, Draft Framework Outline” “Draft of the Project Outputs End User License,” “Procedure for the Supply of the Project Outputs,” and “Price Calculation of the Project Outputs.” These documents were to be reviewed and commented on by ANAT, a department of the C/P organization ANAT, before the third-phase work. However, partly due to the appointment of a new ANAT director-general after a regime change, the operation of data supply was put under the charge of another department of ANAT in place of DTGC. Therefore, comments on these documents could not be obtained before the implementation of the third-phase work in Senegal.

In consideration of these circumstances, the “Rules for Secondary Use and Pricing of the Project Outputs (Draft)” was drawn up (Document 5). This document was presented when the Study Team had a meeting with the ANAT director-general on October 22, at which meeting it was determined that the ANAT staff in charge of public relations and sales would review documents from then on (Photo 2-5).



Photo 2-5 Meeting with ANAT executive director (From left to right, the director-general, secretary general, Mr. Maruyama, A director)

The draft rules (Document 5) defined the project outputs to be covered (Table 2-11), the introduction of licenses, prices and sales agents. It stipulated that the same licenses be used for both internal use

and secondary use, and required the submission of an application giving a detailed description of secondary use. Prices were calculated for four cases with different cost percentages assumed for maintenance of the original digital data. The same prices were set for both internal use and secondary use (Table 2-11) and it was assumed that no fee would be collected for a license for secondary use.

Table 2-11 Proposed prices of the project outputs Unit: FCFA

Project output type \ Percentage of maintenance costs (Ratio to prices)	0%	10%	50%	66%
1/50,000-scale topographic map data (CD-R)	2,500	2,800	5,000	7,500
1/50,000-scale topographic maps (printed maps)	4,800			
1/50,000-scale topographic maps (output maps)	4,200			
1/50,000-scale pan-sharpened ortho images (CD-R)	2,500	2,800	5,000	7,500
1/50,000-scale pan-sharpened ortho images (output maps)	7,000			

- Fourth Phase Work in Senegal (January and February in 2013)

Based on the results of the second and third phase work in Senegal, the rules for pricing and secondary use of the project outputs were drawn up.

Specifically, the team explained to the Director of the Department of General and Financial Affairs of ANAT, who was responsible for these matters, the draft rules for pricing and secondary use that were drawn up during the second phase and third phase work in Senegal, and asked him to study the rules. Later, in the discussions on the Draft Final Report, he explained to the team that he would approve the rules by 1st March 2013 after revising them in accordance with the conditions specific to Senegal, and his explanation was recorded in the minutes of the discussion. The draft rules are attached as document 5.

[Implementation Status: (Output 2) Creation of Description of Demand for Use of 1/50,000-scale Topographic Maps and Gathering/Publication of Examples of Use]

(1) Introduction of GIS and Demand for 1/50,000-scale Topographic Maps at Relevant Government Organizations, etc. (Activities 2-1 and 2-7)

- Administrative Structure in Senegal

In Senegal, the president is the chief of the state and the administrative organization, headed by the premier, is managed by ministers the names of whom are listed on the Website (<http://www.gouv.sn/-Le-Gouvernement-.html>). According to this site, 30 ministers have been appointed in addition to the premier. ANAT is under the control of the Ministry of Regional Planning and Local Government (Ministère de l’Aménagement du territoire et des Collectivités locales).

- NSDI Promotion System

In recent years, efforts to promote the use of geospatial information are under way in line with the concept of NSDI. To promote NSDI, a common practice is to establish a committee consisting of

government organizations related to the maintenance and use of geospatial information, which discusses specific measures.

NSDI of Senegal had been under consideration with assistance from Canada and the United Nations Economic Commission for Africa (UNECA) since the 1990s. As a result, in 2009, a government ordinance was issued to establish a group for discussion and coordination of the relevant organizations for the implementation and monitoring of the geospatial information plan (GICC), and a system for the construction of a national spatial data infrastructure (NSDI) was set up (Document 6).

The ordinance stipulates that GICC shall be chaired by the State Agency of Informatics (ADIE) and have a secretariat managed by ANAT and the Center for Ecological Monitoring (CSE) (Article 3 of the government ordinance). It also stipulates that there shall be seven work groups covering the geodetic reference system, elaboration of the national geospatial information plan, geospatial information database, etc (Article 5 of the government ordinance). Regarding the structuring of this NSDI, technical assistance by Canada (January 2009 to July 2013) is in progress.

Table 2-12 Relevant organizations for the national spatial data infrastructure

Organization name	Abbreviation	English translation
Agence de l'Information de l'Etat	ADIE	State Agency of Informatics
Autorité de Régulation des Télécommunications et des Postes	ARTP	Regulatory Authority of Telecommunications and Posts
Centre d'Entreprenariat et de Développement Technique	CEDT	Center for Entrepreneurship and Technology Development
Centre de Suivi Ecologique	CSE	Center for Ecological Monitoring
Direction Générale des Impôts et des Domaines	DGID	General Directorate of Taxes and State-owned Property
Direction of Mines and Geology	DMG	Directorate of Mines and Geology
Direction des Travaux Géographiques et Cartographiques	DTGC*	Directorate of Geographic and Cartographic Works
Direction de l'Urbanisme et de l'Architecture	DUA	Directorate of Urban Planning and Architecture
Institut National de Pédologie	INP	National Institute of Pedology
Laboratoire d'Etude et de Recherches en Géomatique	LERG	Laboratory for Studies and Research in Geomatics

*: DTGC is specified because the government ordinance was issued before the launch of ANAT.

Visits to User Organizations

To survey the demand for the use of 1/50,000-scale topographic maps, a visiting survey was carried out mainly targeting the relevant organizations for GICC, i.e., the 17 government, public, and international organizations and private companies listed in Table 2-13. Many of these organizations had introduced GIS, understood the necessity of and were interested in the use of the 1/50,000-scale topographic maps to be created in this study. Of these, nine organizations that created and used GIS data (indicated with a circle next to the name in Table 2-13) were interested in the construction of an application using the provisional data of 1/50,000-scale topographic maps.

The detailed results of the visiting survey are listed in the overview of demand in Document 7.

Table 2-13 Introduction of GIS and use of maps and GIS by government organizations, etc.

Organization name (○ indicates an organization wanting to use the provisional data)	Introduction of GIS (Software/Number of users)	Overview	Remarks
○ Directorate of Planning and Management of Water Resources (DGPRE)	ArcGIS Four	<ul style="list-style-type: none"> Linkage between water resources access database and ArcGIS Vectoring of paper-based maps of ANAT 	Visited on June 27, 2011 (by request)
○ Ministry of Health and Prevention (Ministère de la Santé et de la Prévention)	ArcGIS/ArcVIEW Five to six	<ul style="list-style-type: none"> Management of nation-level information on health using GIS Effective functioning of JICA short-term GIS experts 	Visited on June 28, 2011
Directorate of Agriculture (Direction de Agriculture)	None	<ul style="list-style-type: none"> Collection of information on land evaluation and soil from regional organizations for use in determining agricultural policies 	Visited on June 28, 2011
○ Ministry of Education	ArcGIS Four	<ul style="list-style-type: none"> Implementation of School Mapping to gather information on schools and use it in establishing and managing schools 	Visited on June 28, 2011
State Agency of Informatics (Agence de l'Information de l'Etat (ADIE))	Unknown	<ul style="list-style-type: none"> Assistance in IT environment structuring by government organizations 	Visited on June 29, 2011
○ Statistics and Demography Agency (Agence Nationale de la Statistique et de la Démographie (ANSD))	ArcGIS: Eight licenses, four persons (four more to be employed)	<ul style="list-style-type: none"> Use of topographic maps of ANAT, orthophotos of Directorate of Cadastre, and others Use of maps and orthophotos for collection, processing, and expression of data related to national census 	Visited on June 29, 2011
Directorate of Local Communities (Direction des Collectivités locale)	None	<ul style="list-style-type: none"> Questionnaire survey on the number of villages. The directorate intends to count the number of villages using maps and municipal boundaries. 	Visited on July 4, 2011
Directorate of Cadastre (Direction de Cadastre)	Unknown Owning two LPSs	<ul style="list-style-type: none"> Handling of 1/100 to 1/10,000-scale maps. No use of 1/50,000-scale maps. 	Visited on July 4, 2011
○ National Institute of Pedology (Institut National de Pédologie)	ArcGIS: Three licenses, three users	<ul style="list-style-type: none"> Creation of soil maps, land degradation maps, land use maps, analysis of farmland, and guidance to farmers 	Visited on July 5, 2011
○ Center for Ecological Monitoring (Centre de Suivi Ecologique (CSE))	GIS owned	<ul style="list-style-type: none"> Analysis of satellite images (NOAA, Landsat, SPOT, etc.) and creation and supply of thematic maps 	Visited on July 5, 2011
National Water Company of Senegal (Société Nationale des Eaux du Sénégal)	MicroStation	<ul style="list-style-type: none"> Use of large-scale maps for improvement of facilities in urban areas and 1/50,000-scale topographic maps for the plan for pipeline installation between cities 	Visited on July 6, 2011
Directorate of Urbanism and Architecture (Direction de l'Urbanisme et de l'Architecture)	ArcGIS/ArcVIEW /GeoConcept	<ul style="list-style-type: none"> Urban planning, urban management and construction of cities in Senegal Use of mainly large-scale maps. Use of 1/50,000-scale maps to prepare a master plan. 	Visited on July 7, 2011
Organization for the Development of the Senegal River (Organisation pour la mise en valeur du fleuve Sénégal (OMVS))	ArcGIS/ENVI/Erda s	<ul style="list-style-type: none"> An international organization consisting of four countries (Senegal, Mali, Mauritania, and Guinea) to improve infrastructure, carry out environmental impact surveys, etc. The geospatial information for identifying the overall conditions is important. Topographic maps are also used. 	Visited on July 8, 2011
○ Society for the Development and	ArcGIS Five	<ul style="list-style-type: none"> The public corporation for agricultural promotion of the Senegal and Faleme 	Visited on April 23, 2012

Organization name (○ indicates an organization wanting to use the provisional data)	Introduction of GIS (Software/Number of users)	Overview	Remarks
Exploitation of Basin and Delta of the Senegal and Faleme Rivers (Société d'Aménagement et d'Exploitation des terres du Delta et du fleuve Sénégal et de la Falémé (SAED))		rivers, which was established in 1965.	
○ Office of Lake Guiers (Office du Lac de Guiers)	ArcGIS One	▪ Established in 2010 to prevent pollution of Lake Guiers.	Visited on April 23, 2012
○ Saint Louis Region Development Agency (Agences Régionales de Développement)	ArcGIS: Two or three licenses, three users	▪ Technical support for the creation and implementation of development plans of local authorities in the Saint Louis region.	Visited on April 24, 2012
iDEV	ArcGIS/MapINFO /Erdas/ENVI Several users each	▪ An engineering consultant established in 1986. ▪ The company has three departments: Infrastructure, Environment and Geographical Information, and Socio-economic Evaluation.	Visited on April 27, 2012

(2) Coordination for the Creation of Examples of the Use of 1/50,000-scale Digital Topographic Maps (Activities 2-2 and 2-5)

To demonstrate the effectiveness of the JSMAF products and thus contribute to the promotion of their use through the accumulation of examples of the use of JSMAF products and the presentation of the examples at the seminar scheduled for the end of the project, the Study Team determined to loan the interim outputs of the project to some of the relevant organizations that are interested in creating an example of use. Therefore, when the Study Team visited the relevant organizations for the survey on demand conducted in the first and second phase work in Senegal (June to July, 2011 and April and May, 2012, respectively), it also conducted an interview survey on the intentions of these organizations, and identified nine candidate organizations. Although the Study Team examined the possibility of soliciting ideas for use from these organizations and loaning data to some of the organizations that submitted superior ideas, it discussed the topic with ANAT again in the second phase work in Senegal and determined to loan the interim outputs under the following conditions:

- The data for only a limited geographic range is loaned.
- ANAT and the Study Team will determine the organizations to which the data is loaned, without soliciting the candidate organizations for ideas.

Taking into consideration the interview survey results, geographic range of data to be loaned, and the impacts of examples of use, the Study Team selected the following organizations and loaned data to them during the third phase work in Senegal (October 2012).

- CSE
- SAED
- Office du Lac de Guiers
- Ministry of Health and Prevention

The loaned data consisted of four sheets of 1/50,000-scale digital topographic maps covering Lake Guiers, and ALOS pan-sharpened ortho images.

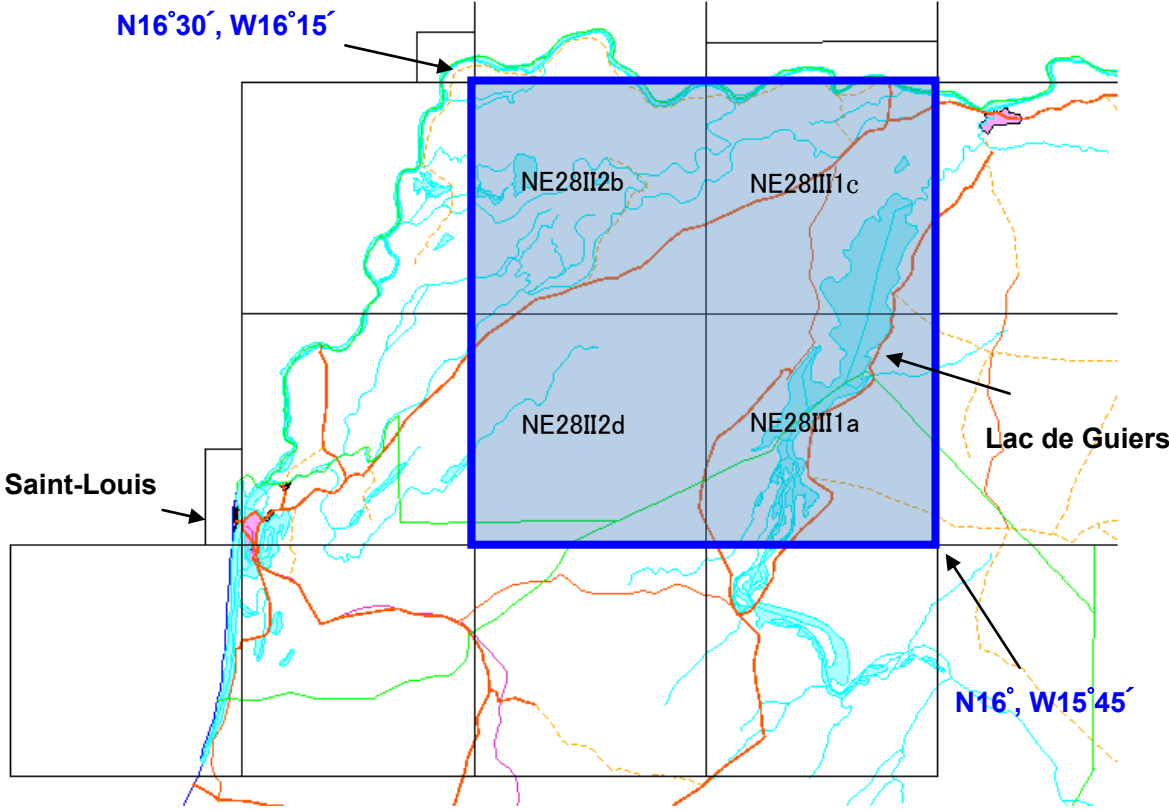


Figure 2-9 Range of loaned interim outputs (area enclosed in blue frames)



Figure 2-10 Loaned pan-sharpened ortho image (NE28III1c) (Includes materials ©JAXA 2011)

Data was loaned after the conclusion of an agreement that defined the conditions for data use such as the prohibition of use other than for the stated purpose, the return of data, and presentation at the seminar.

In the period from the loan of data to the fourth phase work in Senegal (February 2013) in which the project-end seminar will be held, the Study Team has kept close contact with these four organizations and provided follow-up regarding the themes for examples of use and the details of the presentations at the seminar.

(3) Activities in GICC Aimed at Promoting the Use of 1/50,000-scale Digital Topographic Maps (Activities 2-3 and 2-6)

As described in Item (1), the group for discussion and coordination of the relevant organizations for the implementation and monitoring of the geospatial information plan (GICC, chaired by the commissioner of the State Agency of Informatics (ADIE) and with a secretariat managed by the directors of ANAT and the head of the Center for Ecological Monitoring (CSE)) was established in accordance with the government ordinance issued in 2009. Since GICC consists of members from the relevant organizations of the Senegalese government related to geospatial information, the report of the progress of this project is sure to be effective in promoting the use of the JSMAF products. Therefore, in the second phase work in Senegal, after coordination with the ANAT directors who manage the secretariat the Study Team decided to deliver the interim report of this project at the main conference of GICC or at the meeting of a working group acting under its control. Although GICC so far has carried out activities related to technical cooperation by Canada regarding the NSDI construction, the diversification of activities seemed important from the viewpoint of invigorating the GICC. The Canadian experts who were stationed at CSE (delegated from the Canadian Ministry of Natural Resources) also expressed a welcome for the report of the activity status of this project.

Although the Study Team initially attempted to coordinate with ANAT the schedule for delivering a report to GICC or its working group during the third phase work in Senegal (October 2012), it decided to give a presentation at the “National Geomatics Day” seminar held on Tuesday, October 16th 2012 which many participants including the GICC staff were expected to attend, instead of delivering the interim report to GICC. At the seminar, the ANAT staff and the Study Team members in charge of use system plans delivered a presentation on the interim outputs (Document 8). At the seminar, many questions were asked of ANAT, such as “Why aren’t the geospatial information products of ANAT available free of charge?” and “What is the reason for selecting ITRF2000+GRS80 as the geographic coordinating system of JSMAF?” Such questions indicated the high interest among the participants in the geospatial information provided by ANAT and the obligation of ANAT to provide high-quality geospatial information.



Photo 2-6 “Geomatics Day” seminar



Photo 2-7 ANAT staff member delivering a lecture

In addition to the seminar, exhibits were displayed on this day by ANAT and other Senegalese organizations involved in geospatial information. JSMAP exhibited 1/50,000-scale ALOS ortho images and provisional GIS data at the ANAT booth.



Photo 2-8 Exhibits



Photo 2-9 Exhibit of JSMAP interim outputs

(4) Addressing the Demand for 1/50,000-scale Topographic Maps (Activity2-9)

The team carried out the following activities during the fourth phase work in Senegal in order to increase demand for the project outputs.

- a) Assistance in the creation of a pamphlet on the project outputs
- b) Presentation of case-studies of sales promotion activities of topographic maps in Japan
- c) Discussion with the C/Ps on the measures to promote utilization of the topographic maps on the basis of the need for the map

In Activity a, the team member in charge explained to the C/Ps the essential points in the creation of this kind of pamphlet and provided them with advice whenever appropriate, while the C/Ps created the pamphlet by themselves. Figure 2-21 shows a page from the pamphlet created by the C/Ps

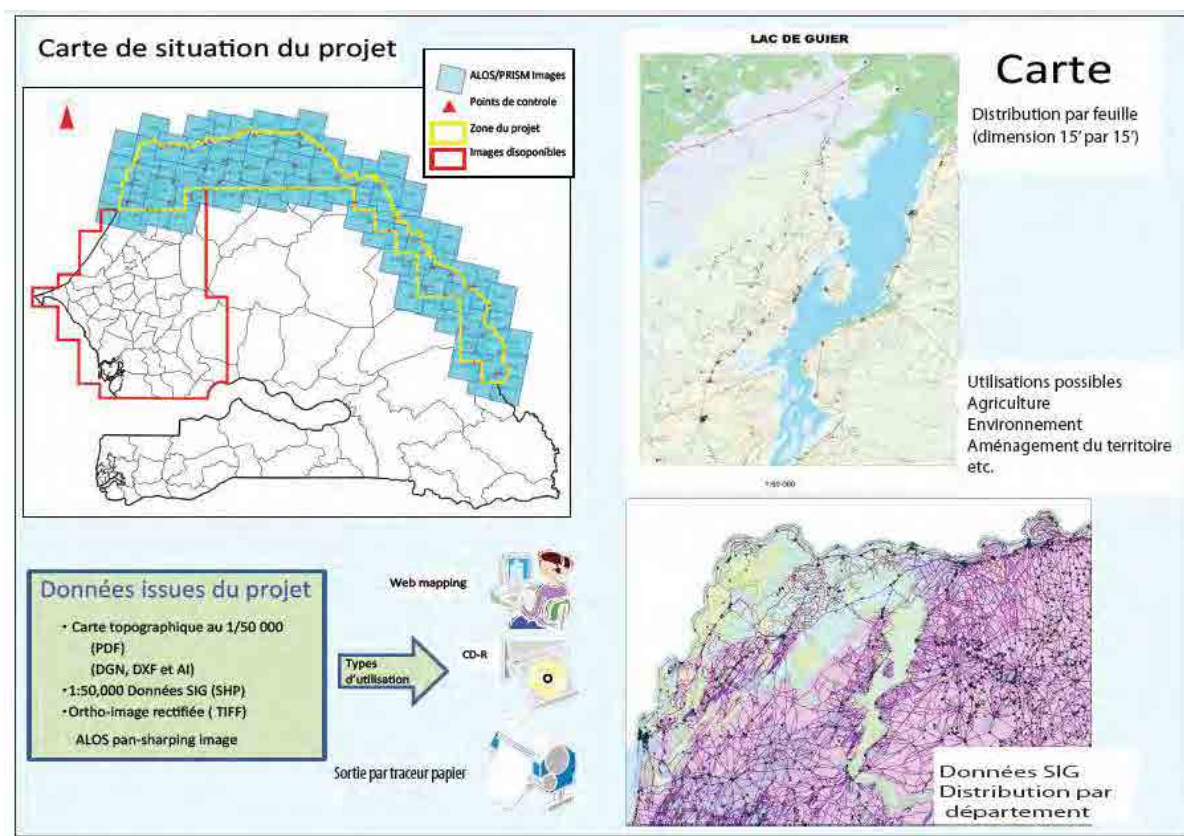


Figure 2-21 Page from the pamphlet presenting the outputs of JSMAP created by the C/Ps

A total of four people, including one team member in charge of the promotion of the use of the pamphlet and the C/Ps, held a brainstorming meeting on Activities b and c. At first, the team member explained to the C/Ps the activities to promote sales of the map products produced by the national survey and mapping institution in Japan. Then, each participant presented his/her ideas for sales promotion and the participants discussed the actual content of the presented ideas and their feasibility. Table 2-22 shows the sales promotion activities raised in the discussion and considered potentially feasible. Document 12 shows draft implementation plans for these activities (including those in charge, method and timing of the implementation)

Table 2-14 Map sales promotion activities raised in the brainstorming

No.	Sales promotion activity	Description
1	Printing of the JSMAPs and their distribution to central and local government offices	The JSMAPs are maps of northern Senegal. The provision of printed maps is essential in promoting their use in rural areas.
2	Meetings for the promotion of the use of JSMAPs in rural areas	Activities to create awareness of the contents and uses of the JSMAPs in rural areas, combined with Activity 1, are essential for the promotion of their use.
3	Establishment of partnership with printers and bookstores	Part of a JSMAP is to be printed in the notebooks used in schools. Previously a map of administrative boundaries was printed in the notebooks.
4	Creation of web pages	Improvement of the existing ANAT website and maintenance of the improved site
5	Creation of a pamphlet and	A pamphlet will be created which explains JSMAPs and

	distribution of copies to colleges and secondary schools	other map products of ANAT in an easy-to-understand way. It should include essential information, such as how to purchase maps, prices and contact addresses.
6	Display and sales of maps at map stores in tourist destinations	This activity will be implemented as part of Activity 3, the activity to establish partnerships.
7	Delivery of maps	Maps will be delivered to users in exchange for a delivery fee as a time-saving service for users. The delivery area will be within Dakar City for the time being
8	Commemoration of Map Day	The Department of Cartography of ANAT is to be opened to the general public. Their interest in maps will be roused by allowing them to experience the place where maps are created.
9	Provision of digital data to the Department of Geography	There are two large universities in Senegal. Three thousand students are enrolled in the Department of Geography at one of the two large universities, Dakar University. The University prints out digital data provided to it, distributes the printouts to the students and use them in class.

[Implementation Status: (Output 4) Regular Public Relations Activities on Geospatial Information Targeting Ordinary Citizens and Young People]

To promote from a long-term perspective the widespread use of the digital maps that are the outputs of this project, it is important to raise the interest in maps among ordinary citizens and young people so that maps are used on a daily basis. Therefore, the Study Team determined to conduct an interview survey on map use in Senegal, survey the situation relating to ANAT public relations for maps, and carry out model activities to raise interest in maps based on the survey results.

(1) Interest of Ordinary Citizens and Young People in Maps and ANAT’s Efforts to Promote Maps (Activity 4-1)

* Interview Survey of Ordinary Citizens and Young People

The results of an interview survey on a total of four persons who are ordinary citizens and young people were as follows:

- The only teaching on the use of maps in high schools and the lower levels of education is to show the locational relation of Senegal to its neighboring countries or on the world map.
- In everyday life, it is common practice to ask people for directions without referring to maps. However, Google Earth is well recognized.

* Interview Survey at Ministry of Education

To learn the situation regarding map education, the Study Team surveyed the secondary school map education curriculum at the Ministry of Education. The secondary schools in Senegal have a four-year course, with grades that are called 6ème, 5ème, 4ème, and 3ème in order from youngest to oldest. The curriculum is designed so that students learn a wide range of maps from the nearest area

to the world as they go up through grades, e.g., the town where the school exists in 6ème, all the land of Senegal in 5ème, western Africa in 4ème, and the world map in 3ème. However, textbooks are not commonly used in Senegal, and the teachers must prepare teaching materials according to the curriculum. Therefore, there is a wide gap between what the curriculum requires and the reality due to insufficient budgets and teacher capacity problems.

The results of the interview survey on ordinary citizens and young people specifically indicate such problems.

* Public Relations Activities for Maps Supplied by ANAT

The public relations activities carried out by ANAT turned out to be quite insufficient, consisting only of brief pamphlets and mention of the Website of its map products.

(2) Visiting Lessons at Secondary Schools (Activities 4-2 and 4-3)

As seen in Section (1), maps are not used in everyday life in Senegal and few activities are carried out to raise interest in maps. To improve this situation, the Study Team proposed holding events such as visiting lessons on maps at schools and an open day on which the mapping facilities of ANAT are opened to the public; and ANAT showed interest in visiting lessons. Therefore, it was decided to give visiting lessons at secondary schools.

* Creation of Rough Draft of Teaching Materials

During the second phase work in Senegal, the Study Team created a rough draft of learning materials in English, taking as their reference maps made by ANAT, maps on the Senegalese government website, and “Maps and Us,” a pamphlet for public education published by the Geospatial Information Authority of Japan (Document 9).

* Identification of Schools Where Visiting Lessons Should Be Given

To identify secondary schools where visiting lessons should be given, the Study Team visited Cours Saint Marie de Hann (a private school) and CEM de Hann (a public school) located near ANAT.

At the public school, we explained the intent of a visiting lesson to geography teachers, from whom cooperation was gained. Since public schools started classes from the second week of October, the schedule of the visiting lesson was set for the fourth week in October.

At the private school, we explained the intent of a visiting lesson to a general affairs clerk, who said he would talk to the principal about it. Later, during the third phase work in Senegal, we gave the same explanation to the principal, from whom cooperation was gained.

* Visiting Lessons at Secondary Schools

On Thursday, October 18th during the third phase work in Senegal, the C/P staff and we visited the public school (CEM de Hann) near ANAT and negotiated with the teachers in charge of geography and history the date of a visiting lesson and what was to be taught. Based on this negotiation, we gave a

visiting lesson at this school on Monday, October 29th. More than one hundred 3^{ème} students (equivalent to senior high school first graders in Japan) gathered and listened to the lecture delivered by the C/P staff (Document 10). In addition, the staff in charge of the system of usage plan made some concluding remarks (Document 11).



Photo 2-10 Classroom where a visiting lesson was given



Photo 2-11 Visiting lesson (right, ANAT staff member: Left, secondary school teacher)



Photo 2-12 ANAT staff member delivering a lecture



Photo 2-13 Students listen attentively

When in the visiting lesson the geography/history teacher asked the students when they used maps, they answered that they only used them in the classroom and nowhere else, and that if they did not know where they were they would ask other people the way. When the teacher then asked them what they would do if they were in Europe or some other country where they could not ask other people as they did in Dakar, the students seemed to understand the importance of maps. As a result, the students seemed more interested in maps after the completion of the open lesson than they did before. The teaching material used by the C/P staff was a PowerPoint document in French that had been created based on the rough draft of the teaching material mentioned earlier.

* Visiting Lessons at a Junior Secondary School during Fourth Phase Work in Senegal

The team and the C/Ps provided a lesson on maps to the students of a junior secondary school for the second time at the West Africa College of the Atlantic (WACA) on Friday, 22nd February 2013, during the fourth phase work in Senegal. This opportunity was made possible through the efforts of the ANAT staff member in charge of public relations in making arrangements for the lesson immediately after the commencement of the fourth phase.

From the project, four C/Ps (including the person in charge of public relations at ANAT) and three Japanese team members participated in the lesson. After opening remarks by the Team Leader, Mr. Harada, the C/Ps gave 33 fourth-grade students (corresponding to second grade students at junior high schools in Japan) with a presentation on topographic maps. After the lesson, the team carried out a questionnaire survey of the students to assess their knowledge of and interest in maps and the impact of the presentation. Table 4 shows the results of this survey.

Table 2-15 Results of the questionnaire survey on the visiting lesson provided at WACA

	Question	Number of “Yeses” (percentage)	Number of “Noes” (percentage)	No answer
General questions on maps	(1) Do you use maps in your everyday life?	9 (27 %)	24 (73 %)	
	(2) Have you studied maps at school?	29 (88 %)	4 (12 %)	
	(3) Have you studied maps of Dakar at school?	23 (72 %)	9 (28 %)	1
	(4) Do you use the Internet in your everyday life?	33 (100 %)	0 (0 %)	
	(5) Are you familiar with Google Maps or other Internet maps?	32 (97 %)	1 (3 %)	
	(6) Do you often use Google Maps or other Internet maps in everyday life?	13 (41 %)	19 (59 %)	1
Questions concerning the presentation on maps	(1) Was the presentation difficult?	2 (6 %)	31 (94 %)	
	(2) Was the presentation interesting?	32 (97 %)	1 (3 %)	
	(3) Did the presentation contain anything you did not know?	13 (39 %)	20 (61 %)	
	(4) Are you more interested in maps than before?	26 (79 %)	7 (21 %)	

Table 2-23 shows that only about 30 % of the students use maps in their everyday lives. It also shows that all the students use the Internet and almost all of them are familiar with Google Maps and other Internet map services. However, only 40 % of them use Google Maps and other Internet map services frequently.

Only two students found the presentation on maps difficult. Almost all the students found it interesting. The fact that almost 80 % of the students said that they were more interested in maps than before proves that the visiting lesson had an impact on the students.



Photo 2-14 Students listening to the presentation on maps



Photo 2-15A C/P giving the presentation on maps

Lesson at WACA

2.14 (18) Seminar for the Promotion of Data Utilization (Work in Senegal)

[Seminar for Senior Government Officials]

The team held a seminar focused on promoting the use of the project outputs at the Hotel King Fahd Palace on Tuesday, 19th February 2013. Approximately 100 people, including senior officials of the Government of Senegal, participated in the seminar. The four organizations (CSE, Ministry of Health, OLAG and SAED) to which the interim outputs of the project had been made available during the third phase work in Senegal gave presentations on examples of the use of the outputs. The C/P organization gave a presentation outlining the activities to promote use of the outputs, including a survey on the demand for the project outputs and the rules for secondary use. The program of the seminar and the list of invited guests are shown below.



Photo 2-16 Final Seminar

[Technical Workshop]

On the following day, Wednesday 20th, the team held a seminar for staff members of ANAT focusing on the technical aspects of the project in the ANAT conference room. Thirty people participated in

the seminar. The original plan was to have presentations on the promotion of use similar to those given at the seminar on the previous day in the first half of the seminar, and presentations on the transfer of the technologies used in the creation of the project outputs in the second half. However, it was assumed that most of the participants of this seminar had also participated in the seminar on the previous day. Therefore, the team decided to cancel the presentations scheduled for the first half, to have the presentations scheduled for the second half in the first half, and to use the second half as an opportunity for the participants to inspect the facilities in the ANAT including a demonstration of the digital plotter, LPS, procured in JSMAF. In the first half, the presentation by the team leader providing an overview of the technology transfer was followed by presentations on the technology transfer in the individual subjects by those C/Ps who participated in it.



Photo 2-17 Opening session

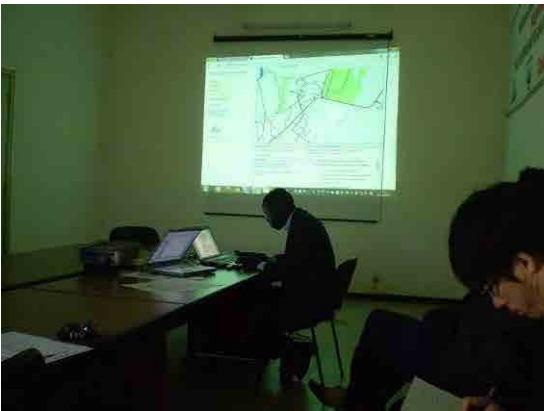


Photo 2-18 Presentation on Web maps



Photo 2-19 Presentation on the Technology Transfer (aerial triangulation)



Photo 2-20 Demonstration of stereo plotting with LPS

2.15 (22) Creation of Orthophoto Data (Work in Japan)

Based on the orientation elements obtained by aerial triangulation, a DEM was obtained using the stereo matching function of the plotting system. Orthophoto data were created using the DEM thus obtained and ALOS/PRISM nadir view images. The orthophotos were pan-sharpened color orthophotos prepared from ALOS/AVNIR-2 color images. The DEM was positioned only as data for creating orthophoto data, and no automatic generation of contour lines using the DEM was performed. The orthophotos were created over the range shown in the figure below.

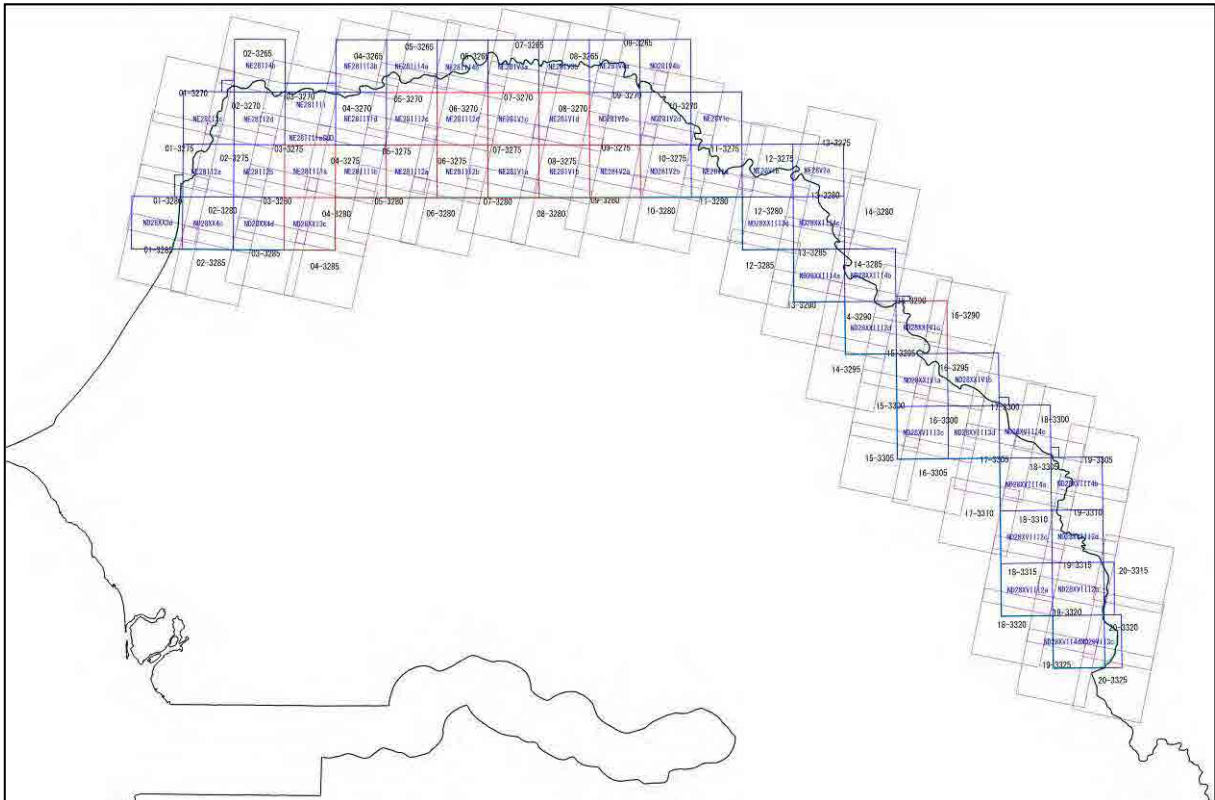


Figure 2-11 Ortho photo grid reference

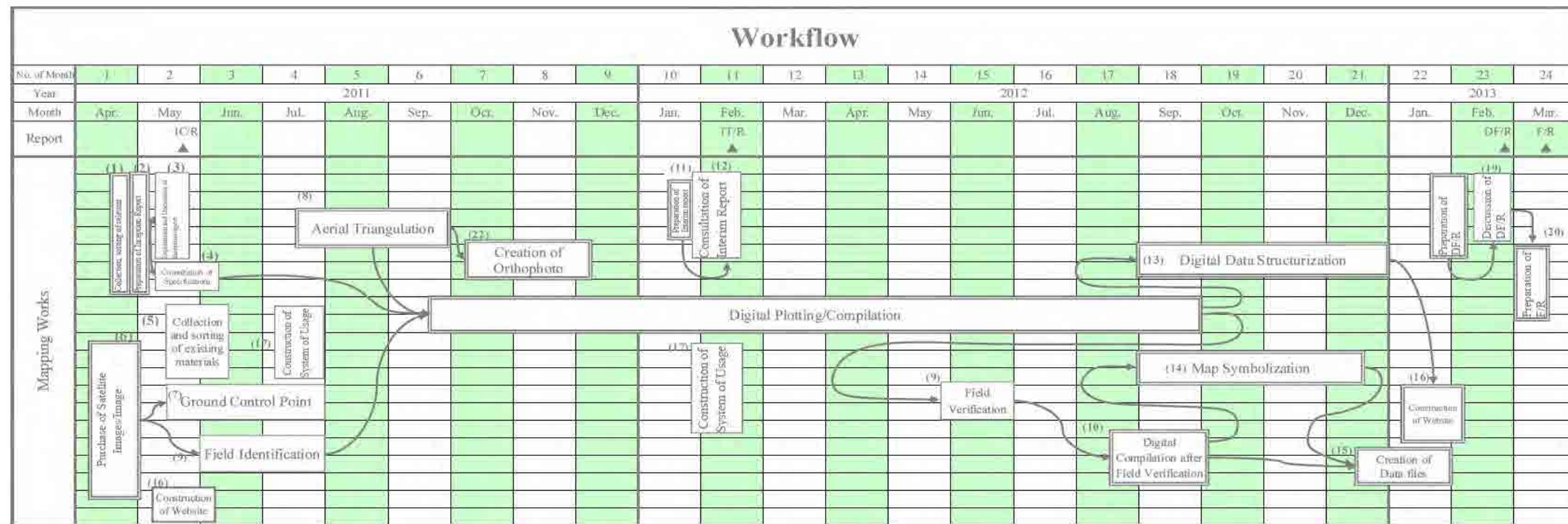
Furthermore, it was determined to fit the created orthophotos into the area after the borders in Mauritania and Mali.

Chapter 3 (21) Technology Transfer Work

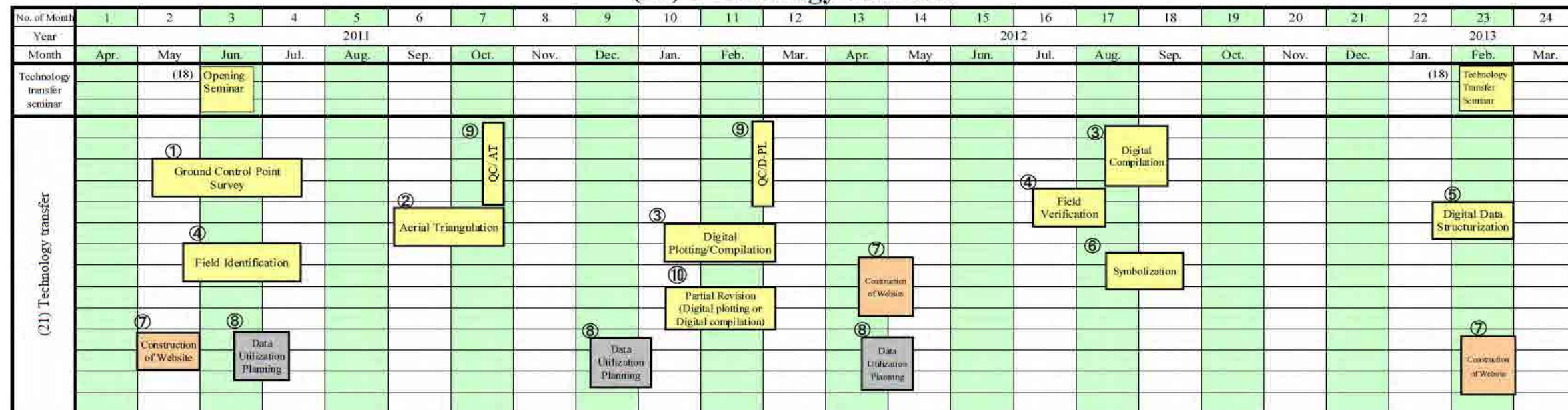
The table below shows the implementation of technology transfer in comparison with the plan.

The details are given in the text.

Table 3-1 Technology transfer work



(21) Technology Transfer



- (1) Collection, Sorting of Relevant Materials
- (2) Preparation of Inception Report
- (3) Explanation and Discussion of Inception Report
- (4) Consultation of Specifications
- (5) Collection and Sorting of Existing Materials
- (6) Purchase of Satellite Images/Image Processing /Creation of Orthophoto
- (7) Ground Control Point Survey
- (8) Aerial Triangulation
- (9) Field Identification/Verification
- (10) Digital Plotting/Compilation
- (11) Preparation of Interim report
- (12) Explanation and Discussion of Interim Report
- (13) Digital data structurization
- (14) Map Symbolization
- (15) Creation of Data files
- (16) Construction of Website
- (17) Construction of System of Usage
- (18) Holding of Technology Transfer Seminar
- (19) Discussion of Draft Final Report
- (20) Preparation of Final Report
- (21) Technology Transfer Work
- (22) Creation of Orthophoto

The technology transfer work was carried out with the following objectives:

- (1) **The technology transfer should enhance the capability of the ANAT of Senegal to create and update of topographic maps independently.**
- (2) **The digital topographic maps and other outputs that have been created are applied as geospatial information, and promote the efficient progress of the national development plan.**

Initially, it was planned in this study to revise the “Overseas Mapping (National Base Map) Standard Specifications” through discussions with ANAT. However, following a request from ANAT, map symbol specifications for Senegal were created on the basis of the African Mapping Standards. The Study Team also surveyed past technology transfer work that provides the background to the current technical capability of ANAT, created the map symbol specifications, manual, etc., created topographic maps and carried out technology transfer based on these.

The table below shows an overview of the technology transfer work.

Table 3-2 Description of technology transfer work

No	Technology transfer work	Description	Method of transfer
①	GCP survey	<ul style="list-style-type: none"> • Selection of GCPs • GNSS survey • Pricking • Pricking point register • Quality (accuracy) control 	Each process learned through OJT
②	Aerial triangulation	<ul style="list-style-type: none"> • Aerial triangulation of satellite images • Aerial triangulation for digital plotting and orthophoto data creation • Quality (accuracy) control • Creation of work manuals 	Each process learned through OJT
③	Digital plotting/digital compilation	<ul style="list-style-type: none"> • Reconfirmation of map symbols of small-scale topographic maps • Appropriate data classification of acquired data • Extraction of unknown and obscure parts • Input of collected data (administrative boundaries and names, road classifications, etc.) • Quality (accuracy) control • Creation of work manuals 	Each process learned through OJT
④	Field identification/Field verification	<ul style="list-style-type: none"> • Creation of identification key • Survey and summary of extracted unknown and obscure parts 	Each process learned through OJT
⑤	Digital data structurization	<ul style="list-style-type: none"> • Structurization of topographic data • Creation of database • Quality (accuracy) control • Creation of work manuals 	Each process learned through OJT
⑥	Map symbolization	<ul style="list-style-type: none"> • Operating procedures for symbolization software • Creation of data in accordance with the map symbol specifications • Layer management • Quality (accuracy) control • Creation of work manuals 	Each process learned through OJT
⑦	Construction of website	<ul style="list-style-type: none"> • Understanding of system in use • Update and upload of partial correction data • Map data management method • System maintenance method • Creation of work manuals 	Each process learned through OJT
⑧	Promotion of	<ul style="list-style-type: none"> • Workshops/seminars for promotion of utilization 	Each process

	utilization/Construction of system of usage	• Survey of existing organizations for construction of a system of usage	learned through OJT
⑨	Quality control	• Supply of Overseas Mapping (National Base Map) Standard Specifications (in English) • Accuracy control following Overseas Mapping (National Base Map) Standard Specifications	Learned through OJT
⑩	Partial correction	• Correction of existing topographic maps using satellite images • Preliminary photo interpretation of secular changes using satellite images • Correction of secular changes using orthophoto data	Each process learned through OJT

3.1 (21) Technology Transfer Work

A description of the technology transfer carried out is given below:

3.1.1 ① GCP Survey

Technology transfer of the items described below was provided to three ANAT engineers through OJT. The trainees were two geodetic survey engineers and one map compilation specialist.

[Selection of GCPs]

The method of selecting GCPs was examined and discussed by the Study Team and ANAT and it was determined as shown below that the method ensured that the pricked planimetric features can be identified in a selected area distinguishable in the ALOS images provided by the Study Team and the Google Earth images, and that there is effective access to them using 1/200,000-scale topographic maps and handy GPS receivers.

- Point allocation plan for satellite images acquired in advance
- Uniform point allocation over the entire work target area in the point allocation plan
- Point allocation within the range of overlap of satellite images, to enable aerial triangulation in the next process
- Point selection focusing on distinct planimetric features in satellite images (It is advised that corners of fences, road intersections and corners of buildings be selected)

[GNSS Survey Method]

The GNSS survey method was explained to ANAT using a GNSS survey procedure manual prepared in advance. The two geodetic survey engineers had experience of a GNSS survey that was implemented with the assistance of IGN France. They had sufficient skills ranging from such basics as setting up a tripod to survey work, as well as knowledge and superior understanding of GNSS.



Photo 3-1 Teaching how to set up a tripod



Photo 3-2 Teaching survey procedures and field book-keeping

The survey drawing engineer on the other hand did not have any experience in geodetic surveying and, taking the opportunity presented by the GNSS survey, received technology transfer in skills ranging from the basics such as setting up a tripod to the survey procedure. However, the methods for setting up a tripod and leveling an antenna “require technical experience and practice” so that it is expected that the skills required will improve only through continued training. The technical training items actually covered were as follows:

- Preventing loss of the equipment by affixing a label etc., on all the survey equipment to indicate the serial number
- Creating a GPS survey operations manual (to prevent operational errors and enable the survey work to be carried out by anyone who simply reads the manual)
- Setting up a tripod
- Informing all the field workers of the order of survey (work schedule) of the day at a meeting on the previous night, etc.
- Setting up a system that allows workers to communicate with each other at all times because in a GNSS survey the timing of the start and end of the observation are important

[Baseline Analysis Procedure]

The Study Team gave a lecture at ANAT using the baseline analysis procedure manual (see Appendix 11), and the ANAT staff actually carried out software-based baseline analysis using the procedure of downloading survey data as well as the method of analyzing baselines between known control points and GCPs. During this process, the specification conditions that must be set prior to the survey and baseline analysis were explained to the ANAT staff, who appeared to gain an improved understanding.

[Net Adjustment]

In the same way as for the baseline analysis, a lecture was given at ANAT using an operations manual created by Leica Geo Office (LGO), and this helped the ANAT staff actually carry out this

process using software installed in the PCs. In addition, the ANAT staff acquired basic knowledge of GNSS and geodetic survey through the net adjustment and the final output report (Appendix 7)..

[Pricking of GCPs]

The technology transfer in GCP pricking was provided to three ANAT engineers through OJT by having them crosscheck the characteristics of ALOS images with the planimetric features and locational relations in the field in order to improve their skills in pricking work. As a result, the engineers were able without problem to identify easy-to-distinguish planimetric features such as the fences and hedges near villages.

- Verification and selection in the field of the GCPs preselected in the point selection process and pricking their locations on the satellite images
- Identifying other planimetric features distinguishable on the satellite images if none of the preselected planimetric features exist due to changes in topography

[Summary of GCP Output]

From the results of the GNSS survey and net adjustment, the output of the GCP pricking was compiled to create a register for each GCP, and the procedure for the creation of the register was explained and taught. It is hoped that ANAT will raise awareness of GCP registers as the GCP output for aerial triangulation, and develop and create its own GCP registers (see Appendix 8).

DESCRIPTION OF PHOTO CONTROL POINT

Station Name	GPO#	Geographical Coordinates CRS:GCS	Latitude	Longitude	Elevation H (m)
			15° 49' 47.87855" N	16° 26' 40.59978" W	40.495
UTM Zone			28 North <th colspan="2">Horizontal Coordinates</th>	Horizontal Coordinates	
			Northing (m)	Easting (m)	Altitude/Ground H (m)
			1750659.896	945000.662	9.276
Observer		Ishino Naoki	Eccentric point		P1
Inspector		K. Ishioka			P2
Site Sketch		DAN-SHUPPEN Image (Scale: approx. 1/50,000)			
Site Photo		ALOS/PFSM Image (Scale: approx. 1/10,000)			
<small>Remarks: This description was prepared by DTCC with JICA Study Team on July 2011.</small> <small>Acquisition of Satellite Image: 2010</small> <small>Satellite Scan No.: 01-8200</small> <small>Type of Satellite Image: ALOS</small>					

DESCRIPTION OF PHOTO CONTROL POINT

Station Name	GPO#	Geographical Coordinates CRS:GCS	Latitude	Longitude	Elevation H (m)
			16° 27' 59.45825" N	15° 47' 45.68935" W	54.172
UTM Zone			28 North	Horizontal Coordinates	
			Northing (m)	Easting (m)	Altitude/Ground H (m)
			1820706.620	415081.682	0.205
Observer		K. Ishioka	Eccentric point		P1
Inspector		K. Ishioka			P2
Site Sketch		DAN-SHUPPEN Image (Scale: approx. 1/50,000)			
Site Photo		ALOS/PFSM Image (Scale: approx. 1/10,000)			
<small>Remarks: This description was prepared by DTCC with JICA Study Team on July 2011.</small> <small>Acquisition of Satellite Image: 2010</small> <small>Satellite Scan No.: 02-8270</small> <small>Type of Satellite Image: ALOS</small>					

Figure 3-1 Example of explanation of pricking points

Table 3-3 Net adjustment results for GCP coordinates

No.	Cartesian Coordinates			Latitude / Longitude (GRS80)		Ellipsoid (m)	Coordinates (UTM Zone 28)		Altitude (m)
	X (m)	Y (m)	Z (m)	Latitude	Longitude		Easting (m)	Northing (m)	
CP01	5876634.549	-1720159.878	1779318.312	16° 18' 23.46149" N	16° 18' 55.34142" W	36.267	359472.302	1803294.046	5.174
CP02	5881518.7	-1730619.023	1753004.876	16° 03' 32.16160" N	16° 23' 46.89425" W	32.1	350632.562	1775957.885	1.249
CP03	5886744.16	-1737538.468	1728644.695	15° 49' 47.87833" N	16° 26' 40.39978" W	40.493	345300.663	1750659.386	9.873
CP04	5879658.75	-1691091.439	1796980.391	16° 28' 22.37685" N	16° 02' 46.13850" W	35.03	388332.615	1821533.258	4.24
CP05	5888646.539	-1700446.043	1758564.68	16° 06' 40.38392" N	16° 06' 25.07580" W	34.106	381623.485	1781555.089	3.735
CP06	5896075.768	-1713637.371	1720807.263	15° 45' 22.72239" N	16° 12' 21.58194" W	59.986	370805.286	1742349.503	29.852
CP07	5887177.131	-1665460.533	1796303.945	16° 27' 59.43823" N	15° 47' 45.63983" W	34.172	415031.633	1820706.62	3.835
CP08	5896130.919	-1678463.182	1754637.056	16° 04' 27.37570" N	15° 53' 24.60270" W	36.624	404791.586	1777355.645	6.599
CP09	5901470.436	-1685888.483	1729610.842	15° 50' 20.44805" N	15° 56' 35.47835" W	51.485	399002.475	1751354.968	21.692
CP10	5894016.424	-1636450.201	1800546.724	16° 30' 23.26448" N	15° 31' 01.56850" W	45.848	444815.287	1825029.504	15.189
CP11	5899036.847	-1643112.426	1778073.379	16° 17' 41.10796" N	15° 33' 52.55646" W	52.88	439681.188	1801623.06	22.447
CP12	5904456.119	-1646611.721	1756876.867	16° 05' 43.02470" N	15° 34' 57.05785" W	56.365	437704.398	1779563.074	26.122
CP13	5907893.94	-1658660.354	1733993.792	15° 52' 48.62520" N	15° 40' 56.13037" W	57.348	426959.275	1755799.925	27.492
CP14	5901268.738	-1606353.191	1803834.895	16° 32' 14.93129" N	15° 13' 38.09133" W	36.14	475752.43	1828403.705	4.625
CP15	5906357.287	-1614686.47	1779832.284	16° 18' 40.63885" N	15° 17' 23.93206" W	61.879	469022.842	1803390.899	30.653
CP16	5911990.316	-1623674.892	1752944.248	16° 03' 29.79265" N	15° 21' 25.65405" W	65.896	461801.398	1775414.461	35.06
CP17	5907430.425	-1574578.466	1811618.224	16° 36' 39.08918" N	14° 55' 29.09868" W	37.566	508026.241	1836508.54	5.637
CP18	5916196.738	-1587551.716	1771647.987	16° 14' 03.15294" N	15° 01' 15.18586" W	75.456	497768.107	1794842.683	43.756
CP19	5924120.075	-1596104.405	1737378.613	15° 54' 42.96592" N	15° 04' 43.85738" W	73.972	491560.105	1759195.746	42.631
CP20	5916410.187	-1551868.487	1801989.986	16° 31' 12.2036" N	14° 41' 51.1059" W	49.052	532276.897	1826486.763	17.277
CP21	5920991.607	-1561043.778	1779101.745	16° 18' 15.79303" N	14° 46' 10.90883" W	70.737	524602.898	1802619.324	39.035
CP22	5926588.101	-1567474.372	1754837.088	16° 04' 33.75802" N	14° 48' 52.12145" W	78.216	519841.776	1777355.853	46.571
CP23	5920733.733	-1521208.342	1813783.199	16° 37' 52.56243" N	14° 24' 33.41051" W	40.151	563000.676	1838857.677	8.147
CP24	5929933.516	-1528180.52	1777817.06	16° 17' 32.36443" N	14° 27' 03.75582" W	58.794	558648.348	1801349.829	26.976
CP25	5935731.004	-1539491.312	1748748.493	16° 01' 07.62532" N	14° 32' 23.51224" W	81.19	549226.469	1771067.796	49.487
CP26	5933080.735	-1494918.271	1795332.692	16° 27' 26.41489" N	14° 08' 31.42780" W	42.196	591583.188	1819718.844	9.117
CP27	5940882.551	-1510904.703	1756081.507	16° 05' 15.96753" N	14° 16' 08.90309" W	69.954	578163.467	1778782.057	37.669
CP28	5947949.527	-1479184.059	1759057.274	16° 06' 56.94737" N	13° 57' 55.70997" W	46.543	610626.591	1782023.915	13.003
CP29	5956120.71	-1455419.572	1751290.123	16° 02' 33.91898" N	13° 43' 53.53874" W	52.956	635695.243	1774079.887	18.883
CP30	5961697.908	-1458936.2	1729557.804	15° 50' 18.23581" N	13° 45' 03.85202" W	96.847	633740.93	1751457.961	63.268
CP31	5963841.976	-1426483.249	1748817.433	16° 01' 10.27179" N	13° 27' 06.37024" W	47.667	665648.726	1771712.299	13.777
CP32	5972883.796	-1441442.673	1705642.789	15° 36' 49.91902" N	13° 34' 04.16891" W	101.118	653535.266	1726740.745	67.681
CP33	5979337.166	-1408853.721	1710028.003	15° 39' 18.54817" N	13° 15' 29.63403" W	48.085	686695.532	1731556.774	14.794
CP34	5981910.048	-1418169.837	1693453.166	15° 29' 58.52272" N	13° 20' 14.07454" W	73.12	678358.614	1714275.792	39.689
CP35	5992221.053	-1387784.515	1682123.479	15° 23' 36.32097" N	13° 02' 22.83158" W	49.884	710394.764	1702796.694	16.835
CP36	5997997.806	-1395303.367	1655498.425	15° 08' 37.89363" N	13° 05' 44.52222" W	106.854	704621.643	1675126.154	73.528
CP37	6006593.456	-1366411.333	1648285.513	15° 04' 35.22957" N	12° 48' 57.03618" W	60.238	734779.016	1667946.41	27.678
CP38	6010515.418	-1378659.988	1623928.092	14° 50' 54.59595" N	12° 55' 07.43230" W	100.541	723951.776	1642612.102	67.468
CP39	6013460.421	-1346208.874	1639904.02	14° 59' 52.87311" N	12° 37' 06.67819" W	59.768	756093.356	1659484.92	28.024
CP40	6018742.35	-1353152.765	1615014.577	14° 45' 54.48332" N	12° 40' 14.66395" W	117.626	750744.588	1633648.542	85.205
CP41	6022775.222	-1324570.452	1623347.03	14° 50' 35.43693" N	12° 24' 12.33009" W	54.278	779437.279	1642603.657	23.131
CP42	6034765.701	-1332927.302	1571769.197	14° 21' 40.69546" N	12° 27' 18.77349" W	122.95	774458.221	1589197.874	91.024
CP43	6034235.761	-1299338.849	1601184.661	14° 38' 09.80864" N	12° 09' 06.59501" W	56.592	806822.071	1620001.12	25.965
CP44	6041374.3	-1310440.778	1565107.857	14° 17' 57.43325" N	12° 14' 18.58452" W	70.405	797928.982	1582600.669	39.239
CP45	6047520.007	-1323571.724	1530443.875	13° 58' 33.78325" N	12° 20' 42.74087" W	137.383	786814.236	1546683.315	106.385
CP46	6050999.107	-1291780.362	1543608.039	14° 05' 55.49593" N	12° 03' 02.63113" W	112.804	818482.206	1560645.478	82.285
CP47	6056734.805	-1296583.23	1516928.461	13° 51' 01.13314" N	12° 04' 59.16920" W	87.234	815322.27	1533094.6	56.916

Note: DTGC20 used the locations and outputs of existing control points.

3.1.2 ② Aerial Triangulation

The technology transfer in aerial triangulation started 2.5 months behind schedule. This was due to a delay in the delivery of the equipment to be supplied.

[Purpose of Work]

The purpose of this technology transfer was to enable the trainees to learn the aerial triangulation process and how to handle the software using ALOS/PRISM data with RPC models to be used in this project, thus enabling ANAT to carry out its own aerial triangulation in the western region, scheduled after the completion of this project. Although not directly related to aerial triangulation, the Study Team also gave instruction in the pan-sharpening technology for the creation of high-resolution color images to be used in the digital plotting process through the synthesizing of black and white images from the PRISM sensor and color images from the ANVIR-2 sensor. This is because this process is part of the preparation for digital plotting.

[Overview of Work]

a) Period

The technology transfer in aerial triangulation was carried out over the following period:

- December 8, 2011 to January 26, 2012 (50 days during the period)

b) Trainees

The trainees were the three ANAT engineers whose names are given below. All the trainees had knowledge of photographic survey but almost no experience in aerial triangulation, and were inexperienced in the actual stereo plotting and aerial triangulation operations.

- Mr. Abdou Khadre Diatta
- Mr. Abdou Gallaye Diouf
- Ms. Awa Ndoeye

c) Software Used

The technology transfer was carried out using the equipment supplied in this project, the Intergraph photographic survey software LPS2011 and satellite image analysis software ERDAS IMAGINE 2011. ERDAS IMAGINE ranks only as the platform for LPS and is automatically installed when LPS is installed. Only LPS was used for the aerial triangulation, and ERDAS IMAGINE was used for pan-sharpening.

[Method of Implementation]

Prior to the technology transfer, the Study Team created an aerial triangulation manual (Appendix 12) and conducted a questionnaire survey to check the trainees' fields of expertise and experience in aerial photographic survey including aerial triangulation. As mentioned earlier, the trainees had almost no experience in aerial triangulation and no experience in stereo plotting. Therefore, the

Study Team determined that the top priority was for the trainees to become accustomed to using the software and the aerial triangulation process, and that the necessary information should be provided as required in the course of many practical practice sessions. This is because both the LPS and ALOS data seem to have been designed without consideration of the fact that many satellite images are used at the same time as in this project, so that they are sometimes very difficult to handle. For example, the scene IDs of satellite images do not indicate which part of the target area they cover. If the LPS product file names assigned from the scene IDs are changed, the LPS files can no longer be imported. However, changing the file names is indispensable in enabling the smooth progress of the work or facilitating the understanding of the work. There was a possibility that this process may complicate the preparatory work, confuse the trainees, and interfere with the understanding of the work flow and key points. To minimize the possibility of such confusion, the Study Team determined to set small blocks in the project target area, give instruction in the main processes and accuracy check method through practical exercises and, after a deeper understanding had been obtained, explain a more effective method. Additionally, prior to implementation of the aerial triangulation in the western part of Senegal that was scheduled for later, the Study Team provided an explanation of and practical training in pan-sharpening.



Photo 3-3 Trainees receive technical training in aerial triangulation

[Description of Implementation, and Results]

➤ Aerial Triangulation

• Preparation

The Study Team explained the sensor information, scene ID, RPC model, etc. of the ALOS satellite. This included an explanation of the necessity for changing scene IDs and the method for changing them, and the accompanying process for creating images. Since, as mentioned earlier, the processes for changing scene IDs and creating images are complicated, the explanation was given after the trainees had practiced a series of aerial triangulations using the original scene IDs so that they would understand the need for these processes.

- Creation of Block Files (Various Settings)

The Study Team carried out technology transfer in the following preparation processes required for the implementation of aerial triangulation using LPS. These processes are also required if no aerial triangulation is carried out but stereo plotting or DEM extraction and orthophoto creation are done using only the RPC model. The trainees had no problems learning the operating methods with regard to the general processing flow using original data and the flow using files created in the preparatory work described in the previous section.

- Setting the sensor model
- Setting and registering projection information
- Registering satellite images
- Registering RPC model files
- Creating pyramid files

- Point Measurement Process

The point measurement process refers to measuring GCPs and tie-points (points connecting multiple photos) in images.

- Tie-point Measurement

Much time was spent in the practical training for this work because it is the most time-consuming process in aerial triangulation. In an ordinary work flow, the operator first conducts an automatic acquisition of tie-points in the software, then checks the results of acquisition for omissions and errors and corrects them interactively. However, since all the trainees were beginners, they were taught to measure all the points in one scene (triplets) interactively to help them understand the locations, point allocation, and number of rays (number of images to be measured) appropriate for tie-point measurement and learn how to operate the software. Then, for efficient technology transfer in measuring tie-points, explanation and training was provided in how to use (set) the tie-point automatic acquisition tool and how to carry out semi-automatic measurement using the manual survey tool.

Since ALOS images are triplet images, there are more redundant images than with other satellite images and aerial photos, so that it is extremely difficult to identify the necessary number of rays from the many images that are displayed. Therefore, the Study Team proposed that the process be broken down into smaller steps to facilitate the trainees' understanding, and advised them to complete each step before going on to the next. This helped the trainees gain a deeper understanding of the tie-point measurement process, and enabled them to check the progress of their work.

➤ GCP Measurement

Using the method of importing the 3D coordinate values of the GCP measurement output and the GCP register, technology transfer in measuring GCPs in images was carried out. The Study Team explained that LPS can display all the images in which the target GCPs can be measured using the RPC model and the 3D coordinates of GCPs; that in principle, all the measurable images should be measured; and that the accuracy of measurement influences the accuracy of all other processes. In addition to this, the trainees recognized how ground photos taken in the field look different in ALOS images and understood the importance of GCP selection.

[Calculation Processing and Accuracy Control]

Technology transfer was carried out in how to readjust the RPC model, i.e., methods for conducting aerial triangulation calculation using the RPC models, GCP and tie-point image coordinates, GCP outputs (3D coordinates/setting parameters), evaluating the calculation results (intersection residual errors and control point residual errors), deleting error points and conducting remeasurement and additional measurement based on the evaluation results. An explanation was also given on how to carry out calculations with different combinations of viewing directions to find images with unsatisfactory accuracy and exclude them from the calculation; and the Study Team successfully completed the technology transfer on how to establish the final results.

[Pan-sharpening]

It is effective to use color images to create topographic maps in order to improve readability. The ALOS/AVNIR-2 images, although color images, have a resolution of about 10 meters, which is not sufficient for creating topographic maps with a scale of 1/50,000. The ALOS/PRISM images on the other hand have a resolution of 2.5 meters, which is sufficient for creating 1/50,000-scale topographic maps, but being black and white images they require experts to interpret the planimetric features. One solution to this dilemma is pan-sharpening processing, in which the color information (such as RGB) from low-resolution color images is synthesized over high-resolution black and white images to create high-resolution color images. The pan-sharpening is widely used in the field of remote sensing using optical satellite images. This project also uses pan-sharpened images in digital plotting and orthophoto creation. As described earlier, ERDAS IMAGINE (product name: Advantage) is automatically installed during the installation of LPS, and basic tools including the pan-sharpening tool are available for use. In this project, therefore, technology transfer in pan-sharpening was carried out.

Since the trainees had experience of using satellite images as well as knowledge about pan-sharpening and, additionally, the pan-sharpening process (software operation), while rather complicated is based on a simple concept, they understood the technique and mastered the technology relatively more easily than they did in the case of aerial triangulation.



Photo 3-4 Technical training in pan-sharpening

[Implementation of Aerial Triangulation Using Supplied Images]

The purpose of technology transfer in this project is to enable the ANAT to create and update 1/50,000-scale topographic maps of the western area of Senegal on its own. ALOS images of the western area (about 45,000 km²) were also supplied. Therefore, the Study Team decided to carry out aerial triangulation in the western area in the latter half of the technology transfer, considering that the trainees had more or less mastered the technology for aerial triangulation through the daily practical training. Since no GCP survey had been conducted in the western area, the processes up to the tie-point measurement were implemented in accordance with the processes learned in the first half of the training.

3.1.3 **③ Digital Plotting/Digital Compilation**

The technology transfer in digital plotting and compilation started 2.5 months behind schedule. This was due to a delay in the delivery of the equipment to be supplied, the same reason as the delay in the technology transfer in aerial triangulation.

3.1.3.1 Digital Plotting

[Purpose of Work]

Technology transfer in digital plotting (referred to below as “this work”) aims to enable the ANAT to acquire the technology, capability and knowledge required to carry out digital plotting and digital compilation on its own, through practical training during the technology transfer. Therefore, the foci of the technology transfer were an understanding of the basic concepts of digital plotting in accordance with the “Overseas Mapping (National Base Map) Standard Specifications” prepared through discussions with the ANAT and the acquisition of digital plotting technology in accordance with the map symbol specifications agreed upon in the discussions etc., on specifications.

[Implementation Guidelines]

The digital plotting work requires a wide range of technologies, insights, and skills such as the ability to interpret planimetric features in satellite image data, the ability to anticipate and imagine the situation in the plotting areas, surveying skills to measure appropriate heights in stereoscopic view, and a basic knowledge of computers, CAD systems and GIS systems.

The technology transfer in this work was carried out following a questionnaire survey on the items shown below, as the technology transfer needed to be carried out efficiently within a limited period of time in a way conforming to ANAT's basic map-making skills.

1. Selection of Technology Transfer Participants by Means of a Questionnaire Survey

Before the start of this work, a questionnaire survey was conducted to gain an understanding of the technical trainees' experience in making maps. On the basis of the survey results, the Study Team selected three engineers to be the recipients of technology transfer in the digital plotting work. Below are shown the questionnaire survey questions, a summary of the answers received, and the selection status of the engineers.

(Questionnaire survey questions)

Q1: What is the total length of your professional career (in years)?
 Q2: What is the total length of your career in stereo plotting (in years)?
 Q3: Have you done any photogrammetric work other than stereo plotting? If so, for how long?
 Q4: What stereo plotting systems have you used? (i.e. A8, B8, A10, etc.)
 Q5: What categories of stereo plotting are you interested in or involved in?
 Q6: What is your preferred field of interest in your future profession?

Table 3-4 Selection of engineers for digital plotting / digital compilation

Question	c/p-A	c/p-B	c/p-C	c/p-D	c/p-E	c/p-F
Q1	32y	6y	6y	6y	6y	-
Q2	none	none	2y	2y	none	-
Q3	No	3m	3m	Yes	no	-
Q4	-	-	-	GeoView	-	-
Q5	-	-	DEM	-	-	-
Q6	LPS,PRO600	-	LPS,PRO600	Photogrammetry	-	-
Selection status	☉	☐	☉	☐	☉	☐

Selection status: ☉ digital plotting ☐ digital compilation

2. Selection of Training Areas

The areas to be used for practical training were selected. Since areas with as many acquisition criteria features as possible are preferable as training areas, an area near the city of Saint Louis and part of an area near Kidira city, Tambacounda region which has relatively more differences in elevation than other parts of Senegal.

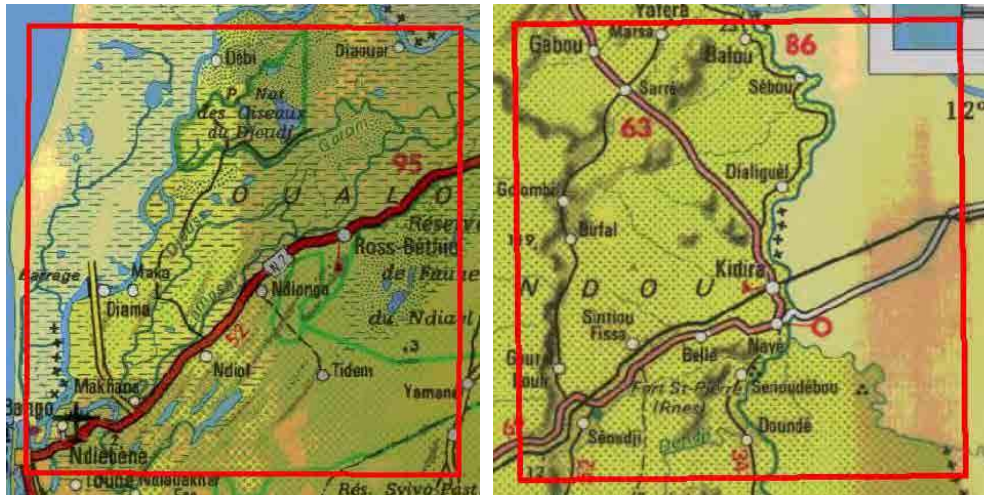


Figure 3-2 Areas near the cities of Saint Louis and Kidira

3. Method of Technology Transfer

The technology transfer was carried out as follows: After an explanation of the basic overview of the digital plotting work and the detailed work description and a concrete demonstration of the operation of the plotting system, etc. using real data, the trainee engineers carried out digital plotting and compilation for themselves. Questions that arose during the technology transfer work were discussed with ANAT in an attempt to resolve problems as quickly as possible to prevent any hindrance to the mastery of the technology of subsequent processes.

The practical training was carried out as a series of procedures for the acquisition of planimetric features for the digital plotting work. Below are shown the actual procedures used in the work and an example of individual training items (Figure 3-3).

Policy of capacity-building

Procedure for study of digital plotting

Step1 : I show you how to operate .

↓

Step2 : CP study how to operate.

↓

Step3 : CP carry out plotting at small area.

↓

Step4 : We discuss about problem.

↓

Step5 : CP carry out plotting at whole area.

Lesson4 Anyway let's Digital Plotting .3 2012.1.30~

- **Challenge !**
 - Let's line features of digital plot ! (Operation manual:p19,p27 – p29)
 - Skeletal line features such as *roads, railways and rivers* .
 - Write with height adjustment.
 - Anyway Let's Digital Plotting!
- **Goal ! (Checkpoint)**
 - Did you know how to digital plot a line feature?

Skeletal line sample

Figure 3-3 Policy for technology transfer and example of individual training material

[Equipment and Main Document Used]

The equipment and reference materials used in this work are shown below.

1. Equipment Used

This work was carried out using the PRO600 system supplied as an extension to LPS (Leica

Photogrammetry Suite 2011), a software copy plotter. The PRO600 system is CAD software that works as an extension function of the MicroStation system used for the digital compilation work.

The hardware for this system, shown in the photograph below, consists of a PC, 3D survey unit, subdisplay, and a dedicated mouse, the TopoMouse, etc. This system allows the operator to save topographic map information by tracing planimetric features as the stereo monitor displays a stereo model, consisting of two satellite images for which aerial triangulation has been completed.

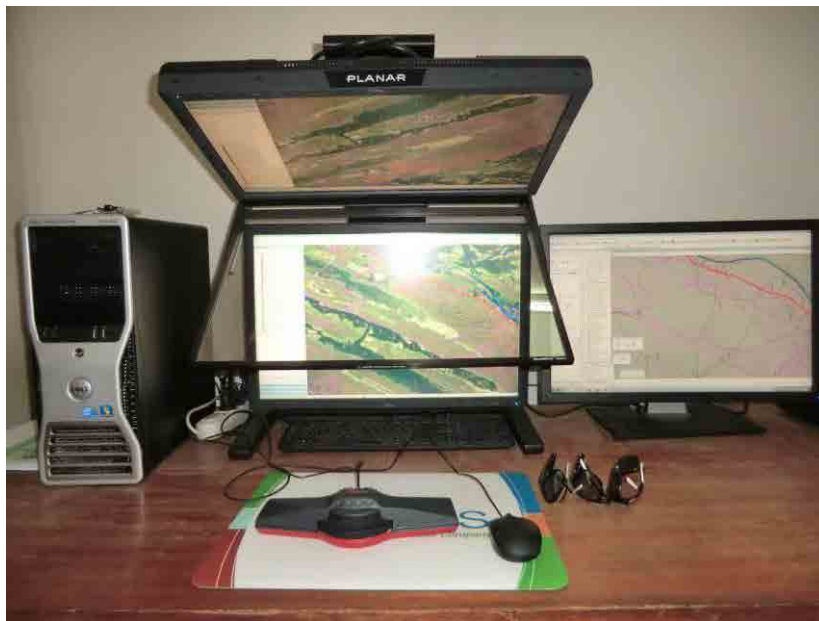


Photo 3-5 Soft-copy plotter used in this work

2. Main Reference Materials Used in This Work

The main reference materials used in this work are listed below.

- ① “Overseas Mapping (National Base Map) Standard Specifications” and map symbol specifications
- ② Field identification materials
- ③ Field feature interpretation key
- ④ LPS system and PRO600 system operation manuals
- ⑤ Sample data (digital plotting data)
- ⑥ Partial correction work guidelines

[Content of Technology Transfer Work]

1. General Explanation of Digital Plotting Work

Before the technology transfer, a general explanation of digital plotting in this work was given. Emphasis was placed on the following three items as the most important items in this work.

- (1) The accuracy of the topographic maps can be ensured by obtaining planimetric features through the placing of a measurement marker (measuring mark) at the appropriate elevation of the feature. Since this requires proficiency, it takes time to obtain measurement values of sufficient accuracy.
- (2) The operator needs to obtain topographic features by making predictive decisions in the stereograph interpretation.
- (3) The operator needs to have the special skill of being able to pick out planimetric features that match the acquisition criteria while keeping in mind an image of the scale of the map to be created (Long experience is needed as this requires proficiency).

2. Startup and Basic Initial Setup of the PRO600 System

Using the system operating manual, the Study Team provided practical training in how to start up the PRO600 system and make various settings. At this time, digital plotting data that had been prepared in advance was used to facilitate understanding by the technical trainees. In addition, they were instructed on how to create, correct, or compile various table files to be used for the initial setup of the plotting work.

3. Explanation of Operation of the TopoMouse System

Using the operating manual and the table of corresponding functions, the Study Team explained how to use the TopoMouse system and the functions of the buttons. In addition to the functions of an ordinary system mouse, TopoMouse offers individual functions that can be assigned to multiple buttons and used by the operator.

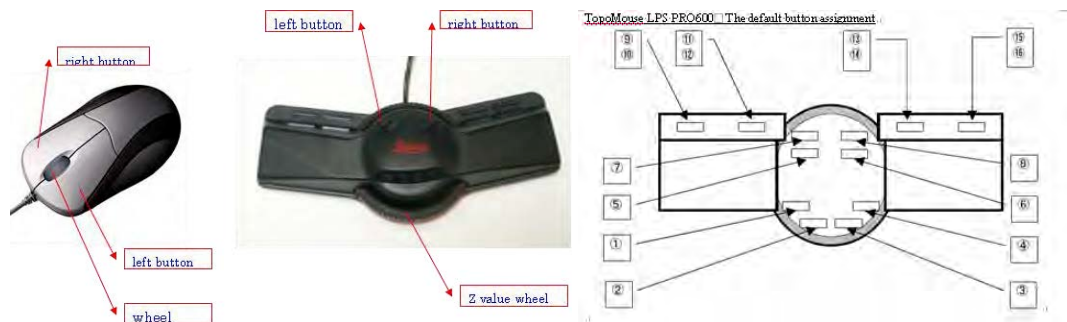


Figure Figure 3-4 TopoMouse and an example of how to operate it

4. Acquisition of Skeletal Features (Roads, Railways, Rivers, etc.)

With regard to the procedure for acquiring skeletal features (line data), the Study Team instructed the trainees to read the road type while referring to the reference materials (existing maps, etc), and to carry out stereo image interpretation while placing the measuring mark on the road elevation for continuous data acquisition.

An explanation was also given of the technology for maintaining the basic data structure of topographic maps and the positional accuracy of planimetric features, including the use of various functions of the plotting system such as layer switching between planimetric features and edge matching (snap) with other parameter data, and the technique for acquiring planimetric feature data while matching heights.

5. Acquisition of Features Such as Buildings, Enclosures, Retaining Walls, Tanks, etc.

With regard to the procedure for acquiring structural features (mainly point data), the Study Team instructed the trainees to verify the positions of structural features with reference to the materials (field identification materials: field identification photos, KMZ, existing maps, etc.) and to acquire planimetric feature data of the same positions through stereo image interpretation.

An explanation was also given of convenient plotting system functions (functions linked with GoogleEarth), e.g., the function for entering symbol mode, the function for positioning symbol data with a rotational angle, and other such applied functions.

6. Acquisition of Vegetation Features (Rice Paddy, Cultivated Land, Plantations, Forests)

With regard to the procedure for acquiring vegetation features, the Study Team instructed the trainees to acquire vegetation boundaries while identifying the distribution of vegetation through stereo image interpretation using as reference the field identification photos examined in the previous process and the feature interpretation key. At this time, they were instructed to acquire data by matching the edges of vegetation areas to structural features and structures on lines to finally form polygons with vegetation boundaries, to acquire data so that all the work areas are be classified into one or other land use status, and pay attention to the interconnection of linear features so as to reduce errors in polygon generation in subsequent processes.

7. Acquisition of Topographic Data (Contour Lines, Individual Elevation Points, etc.)

With regard to the procedure for acquiring topographic data, the Study Team instructed the trainees to read the ambient topographic conditions while referring to the existing map materials and to trace the same elevations on the ground surface to draw the contour lines.

With regard to the procedure for acquiring individual elevation point data, they were instructed to acquire one point per 2.5 km square, giving priority to distinctive points such as roads and hilltops.

As for the plotting system functions, the settings to fix the Z wheel, the function to enter a specified elevation value, and the function to raise or lower the contour line values were explained.

The photograph below shows technology transfer in digital plotting in progress.



Photo 3-6 Technology transfer in digital plotting

8. Check and Correction of Data Using the PRO600 System

Following the system operating manual, an explanation was given of how to inspect the edge matching of individual data and correct errors that are found.

In the practical training, the technical trainees inspected and corrected the digital plotting data created by them. They were also instructed about cases in which errors tend to occur, e.g., data connections.

9. Check and Correction of Plotting Data on Output Maps

The plotting data acquired in the practical training was output on roll paper using a large format plotter (Photo 3-6). Using the output materials, an explanation was given of how to check for omissions in acquisition and misentries, selections and acquisition density balance. In the practical training, based on the procedure and rules for pointing out problems they were taught how to use leader lines and type symbols according to the content of the problem (Photo 3-7*).

After plotting data has been checked and corrected with reference to the inspection sheet after the inspection and stereo image interpretation has been carried out, some parts may still remain obscure. An explanation was given on how to set up flags in the plotting data so that they can be looked at again in the supplementary survey.



Photo 3-7 Output of inspection maps on large-format plotter



Photo 3-8 Scene of map inspection by technical trainees

10. Quality Control (Creation of Quality Control Sheet)

How to fill out quality control sheets was explained using a standard quality control sheet form for digital plotting work. In the practical training, the trainees were instructed to check the output inspection maps, etc. to inspect each of the planimetric features for errors and omissions, to count them, and write the numbers down.

It was also explained to the trainees that the standard quality control sheet also listed the acquisition items for large scale maps and the items to be checked in the digital compilation work, etc. and that these should be excluded from digital plotting quality control.

[Map Updating Work]

Based on the map updating work guideline material, an explanation was given of the purpose of the work and the work procedure. A theoretical explanation only was given, using the guideline material, because there was no existing data available in this project on which partial correction could be carried out.

[Content of Technology Transfer Work]

The technology transfer work for digital plotting was carried out according to the individual procedures described above. A digital plotting work manual was created as required, by adding operating manuals as required according to the status of individual tasks. Below is shown the work flow and the approximate duration of the tasks.

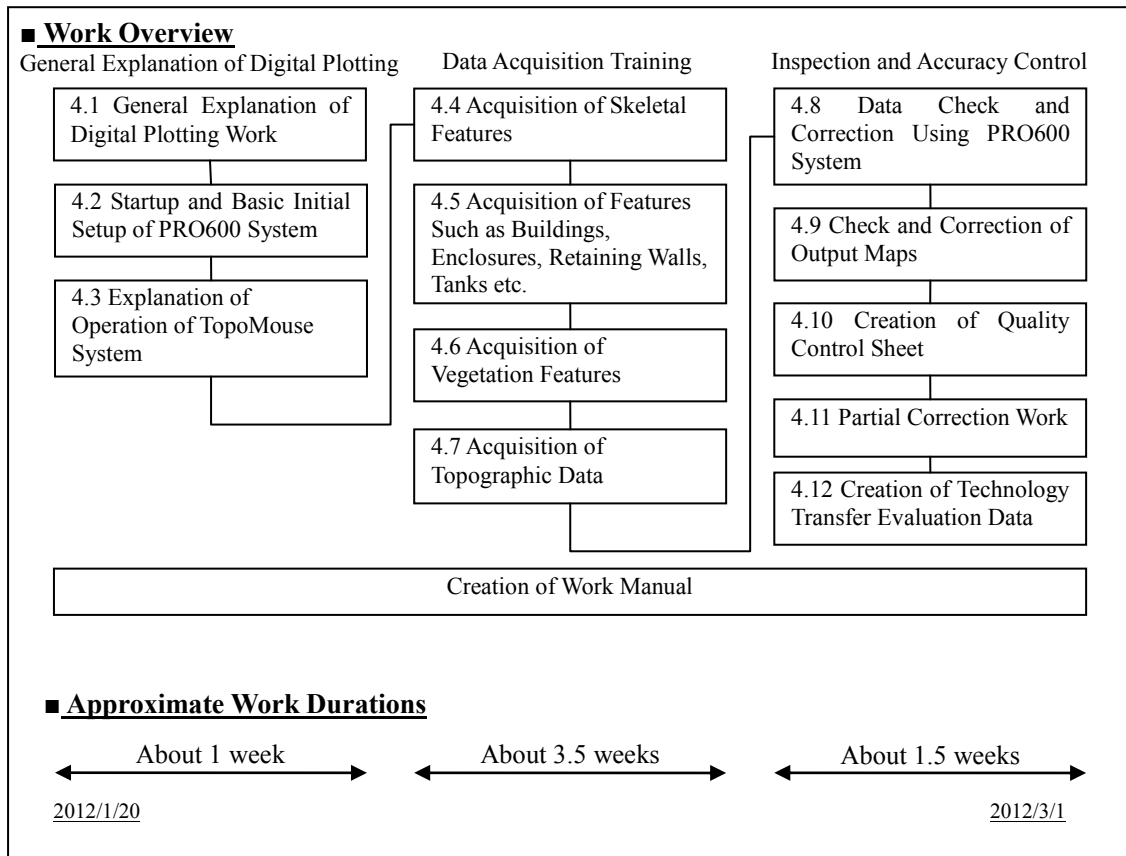


Figure 3-5 Work flow and approximate duration of tasks for technology transfer in digital plotting

3.1.3.2 Digital Compilation

For the digital compilation work within the ANAT, technology transfer was implemented covering the preparatory work from the receipt of the data after completion of the digital plotting, which is the process prior to digital compilation, up to the start of the digital compilation.

In the technology transfer for this project, instruction was given in the basic operation of the respective software applications using the digital compilation system software that has been introduced. It being the case that software would be used that was being introduced for the first time for this project, a lot of time was spent on the technology transfer of the basic operations. After that, technology transfer of practical operations was implemented, and technology transfer was carried out of the operations needed to execute digital compilation based on the 1:50,000-scale symbol specifications being used in this project.

【Period of technology transfer, and trainees】

Technology transfer for digital compilation was implemented in two phases. The table below shows the period in which each phase was implemented, and the number of participants.

All the trainees were ANAT engineers, and as stated earlier none of them had any practical experience in compilation work.

Table 3-5 Period of implementation of technology transfer in digital compilation and digital compilation of field verification, and number of trainees

No.	Period of training	Number of trainees
Phase 1	January 15 th 2012 to March 4 th 2012	3
Phase 2	August 7 th 2012 to September 6 th 2012	2

【Materials used (software)】

In this project the CAD software listed below was introduced and used.

- MicroStation V8 i
- Bentley MAP V8 i

【Practical content of the technology transfer】

The technology transfer was carried out with the focus on operations, with repeated explanation and practical training in the 5 subjects listed below, so as to enable the trainees to gain a reliable mastery of the technology.

a. Understanding of 1:5,000-scale symbol specifications

In the past, digital plotting and compilation in the ANAT has deciphered planimetric features on the model and treated them as data associated with one of the layers (types of feature) already established in the system configuration. However, in the classification of topographic map data, the relevant specifications (1:50,000-scale symbol specifications) form the basis determining the acquisition and treatment of data. For this reason, a detailed explanation was given of the symbol specifications for the 1:50,000-scale topographic maps being produced in this project and the trainees were helped to understand the features that should be acquired, the standards for their acquisition and their data types. The importance of the following items in the acquisition and handling of mapping specification data was also impressed on the trainees.

- ① Any unidentified planimetric feature should be extracted as a survey point of field verification; the worker must not try to interpret the feature, but always verify the feature in the field.
- ② Close attention must be paid to data type, and any mistakes rectified.



Fig. 3-6 1:50,000-scale symbol specifications (cover) and sample of symbol specifications content

【Basic operation technology for the introduced digital compilation system software】

As the ANAT has almost no experience of digital compilation work, particular emphasis was placed in the technology transfer in understanding the basic user interface, tools, operating procedures, etc., of the CAD software (MicroStation V8 I, hereinafter referred to as “V8”) introduced in this project. In addition an explanation was given of the basic operating procedure for Bentley MAP V8i, also introduced in this project, and the differences between how to use this and the V8, gaining the trainees’ understanding and enabling the technology transfer to proceed smoothly.

【Digital compilation configuration technology based on the symbol specifications】

Initially the symbols and line types necessary for use in the topographic map data output maps, one part of the digital compilation environment, that were used were those prepared and provided by the Study Team, based on the symbol specifications. However, in consideration of the fact that in the future the trainees would have to carry out operations by themselves, technology transfer was carried out in the procedure and method for the preparation of the symbols and line types used in the 1:50,000-scale topographic map symbol specifications, and in how to use these to configure the environment.

Technology transfer was carried out in how to set and call up the prepared symbols and line types, and also in the configuration of V8.

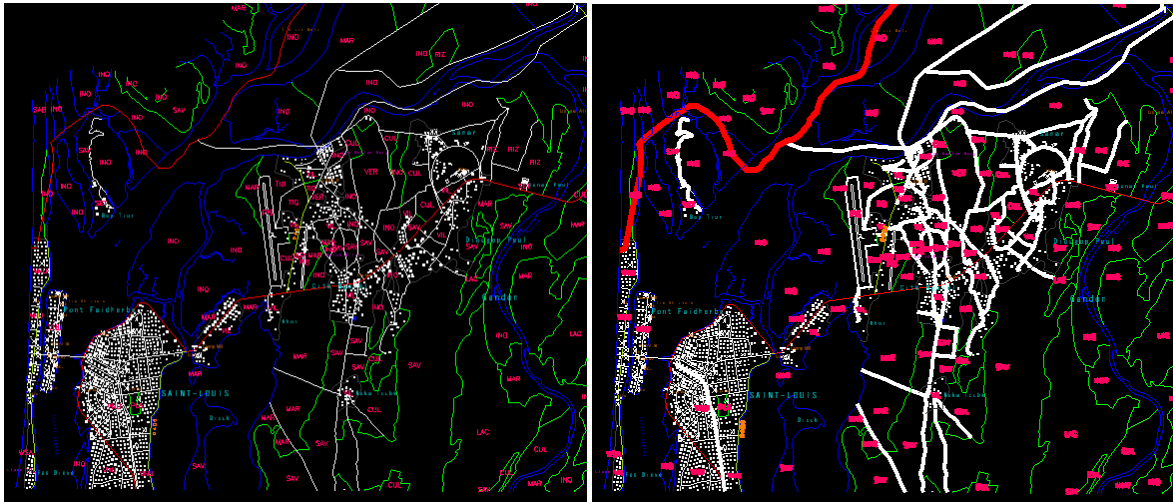


Fig. 3-7 Before and after the setting of line types

【Basic operations needed for digital compilation】

As was mentioned above, ANAT has almost no experience in digital compilation work. For this reason, technology transfer covering the 4 items listed below was carried out, with emphasis on the operating method and tools it was expected would be used in this project in the work using V8.

- All aspects of tools
- Short-cut function
- Preparation of command files
- Preparation, revision and checking of topology

【Results of technology transfer】

The results of the implementation of the technology transfer were as follows.

- Understanding of the 1:50,000-scale symbol specifications
 When faced with an unidentified planimetric feature, the practice has been to deal with it by having the worker make changes to the layer using his own discretion; but with this method there is the danger that it will have an adverse effect on the processes that follow. In cases like this it is necessary to always check with the symbol specifications as the work progresses; the importance of the symbol specifications in cases like this was explained, and the trainees were helped to understand this point.
- Basic skills in operating the digital compilation system software that was introduced
 None of the technical trainees had any experience of using V8, but as some time was spent on basic operating skills, there were no problems in the technology transfer of the basic operations. However, it was seen that some trainees were a little bewildered by the arrangement of the tools; the confusion was resolved by using the V8 customization function to change the layout of the user interface to be in keeping with the perceptions of the trainees.

- Skills in configuring the digital compilation environment based on the symbol specifications

The technology for the preparation of symbols was transferred without much problem. As it was anticipated that due to the wide variety of set points the preparation of line types would take time to master, efforts were made to transfer the technology smoothly by using a method of training that began with the preparation of simple line types and gradually moved on to more complicated line types.

Technology transfer was also implemented for the configuration of the V8 environment, including the setting of the symbols and line types that had been prepared, calling them up, etc.

- Basic operations necessary for digital compilation

- * All aspects of tools

- The tools necessary for the preparation of 1:50,000-scale topographic maps were each explained and demonstrated separately, and the actions performed by the tools were taught through practice.

- * Short-cut function

- As the ANAT trainees had no experience of using keyboard shortcuts, they were given a demonstration of how to use the mouse and keyboard together and taught through practice how to do this. It is possible to do the work using only the mouse, but combining the mouse with keyboard shortcuts allows for much greater efficiency.

- * Preparation of command files

- Technology transfer was carried out to some extent in the handling of command files that prepare data automatically, the handling of layers and set points and the preparation of erasable command files. However, the trainees had until this time no experience of the preparation of this kind of file, and it was considered that they would need further experience in the future.

- * Preparation, revision and checking of topology

- Technology transfer was carried out in the use of Bentley MAP to check whether or not the polygon data set out in the symbol specifications had been generated correctly, to make revisions and prepare the data. In this process, too, the importance of the symbol specifications and methods of putting it to effective use were reaffirmed.

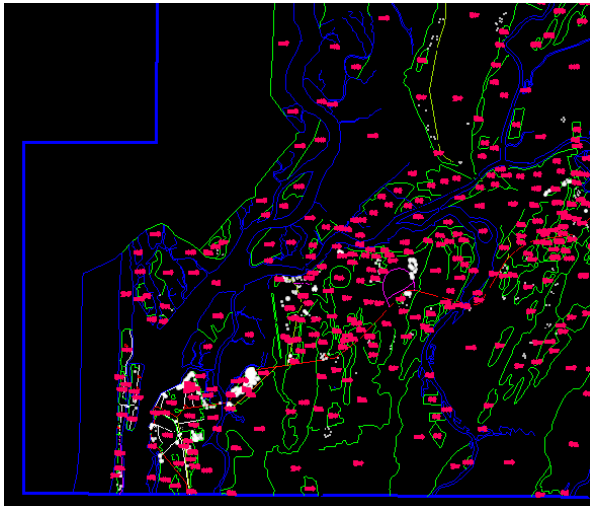
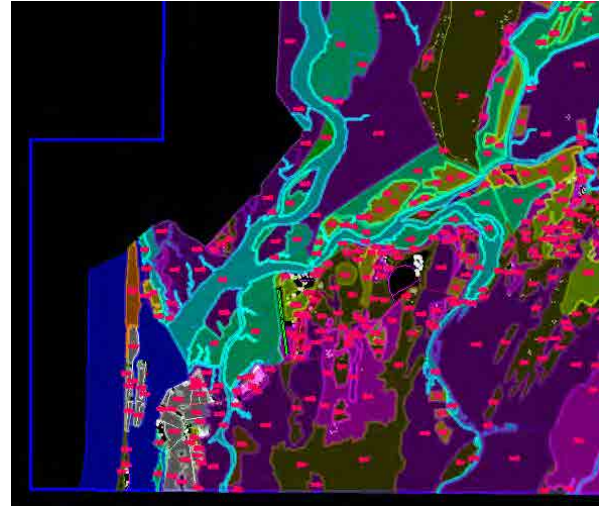


Fig. 3-8 Before preparation of polygons



After preparation of polygons



Photo 3-9 Trainees carry out practical exercises

3.1.4 ④ Field identification/Field verification

Guidance was given to the ANAT to enable them to understand the basic principles of the field identification and to enable them to carry out the field work in accordance with the specifications. In this process an interpretation key was also prepared, and guidance given to help maintain efficiency and accuracy in conformity with the specifications in the subsequent work (digital compilation). As a result of this guidance, the ANAT trainees now have experience in map preparation, including detailed points such as local information; it may be said that the guidance was more effective than had been anticipated. The field identification was incorporated into the technology transfer in the form of OJT, with the emphasis on the following three points.

【Purpose of the field identification/verification】

1. To confirm in the field any geographical information necessary for subsequent work (digital plotting, digital compilation) that does not show on the photographs (images), and to sort (store) the data.

2. To prepare an instructional interpretation key for deciphering the photographs (images), in order to facilitate the digital plotting.
3. To allow the ANAT trainees to understand and learn the techniques to enable them to update (revise) the data through self-help efforts even after the completion of the original survey.

On the basis of the above, four ANAT engineers took part in technology transfer of the following items.

【Instruction given prior to heading out to the field】

- ① Understanding the difference between satellite images and aerial photographs (color tone, configuration, texture, etc.)
- ② Confirmation and understanding of selection criteria for applicable map symbol
- ③ Selection of points to be changed after comparison of existing materials and satellite images, and of illegible points
- ④ Understanding of how to draw up a work plan conducive to the efficient progress of the work (allocation of the appropriate number of personnel and number of days for the amount of work, troubleshooting, etc.)

【Instruction given in the field】

- ① Understanding of the importance of confirming the sequence of operations pertaining to implementation of the work
- ② Understanding of the methods of acquiring data (proper methods of photography using a GPS camera; direction, distance, insertion of map symbol code, etc.)
- ③ Explanation and understanding of methods of verification in the field of planimetric features etc., that are difficult to interpret
- ④ Instruction in and understanding of the importance of the interpretation key and how to prepare one
- ⑤ Instruction in and understanding of how to organize and store the data

【Instruction given after completion of the field identification】

Instruction in and understanding of methods of organizing the survey data (matching of the ground photographs with the positional information acquired in the field using the GPS camera) were promoted.

【Technology transfer in the field verification】

The ANAT seem to have more or less fully understood the contents of the technology transfer in field verification after a lecture on the basic concepts of field verification and instruction in the field verification work, data storage and data filing in accordance with the specifications provided by the Study Team to the ANAT. It seems that the technology transfer was successfully

implemented in general because most of the ANAT staff were engineers with previous experience in field identification. The Study Team used the time before the beginning of the day's field work and during the evaluation meetings held during the time for data filing at the end of the day's work to converse with the ANAT side in order to have as many opportunities as possible for communication with them. The items of technology transfer were as follows:

- Management of the image data obtained using GPS cameras (creation of DL+KML)
- Management of log data from Garmin GPS devices (data log of the GPS satellite orbit information)
- Compilation of annotation data at the lodgings (by individual C/Ps, on their laptop computers)
- Recharging of batteries of devices used in the field (managed by individual C/Ps)
- Reporting on the day's work and preparation of the work plan for the following day (progress of the work monitored by a Japanese expert)

3.1.5 ⑤ Digital Data Structurization

The Study Team transferred the technologies for structuring digital data using the ArcGIS 10.0 software that was procured in this Project. The staff members of the ANAT who participated in the technology transfer on this subject had already taken a training course in which this software was used. Therefore, the basic manipulation of this software, which had been included in the original schedule, was removed from the technology transfer for the structuring of digital data using this software. Instead, technology transfer was carried out with the focus on the software tools used in the structuring of digital data (structuring of digital topographic map data), which the participants used in their everyday work.

[Period of technology transfer, and trainees]

Duration: From 31st January to 15th February 2013

Number of participants: 3 (including two who had taken a training course in ArcGIS)

[Materials used (software)]

The software procured in this Project and used in the technology transfer was ArcGIS 10.0, with a single-use license from the American company, ESRI.

[Practical content of the technology transfer]

1. Conversion from the MicroStation .dgn file format to the ArcGIS SHAPEfile format

The SHAPE file format is the standard data format in ArcGIS and the main data format used for the editing and management of data.

In this Project, topographic map data are to be provided in the MicroStation .dgn file format.

Therefore, in order for the topographic map data to be used with ArcGIS, the data format has to be converted from the .dgn file format to a format compatible with ArcGIS. As the SHAPE file format was selected as the format for the topographic map data to be distributed via the website in the Project, the SHAPE file format was also used for the structuring of digital data.

As the topographic map data are to be created from 1/50,000-scale map sheets, it is necessary to create seamless data that are easy to use as GIS data. In preparation for the conversion to the SHAPE file format, the Study Team explained to the participants the method for combining DGN data created from a map sheet on the MicroStation platform, and had them practice this method.

The Study Team transferred to the participants the technologies used in the two methods of converting data in the SHAPE file format, one using ArcToolbox and the other using ArcCatalog. The Study Team explained and provided practical training in methods for the conversion of annotations, points, lines and polygon data, and how to configure the settings of the tools to be used in the conversion.

2. Structuring of the data

A topology is created by sorting the topographic map data converted to the SHAPEfile format by feature class, which defines the contents of the .dgn file on the basis of the layer information in the dgn.

The Study Team explained and provided practical training in the following methods required in the structuring process.

- A method of editing a topology using ArcToolbox
- A method of combining a feature represented on more than one map sheet
- A method of adding an attribute to each feature
- A method of sorting the data by defined feature class

3. Defining projection

The Study Team explained and provided practical training in how to define projection using ArcCatalog. As the number of feature classes defined in this Project exceeded 200, the team also explained how to carry out batch projection definition.

4. Setting symbols

The Study Team explained and provided practical training in how to set and create a symbol for each feature. In the practical training, the C/Ps created their own original symbols for point, line and polygon features.

5. Labeling

The Study Team explained and provided practical training in how to display a label created from its attribute and how to display labels for individual features at different angles referring to 1/50,000-scale map prints.

6. Creation of Data for WebGIS

As the data were to be distributed by department on the WebGIS, the Study Team explained and provided practical training in how to divide the data by department.

As more than 200 SHAPEfiles were required for the data to be created in this Project, the Study Team

also explained how to divide the data in batch using ArcToolbox. Acquisition of a file name using Command Prompt is useful for the creation of a batch. However, the participants had no experience in using Command Prompt. Therefore, the team created a manual on how to use Command Prompt and provided the participants with practical training in using it.



Photo 3-10 Technology transfer on the structuring of digital data

[Results of technology transfer]

The technology transfer achieved the following results:

- * The participants were able to master the technology required for the conversion of the topographic map data from .dgn-format data to ArcGIS data.
- * They were able to master the technology to classify topographic map data converted to the SHAPEfile format by feature class, create a topology, identify and correct errors, and create GIS data.
- * They mastered the technology to divide the data required for the creation of data for WebGIS.
- * They were able to master the technology required to process a large amount of data using the batch processing feature of ArcToolbox

3.1.6 ⑥ Map symbolization

The technology transfer in map symbolization was implemented for the purpose of enabling the ANAT to create independently the data required for printing 1/50,000-scale topographic maps. Data digitally compiled after field verification (in DXF format) were used in the technology transfer in map symbolization.

[Implementation period and beneficiaries]

The technology transfer in map symbolization was implemented as follows:

- Implementation period: from August 9th, 2011 to September 3rd, 2011
- Number of participants: Three

None of the participants had experience in the actual work of map symbolization or in the use of Adobe Illustrator which was used in the map symbolization.

【Equipment (software) used】

The graphic software procured for this project, Adobe Illustrator CS5, was used in the technology transfer in map symbolization.

【Content of the technology transfer】

The data of an actual area which had been digitally compiled after the field verification were used for efficient implementation of the technology transfer in a limited period. The content of the implemented technology transfer are as follows:

a. Lecture on the printing environment

The Study Team provided a lecture on the printing environment required for printing large numbers of copies of the data created in the map symbolization and on the conditions necessary for data entry.

- Explanation of DTP (desk-top publishing)
- Conditions which must be satisfied by input data for the printing of topographic maps
- Overprint
- Film output
- Other items

b. Basic operation of Adobe Illustrator CS5

The technology transfer was carried out focusing on the functions required for the creation of the topographic map data for printing. The items of technology transfer were as follows:

- How to use the selection tool;
- How to use digital input to draw SHAPES accurately;
- How to scale up/down, rotate and move SHAPES;
- How to use the Group, Lock and Hide commands;
- How to paste and draw lines in different ways;
- How to manipulate layers;
- How to create patterns and brushes;
- Etc.

c. Preparation for the map symbolization work

The technology transfer in the items mentioned below was implemented in order to enable the C/Ps to create the objects required for the creation of topographic map data for printing in accordance with the symbol specifications.

- How to register swatch colors (process colors),
- How to create and register vegetation patterns
- How to create and register brush patterns,
- How to create symbol marks,

- How to create a pallet file to be used as a library, and
- How to create a working template file

d. Map symbolization work

The C/Ps practiced map symbolization using the data file (in DXF format) created in the digital compilation (carried out as part of the Work in Japan) following field verification as described below (map sheet number: NE28IV2c):

- Conversion of the scale of the data file (in DXF format)
- Arrangement of the vertical order of layers
- Conversion of objects in accordance with the symbol specifications
- Correction of inconsistencies
- Trimming of topographic maps

e. Creation of topographic map data file for printing through the integration of topographic map data and marginal information data



Photo 3-10 Technology transfer in map symbolization

【Outputs of the technology transfer】

a. Printing environment configuration

The C/Ps understood the general concept of digital data printing from the explanation on the difference between the film output for printing and the conventional plotter output (RGB), and the significance of overprinting as a measure to prevent misregistration.

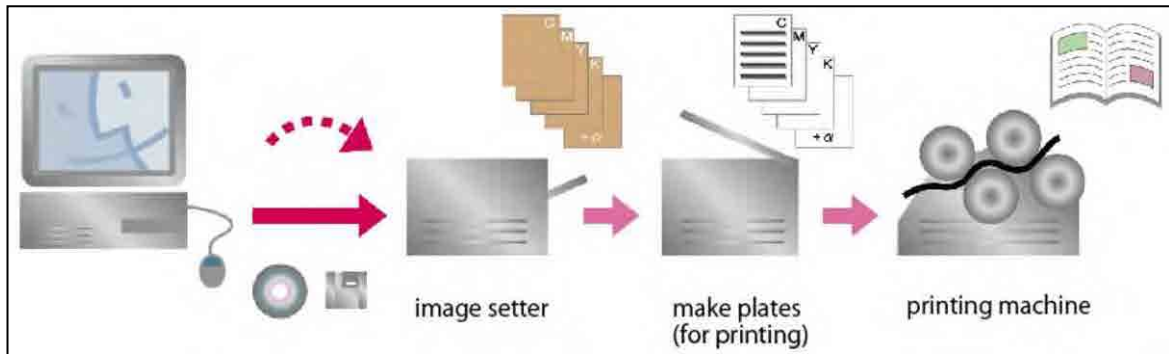


Figure 3-9 Flow of digital data printing

b. Basic Operation of Adobe Illustrator CS5

The C/Ps mastered the operation of Adobe Illustrator required for map symbolization more or less completely from the explanation in the basic operation manual specifically prepared for the map symbolization in this technology transfer and through the on-the-job training (OJT) in assigned tasks. A large amount of time was used for technology transfer in layer manipulation and methods of creating patterns and brushes, which are useful in the map symbolization.



Figure 3-10 DTGC Logo created by a ANAT trainee

c. Preparation for the map symbolization work

*** Registration of swatch colors**

The C/Ps created swatch colors to be used in the map symbolization in accordance with the symbol specifications. It was now possible to change the color of all patterns, brushes and symbol marks created with a swatch color at a stroke by changing the swatch color when such a change of color was required.

*** Creation of a pallet file**

The C/Ps created vegetation patterns, symbol brushes (marks) and line brushes (for representing features such as depressions and boundaries) in accordance with the symbol specifications. The C/Ps placed each of these on a layer named with its symbol code and compiled the layers in a file. This file now made it possible to efficiently convert a DXF file into a file in the right format for the symbolization.

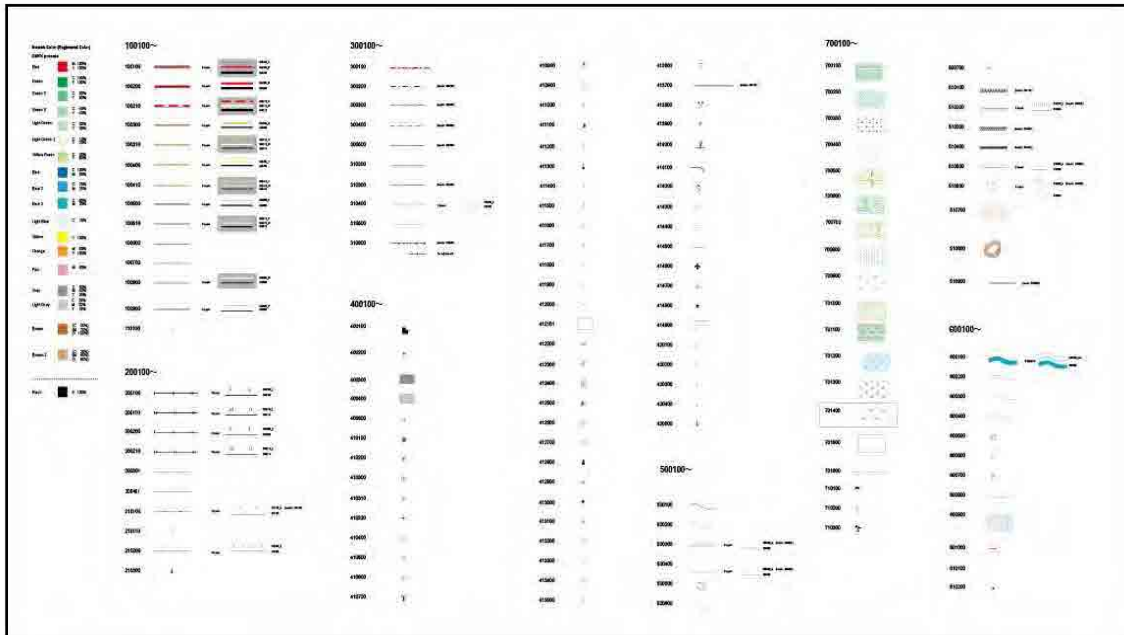


Figure 3-11 (Part of) Pallet file including layer information

*** Creation of a template file**

The C/Ps created a file for map compilation containing the information on the vertical order of layers (map symbols). The efficient arrangement of the vertical order of map symbols to be represented in the map symbolization by pasting DXF data onto this file was now possible.

d. Map symbolization work

*** Conversion of the scale of DXF data**

The C/Ps managed to convert DXF data which did not have an absolute scale into data at the exact scale of 1/50,000 by using a scaling-down rate of 2 % when entering the DXF data into Illustrator.



Figure 3-12 DXF file as an output of the digital compilation

* Arrangement of the vertical order of layers

The C/Ps arranged the layers in the vertical order as represented in the map symbolization by copying the DXF file entered into Adobe Illustrator and pasting it onto the “template file” created in the preparatory stage.

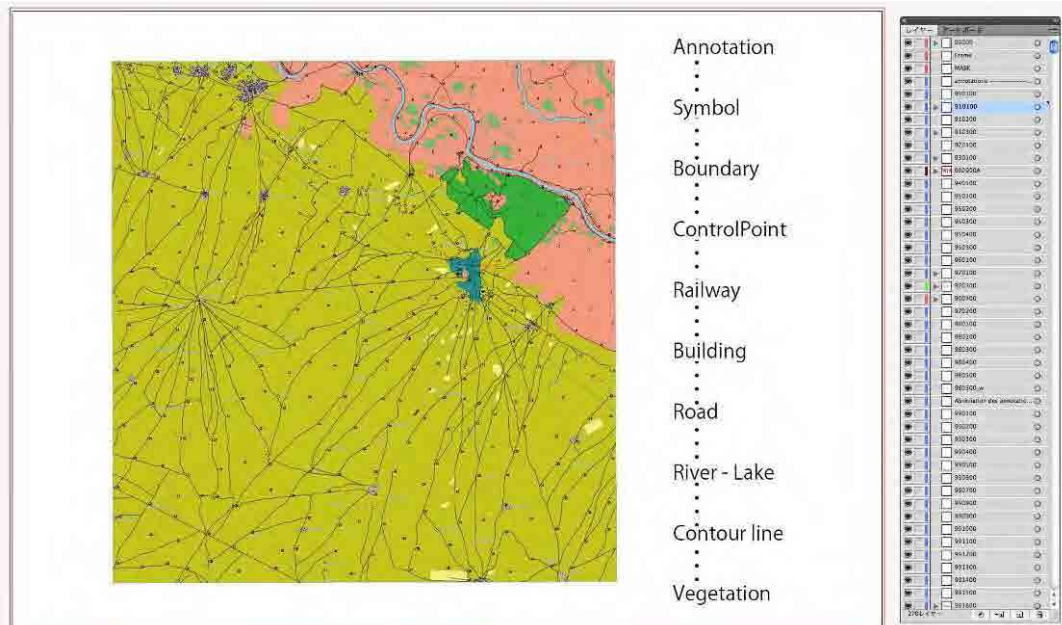


Figure 3-13 DXF file with layers in the appropriate vertical order on the template file

* Conversion of objects in accordance with the symbol specifications

The C/Ps copied and pasted the map symbols onto the pallet file created in the preparatory stage and applied the symbol specifications to objects on layers using the Eyedropper Tool.

The C/Ps practiced changing the colors of polygons and filling in polygons with different patterns, changing line types, line colors and line widths and changing fonts, sizes and colors of annotations. They practiced representation of a road using a double line (representation of a line object using two lines) on two layers, the original layer and an additional copied layer. The C/Ps mastered the series of operations described above.

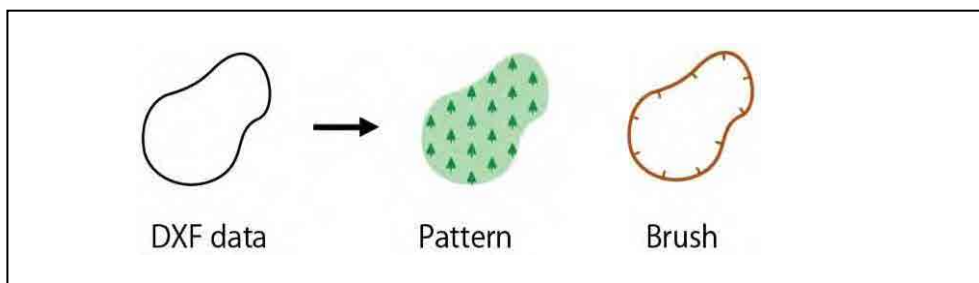


Figure 3-14 Conversion of a DXF data with Pattern and Brush tools

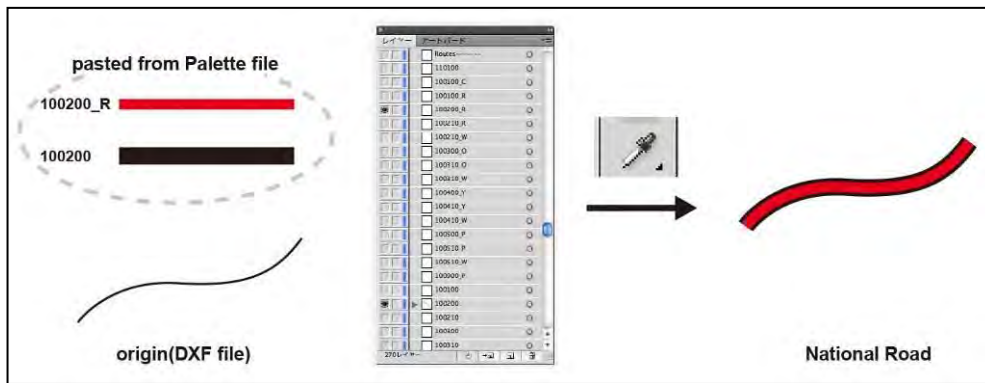


Figure 3-15 An example of a map symbol to be represented on more than one layer (code: 100200)

* Correction of inconsistencies

When attributes of data in DXF format represented with single lines such as precipices and railway lines have been converted in batch with the application of Line Brush, inconsistencies will appear on some parts of the lines. In such cases, consistency will be restored either by cutting the line into segments and manually correcting the segments with inconsistencies, or by using the command “Simplify” or “Round Corner,” which allows a reduction in the number of segments (points) without changing the SHAPE of the line. The Study Team also transferred to the ANAT side the technologies used in the above-mentioned procedure.

* Trimming of maps

All objects from the data digitally compiled after field verification (in DXF format) are cut by a neatline and some may lack data within a map framework. If an object lacking data is an object with line width such as a road, the data for the object will be extended beyond the neatline to eliminate the lack of data and delete the part outside the map framework using “Clipping Mask” for layer manipulation. The Study Team also transferred the technologies for this method to the C/Ps.

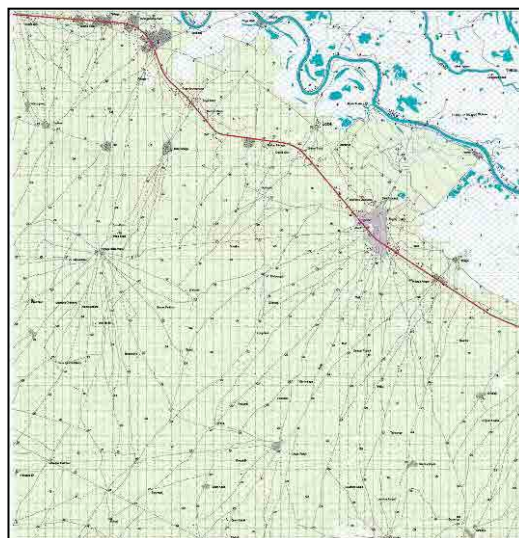


Figure 3-16 Map-symbolized file (NE28IV2c)

e. Creation of a topographic map data file for printing through the integration of topographic map data and marginal information data

The Study Team transferred the technologies required for the creation of topographic map data for printing through the replacement of map sheet number, road destinations, railway lines, etc. and map sheet title after integrating the basic marginal information file including Trim Marks (also called *tombos*) and the created topographic map data.

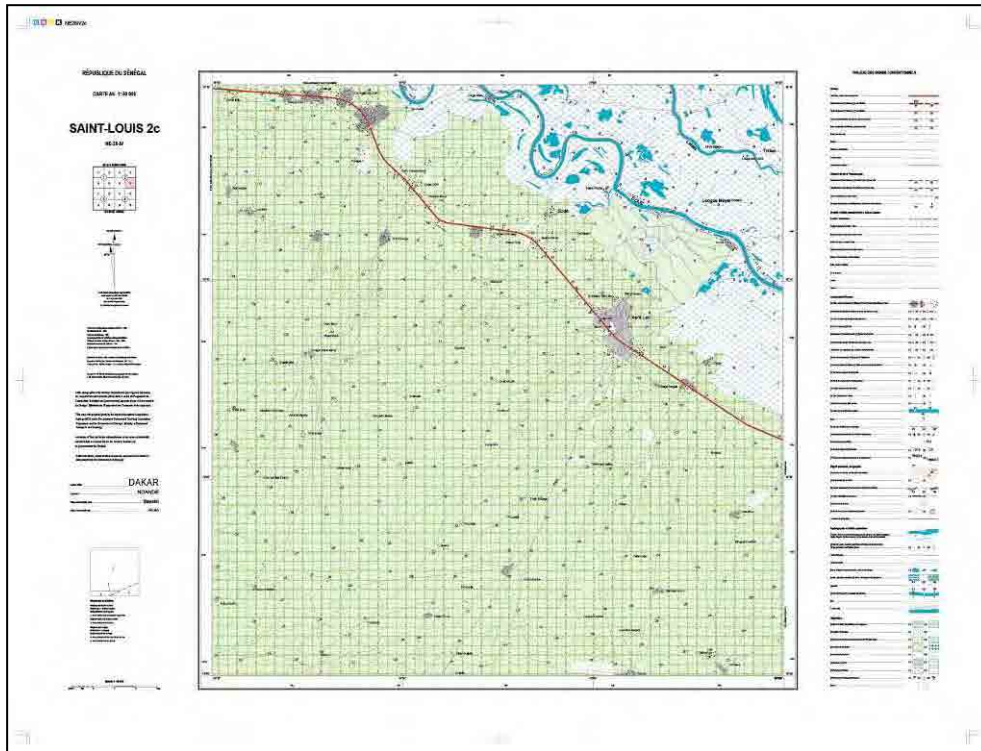


Figure 3-17 Completed topographic map data for printing (NE28IV2c)

3.1.7 ⑦ Structuring of Website

The technology for the creation of a website was transferred to an ANAT IT engineer as follows:

[Purpose of the technology transfer]

The purpose of the technology transfer for the creation of a website (referred to below as “this work”) was for the ANAT and the ANAT to acquire by means of practical training the knowledge required for the maintenance of a website, including the ability to update it by themselves.

[Focal point in the implementation of the technology transfer]

Multiple open-source programs were used in the creation of the website. Therefore, a member of the Study Team (the instructor) first explained each of the programs constituting the website to the ANAT engineer (the participant) and, after the participant had understood the systems used on the website, explained to him the procedures required for the maintenance of the website, such as data registration.

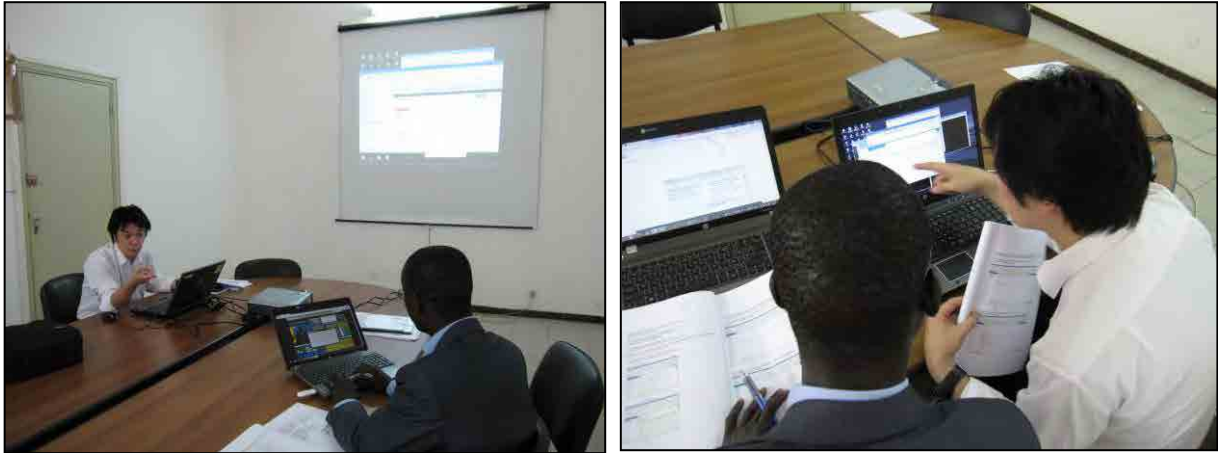


Photo 3-12 Technology transfer for website creation

3.1.8 ⑧ Promotion of Data utilization/Structuring of a system of use

【Plan for the technology transfer】

The Study Team defined the goals and the outputs required for achievement of the goals of the entire study, including the technology transfer, with regard to the promotion of the utilization of topographic map data and the establishment of a system of utilization (see 2.13 (17) Structuring of System of Usage). The goals and outputs relating to the technology transfer are described below.

* Goals

- (3) The capacity to identify needs and to implement activities which lead from needs to actual utilization and the capacity to smoothly operate and maintain a system for secondary utilization

* Outputs

- (3) The results of a case study on permission for secondary use and fee collection are to be compiled and a report on a study on how to turn the needs for the use of topographic maps into actual utilization is to be prepared.

The Study Team selected the activities mentioned in Table 3-6 in order to achieve the outputs mentioned above.

Table 3-6 Activities corresponding to the outputs of the technology transfer regarding promotion of the utilization of map data and establishment of a system of utilization

Output	Activity
3. The results of a case study on permission for secondary use and fee collection are to	3-1 The Study Team explains to the C/Ps the concepts of copyright and pricing of geospatial information in Japan and other countries, and consults with them on the applicability of those concepts in Senegal
	3-2 The Study Team explains the activities to identify the needs of organizations interested in the use of geospatial information and the measures taken to promote the use of geospatial information in Japan. The C/Ps carry out a study on methods to

be compiled and a report on a study on how to turn the needs for the use of topographic maps into actual utilization is to be prepared.	identify the needs in Senegal using the information provided by the Study Team as reference.
	3-3 The Study Team has the C/Ps observe its study on the needs for topographic maps in government organizations concerned with the maps, to provide them with opportunities to practice methods of identifying those needs.
	3-4 The Study Team explains to the C/Ps the laws and regulations relating to copyright in Senegal, the handling of the copyright of documents issued by the relevant governmental organizations and copyright fee collection on the basis of the results of 1-1 and 1-2 and helps them deepen their understanding of the similarities and differences between Senegal and other countries, including Japan.
	3-5 The Study Team explains to the C/Ps the economic impact of topographic maps and facilitates their understanding of the importance of activities to promote their use.
	3-6 The Study Team allows the C/Ps to consider what activities should be taken in response to the needs, on the basis of the results of the needs survey described in 2-1. The Study Team helps the C/Ps master how to conduct surveys by having them carry out independently a supplementary needs survey at the governmental organizations concerned.
	3-7 The Study Team explains to the C/Ps the internal regulations on permission for secondary use and fee collection including the underlying concepts, and helps them master how to maintain the system under changing social conditions.
	3-8 The Study Team helps the C/Ps master how to promote the use of topographic information through assistance in the implementation of workshops. In the workshops the team has the C/Ps explain the system for the secondary use of topographic maps.
	3-9 The Study Team has the C/Ps compile reports on the identification of the needs for the use of topographic maps and measures to satisfy those needs.

The four phases of the Work in Senegal were conducted in order to implement the activities described above.

【Summary of the obtained outputs】

The major outputs obtained from the technology transfer implemented in line with the plan described above are as follows:

Output 3:

- The C/Ps were given opportunities to conduct surveys to identify the needs for geospatial information at relevant government organizations and mastered how to conduct such surveys.
- The C/Ps has understood the basic concepts of the secondary use of geospatial information and pricing, including those in place in various foreign countries.
- The C/Ps have implemented activities which led the need for the geospatial information to its use (including the creation of pamphlets for potential users (to be implemented)) and realized the importance of the activities.

【Implementation of the activities: (Output 3) Permission for secondary utilization and pricing of topographic maps and promotion of their use】

The Study Team implemented activities relating to output 3 in accordance with the plan. The establishment of a practical system for the promotion of the data utilization including secondary use is required more urgently than the mathematic analyses based on many assumptions. The C/Ps might

have failed to comprehend how to perform tasks if they had been given too many tasks. However, they had fully recognized the importance of the topographic maps including their economic significance through the practical activities such as visits to the organizations interested in the digital topographic map data and activities related to accumulation of the cases of the data utilization. These facts have led the Study Team to conclude that the original goal for Activity 3-5 in Table 3-6 has been achieved.

(1) Identification of the needs for geospatial information at government organizations

As mentioned in 2.13, in the first and second phases of Work in Senegal the Study Team visited 17 government, public and international institutions and private companies to identify their needs for 1/50,000-scale topographic maps. The team had the C/P staff accompany them on the study and provided them with opportunities to practice the study methods.

(2) Secondary utilization of the geospatial information, and pricing

In the first phase of Work in Senegal the Study Team explained to the C/Ps the handling of copyright and pricing for the use of copyright in Japan and the Western countries using reference materials, to deepen their understanding of world trends regarding copyright.

During the second and third phases of Work in Senegal the Study Team prepared a rough draft plan and a draft plan for secondary utilization and pricing, respectively, and tried to deepen the C/Ps' understanding of the concept of secondary utilization and pricing through an exchange of opinions on those documents.

The C/Ps responsible for the provision of the geospatial data had been replaced before the third phase work in Senegal partly due to the appointment of the new Director General of the ANAT following the inauguration of the new President in March 2012. Because of the appointment of the new C/Ps, the Study Team had to explain the study for the second time to them. However, the team tried to use this as an opportunity to improve the efficiency of the technology transfer as the team expected the second explanation to have the impact of enhancing the awareness of this project within the ANAT.

(3) Promotion of the utilization of geospatial information on the basis of needs

As mentioned in 2.13, in the first, second and third phases of Work in Senegal the Study Team conducted a study on the needs for the utilization of the outputs of this project, i.e., digital topographic maps, and loaned copies of the interim results of the study to four organizations, in order to facilitate the creation of cases of use. The team implemented the series of activities with the C/Ps mentioned above so that they could have the opportunity to practice methodology in the promotion of utilization.

(A description of the activities implemented in the fourth phase of Work in Senegal to be added)

- To visit potential users in person and listen to their needs
- To bring samples to potential users to show them the usefulness of the maps visually
- To inspect the places where geospatial information is utilized
- To compile the results of the study

As also mentioned in 2.13, in the fourth phase work in Senegal the team held a brainstorming meeting with the C/Ps and gave them the opportunity to think up sales promotion activities as a group. The proceedings of the brainstorming meeting were as follows:

- The member of the Japanese side in charge of sales promotion gave a presentation on sales promotion activities for the topographic maps created by the Geospatial Information Authority of Japan.
- Each participant proposed ideas for sales promotion activities which s/he had created from the examples in Japan or her/his experience in Senegal. These ideas were recorded on paper.
- The participants turned each idea into a more practical activity and enhanced its feasibility by discussing when, how and by whom it was to be implemented
- The participants summarized the final outcome of the meeting in a table (see Document 12).

The staff member in charge of public relations and sales who was to be most involved in the sale promotion activities was supposed to participate in the meeting. However, due to unforeseeable circumstances, he was not able to do so. The participants strongly requested that the staff member should be informed of the outcome of the meeting and should endeavor to plan the details of the activities so that they could be put into operation.

In general, the participants were actively engaged in the discussion, and the output of the discussion was considered more concrete than expected. As the activities proposed in the meeting were only tentative ideas requiring further development to make them feasible, the team hopes that the C/P side will hold further discussions on sales promotion activities based on the proposed activities.

3.1.9 **⑨ Quality Control**

The technologies for the implementation of accuracy control, which is a part of the quality control, was transferred to the C/Ps so that they could improve their understanding of the correction of errors and inspection in accordance with the work specifications at each stage of the digital mapping process and acquire the capacity to control the quality of the digital topographic map creation work. While ANAT had not created medium-scale topographic maps, they had had experience in creating small- and large-scale maps. Therefore, the Study Team urged them to follow the work specifications in each stage of topographic map creation and in particular to acquire inspection skills through OJT in digital plotting and compilation.

The Study Team transferred to the C/Ps the technologies for the confirmation of conformity with specifications (work specifications, etc.), quantity inspection with quality control sheets and check lists, and visual inspection of the outputs of the process consisting of the digital plotting/compilation and the map symbolization. The reason for the selection of the outputs of the above-mentioned process for the technology transfer in quality control is that virtually all the quality control work is required for the process concerned and, therefore in general, most of the important quality control work is implemented during the digital plotting, digital compilation and map symbolization.

3.1.9.1 Digital plotting

*** Data check**

MicroStation V8 now has a data logic check function added to the automatic processing. The use of this function to check and correct the data was included in the technology transfer. The error messages generated in this checking process also provided information for deciding which planimetric features should be given attention when carrying out digital compilation in order to reduce the number of errors. It is expected that this will lead to greater efficiency in the digital compilation work.

*** Output, visual inspection**

Technology transfer was carried out in the technique of outputting the topographic data following digital compilation and making a visual inspection through comparison with the field identification photographs.

*** Optimization of data management**

There was no consistency in the management of data files after the completion of each process; the files were under the personal management of the workers. The trainees were urged to understand the need for uniform management of the digital data, and the dangers of data being erased. To deal with these problems, it was suggested that a folder be created for each process within which the data could be uniformly managed; and further, that back-up copies of the folders should be made.

3.1.9.2 Digital Compilation/symbolization

Technology transfer was carried out in logical test methods for digital data using V8 and Bentley MAP, and in how to conduct analog testing of data output maps, as a part of the quality control. It was explained that these kinds of quality control are extremely important as following digital compilation the data is used in the structurization and map symbolization work, and advice was also given regarding data quality control methods.

The table below shows the quality control sheet form used for accuracy control at individual stages of the work (i.e. digital plotting, digital compilation and map symbolization).

Sample quality control sheet			Digital plotting,Data compilation/Symbolization			Quality control sheets			Checked Date : _____		
Project Name	Sheet Name/No.		Mapping Scale	Volume		Executive Organization			Chief Engineer		Checked by
				Km							
Item	Missing	Error	Item	Missing	Error	Item	Missing	Error	Item	Missing	Error
Geodetic points			Railway institutions			Water features			Water name		
Classification			Over bridge			Classification of symbol items			Place ground name		
Value			Platform			Position of symbol items			Marginal information		
Contour Lines			Administrative Boundaries			Form of line items			Sheet Name/No.		
Form			Classification			Traffic			District name		
Value			Form			Classification			Neat & Grid Line		
Roads			Public facilities			Position			Coordinates Value,etc.		
Classification			Classification			Vegetation			Scale Bar/Map symbol		
Form			Position			Form of boundary			Sheet index		
Road institutions			Buildings			Classification of symbol			Sheet History		
Embankment			Classification			Natural features			Planning / Executing Org.		
Underpass			Form			Classification			Others		
Over bridge			Fences			Form			Connection between adjacent sheets		
Distance marker			Form			Flow direction					
Bridge			Building symbols			Annotation					
Foot bridge			Classification			Administration name					
Road divider			Position			Road name					
Railways			Accessory objects			Road institution name					
Classification			Classification of symbols			Railway name					
Form			Position of symbols			Railway station name					
			Form of lines			Building name					

Figure 3-18 Quality control sheet form

3.1.10 ⑩ Map Updating work

The Map updating work as conducted in line with the workflow below.

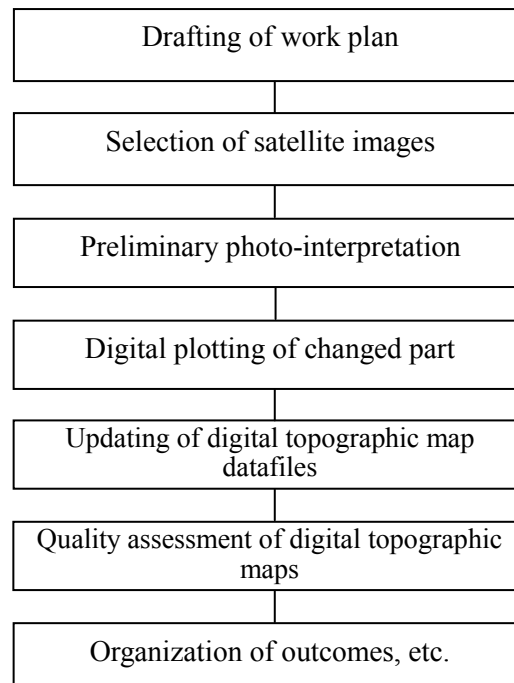


Fig. 3-19 Map updating workflow

Instruction was given to enable the trainees when necessary to use the latest satellite images and materials on the secular changes when a change occurs in a natural feature or in the geographical

information, to carry out partial revision of the change. It is expected that there will be changes in the geographical information of the mapped area due to changes in natural features, spreading urbanization, improvements to infrastructure, etc. With regard to the structuring of a system to obtain from the relevant agencies the information needed for the updating of secular changes, timing of the updating, drafting of a updating plan, etc., a survey of the skill level of the ANAT indicated that in the first instance priority should be given to the preparation of topographic maps of the areas for which satellite images were provided; this and the small number of engineers dictated that guidance be limited to work on actual secular changes. In addition, in order to improve the quality of the technology transfer a updating work manual was prepared and instruction given in work using the manual. The work of technology transfer was carried out at the time of the technology transfer in plotting and compilation.

The map updating work further necessitated the following work.

- Digital plotting of existing maps (Including contour lines)
- Preliminary photo-interpretation of sections of secular change
- Plotting/compilation of sections of secular change

Plotting/compilation of sections of secular change of the above work processes are roughly the same processes as for first-time plotting. Thus the technology transfer in updating work was carried out with the addition of the above work.

3.2 Evaluation of the technology transfer

*** Overall Evaluation of the Technology Transfer**

The Study Team decided not to evaluate the results of the technology transfer quantitatively for the overall evaluation of the technology transfer because none of the trainees participated in the entire course of the technology transfer. Nonetheless, the Study Team found that the levels of knowledge and technology of each of the trainees immediately after the completion of the technology transfer were sufficient to continue to create topographic maps.

Therefore, the trainees have to make sure not to forget the technologies for the creation of topographic maps acquired in the technology transfer in a short period of time. Instead, they should continue to use the technologies in order to perfect their map creation skill and, by doing so, try to improve the efficiency and accuracy of their map creation. The organizational structure of the institution for map creation has to be improved and restructured in order to guarantee the continued use of the technologies and improve the efficiency and accuracy. The recommendation of the Study Team on this issue is described in detail in Chapter 7, **“7.2 Recommendation on the basis of the Outcomes of the implementation of this Study, 1. Recommendation on Database Management.”**

*** Detail of the Evaluation of the Technology Transfer**

The evaluation of the technology transfer was implemented by the method given below.

- Evaluation by means of a questionnaire to be filled out by the recipients of the technology transfer before start of the work
- Evaluation from the results of a questionnaire to be filled out by participants in the technology transfer
- Evaluation from the degree of progress in transfer work through OJT
- Comprehensive evaluation by the Study Team (To be evaluated on the outputs of the four map sheets being created by the ANAT)

The overall evaluation by the Study Team was carried out by comparing as shown below the sections of the topographical map created by the ANAT trainees themselves with the topographical maps of the same area created by the Study Team. Their evaluation was as follows.

【Overall Evaluation】

- It was expected that when the technology transfer was finished there would be four completed topographical maps created by ANAT, but the slow progress resulted in the completion of less than one map. It is thought that the reason for this is that after the technology transfer not sufficient work was done to enable the engineers to operate the workstation and improve their skills.
- In the digital plotting work some good results can be seen, so that it can be assessed that the engineers understood the content of the technology transfer and possess the ability to acquire digital plotting data. However, it is thought that the reason progress was disappointing was that time was taken up in carrying out the normal duties of ANAT and cooperating with other projects, so that there was not enough time to carry out the digital plotting work.
- With regard to the technological transfer of digital compilation and map symbolization, there is no evidence of any digital compilation and map symbolization work being carried out after the acquisition of the digital data, as a result of which no overall evaluation can be made. The Study Team has prepared operating manuals on how to operate the compilation software and to assist in the creation of topographical maps and has provided these to the counterparts, and it is hoped that these manuals will be helpful to the ANAT in the future in creating their own topographical maps.
- There is apparent a lack of experience in photogrammetry – stereopsis, the selection of which planimetric features ought to be indicated, etc., – which is of the utmost importance in the creation of topographical maps. Experience in the creation of topographical maps, including time spent in the operation of the software for digital plotting, digital compilation and map symbolization over the long term, will be needed in order to bring these necessary skills and abilities up to a good enough level. We consider that raising the level of skill overall in the work of creating topographical maps will require hard work on the part of ANAT itself in the

future.

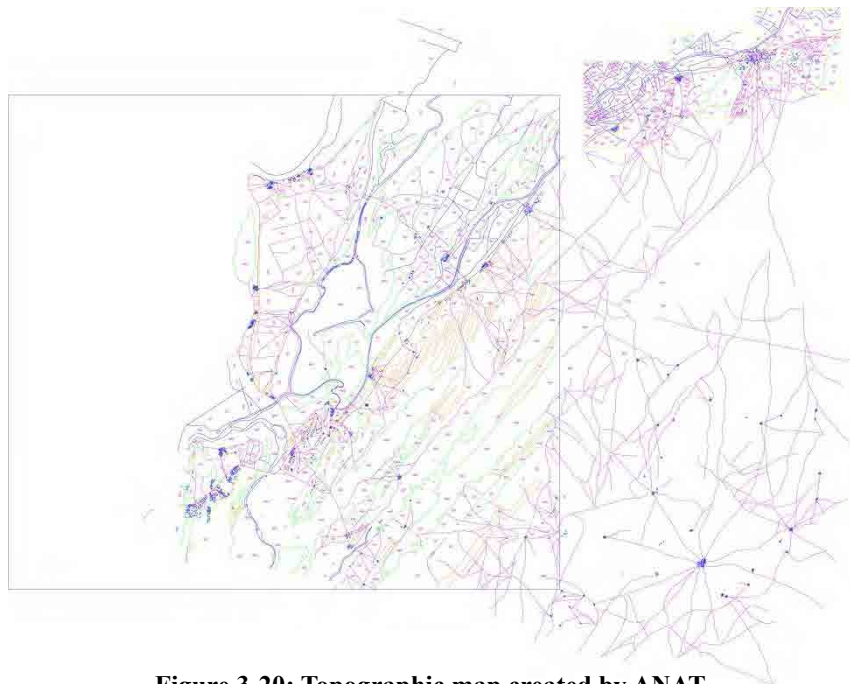


Figure 3-20: Topographic map created by ANAT

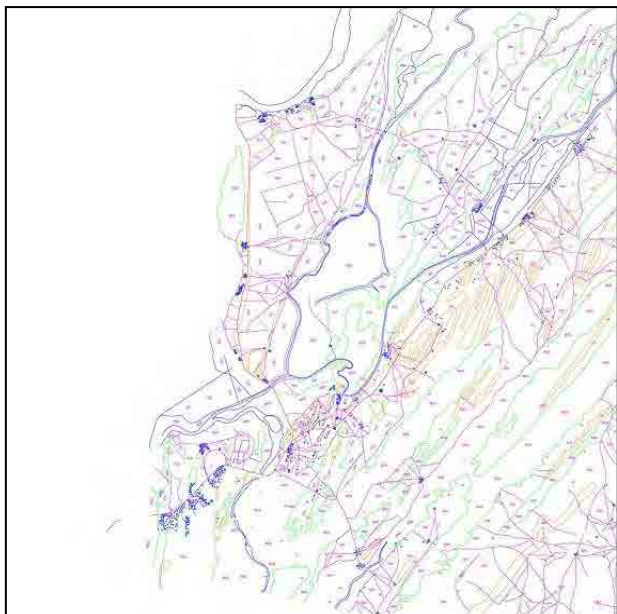


Figure 3-21: Output of the plotting by the ANAT engineers (during the plotting process)

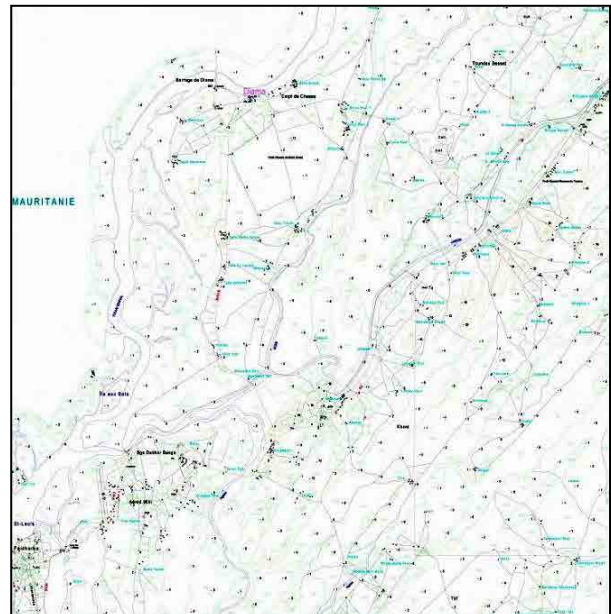


Figure 3-22: Output of the plotting created by the Study Team (at the completion of the plotting and compilation)

Below is a description of the results of the evaluation of the technology transfer implemented for each stage of the digital topographic map creation.

① Ground control point survey

The Study Team carried out technology transfer for the ground control point survey through OJT

while the team was implementing the survey in the field. The two geodetic survey engineers among the C/Ps had previous experience in GNSS survey in a project implemented by EU and had basic knowledge and technical skills relating to geodetic surveying. However, as they had practiced only the process from planning to filing of outputs in the GNSS observation and had little experience in comprehensive management of the entire process, there was more for them to learn through OJT. The other C/P, a cartographer, who had no experience in geodetic survey, managed to acquire the skills to conduct GNSS observation independently with the correct procedure and was strongly motivated to acquire technical knowledge. However, he needs further experience to learn the basic skills of how to install a tripod and the basic skills of surveying.

The Study Team held a meeting with the ANAT side every evening except for weekends and holidays during implementation of the field work. The team members listened to the questions and problems of the C/P engineers and provided them with appropriate guidance for every question and problem. The Study Team considers that the use of this approach enabled the technology transfer to be carried out with relevance to the actual work of the C/Ps.

As the Study Team noticed during implementation of the study that ANAT did not seem to have an established system for basic management of equipment, the team provided ANAT with instruction on methods, such as allotting a management number to each piece of equipment so that a manager can manage all equipment centrally from his PC. As it seems that this problem of the lack of a management system is not limited to the management of equipment but is an organizational problem of ANAT, the Study Team will have to continue providing appropriate advice and instruction to ANAT during the implementation of this study.

② Aerial triangulation

The technology transfer in aerial triangulation was implemented in the form of practical training using the images of the project area (the Northern Region) and the available satellite images (of the Western Region). Although none of the three participants had had previous experience in photogrammetry, through repeated practice on the job they learned the series of processes using LPS, from the creation of a project file to the evaluation of the calculation results and how to use the software. While the Study Team had expected that it would not be possible within the designated period for the C/Ps to complete the aerial triangulation of the Western Region which was carried out in the latter half of the technology transfer, the C/Ps managed to complete the work up to the measurement of tie points and the evaluation of the accuracy of the measurements as they became increasingly familiar with the operation of the software. Although they had some problems in the accuracy of measurements and oversights in the verification of point arrangement and the number of rays, these are very technical parts of the work which require a lot of experience. Therefore, the Study Team concludes that the current technical capacity of the C/Ps is at a level which will enable them to plan and implement the aerial triangulation using ALOS images on their own.

As the Study Team has confirmed that the C/Ps can handle pan-sharpen imagery on their own, albeit with the help of the manual (Attachment-25), the team considers that they can use this technology for updating topographic maps with partial correction and for other types of work.

As the engineers of ANAT are specialists not in photogrammetry (even though they have the knowledge) but in cartography, they have been skillful at creating maps by processing and making adjustments to existing map sheets and images. Therefore, prior to the technology transfer the Study Team was uncertain how ready the C/P would be to learn aerial triangulation, in which accuracy is the basic requirement. However, the participants were enthusiastic in practicing the procedures for aerial triangulation, which they had never done before, from their intention to be able to create and manage topographic maps and the geospatial information of Senegal by themselves in the future. As a consequence, they seem to have made satisfactory progress in the limited time. Although they have to complete their observation of ground control points, final calculations and accuracy control in order to complete the aerial triangulation of the Western Region, the Study Team is convinced that they will be able to produce satisfactory outputs on their own.

③/⑩ Digital plotting/Digital compilation (including partial correction)

* Digital Plotting

After the implementation of the technology transfer, the Study Team confirmed the proficiency of each participant by providing him/her with a new task in the digital plotting of a sample area selected for him/her. The eight criteria used to confirm proficiency are shown in Table 3-5. The proficiency of each participant on each criterion was evaluated with ○ and Δ.

Table 3-7 Proficiency in digital plotting/compilation

Confirmation criterion	Trainee A	Trainee B	Trainee C
Understanding of the basic concept	○	○	Δ
Understanding of the symbol specifications	○	○	Δ
Proficiency in basic equipment operation	○	○	○
Proficiency in system operation	○	Δ	○
Understanding of topographic photo interpretation	○	○	Δ
Utilization of the results of the field identification	○	○	○
Digital plotting	○	Δ	○
Inspection and correction of data	Δ	○	○

○: The C/P has understood the explanation of the activities undertaken in the technology transfer and (s)he is motivated to improve his/her capability through further practice in the future.

Δ: The C/P seems to require additional basic instruction.

While the table above shows the difference in proficiency between the C/Ps, it also shows that at

least one of them is proficient in each of the eight criteria. Therefore, the team considers that it is possible for the C/Ps to master the technologies required for digital plotting by sharing information between themselves and continuing with self-sustained training. Figure 3-5 shows the sample data created by the three C/Ps.

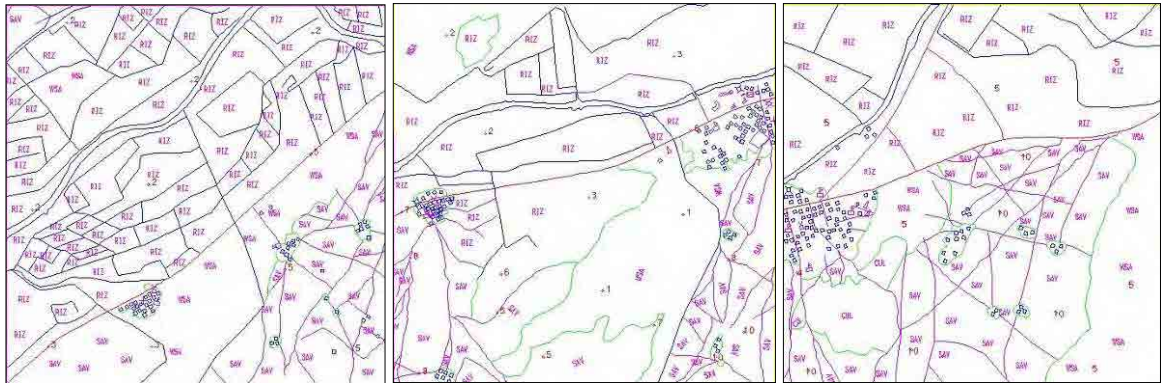


Figure 3-20 Sample created by Trainee A Sample created by Trainee B Sample created by Trainee C

*** Digital Compilation**

The C/Ps seem to have understood the importance of the symbol specifications and map specifications in the creation of 1/50,000-scale digital topographic maps and have acquired the technical capacity to implement digital compilation in accordance with those specifications without problem. The newest version of the software which was used in this technology transfer includes a data logic check function, the use of which made possible precise quality control.

Through the implementation of this technology transfer it became clear that the interest of the ANAT in the new technology, their understanding of it and ability to absorb it is extremely high. We hope that they will reconsider the way they do digital compilation work, make good use of the most up-to-date software that was introduced and carry out their digital compilation work more efficiently.

④ Field identification/verification

This was the trainees' first field identification using satellite images and a GPS camera, but they did have some experience of field identification and with respect to know-how, it may be said that all the trainees understood.

The greatest importance was attached in particular to the importance of the preparatory work prior to the survey, and this was explained repeatedly. The result of this was that while the initial plan was to survey all 54 map sheets, due to the large number of scattered settlements and the time taken to move between them, roughly 80% of the work was completed; thus a plan was drawn up for the ANAT itself to carry out the remaining work, and the ANAT did carry out the work itself, in coordination with the Japanese Study Team. From the results of the field identification carried out by the ANAT trainees it was ascertained that the field identification had been carried out in accordance with the instructions of the Study Team.

⑤ GIS Data Structuring

The Study Team evaluated whether or not the technical level of the participants had reached the level at which they were able to structure digital data using ArcGIS by themselves, on the basis of the output of a pilot project for creating GIS data from the topographic map data in the .dgn file format.

The technical components of the pilot project were the conversion of data in standard formats such as .dgn, .dwg, .DXF and .SHAPE to the feature classes, data editing, the creation of topologies, the identification and correction of errors, the creation of layers and the creation of map documents. The Study Team confirmed from the results of the pilot project, which the participants undertook repeatedly, that the participants had successfully mastered those technologies. From this observation, the Study Team concludes that the ANAT is capable of independently creating structured GIS data using ArcGIS.

The staff members of ANAT had had some experience in using ArcGIS in their work. This being the case, the Study Team transferred the concept of and the method for the effective use of the tools of ArcGIS, and the technology to make the method more efficient.

Following the technology transfer, the participants now have a solid understanding of the structuring of digital data using ArcGIS. However, it was regrettable to note that some of the participants, who are administrators at present or may be in the future, did not seem to have a strong motivation to absorb new technologies.

The participants had to do the same work repeatedly at many stages in the structuring of the GIS data implemented in the Project. However, the Study Team did not observe in the participants the will to improve the efficiency of the work. They seemed to be satisfied with the level of technologies they had, and seemed to have little interest in acquiring advanced technical knowledge. These observations have led the Study Team to consider that measures to enhance motivation of ANAT members will be required if the implementation of technology transfer on ArcGIS and other subjects is to be continued and upgraded, and that because of its importance priority should be given to assistance in raising motivation.

⑥ Map symbolization

Despite having no previous experience in using the graphic software, Adobe Illustrator, in this technology transfer the ANAT engineers were able to acquire the ability to perform independently a series of tasks, from the creation of objects to be used in the symbolization and the entry of data digitally compiled after field verification (in DXF format) to the data compilation for symbolization. On the basis of this observation, the Study Team concludes that their understanding and proficiency have almost reached the level at which they will be able to create topographic map data for printing.

The Study Team expects the map symbolization technologies transferred in this study to be used in the creation of 1/50,000-scale map symbolization data and to open up the possibility for the

creation of small-scale maps through a scaling-down compilation of the data. The team also expects these technologies to open up possibilities for the creation of thematic maps through modification of the specifications. In order to realize these possibilities, the Study Team expects ANAT to maintain, extend and improve on the technologies acquired in the technology transfer and to create independently various data for printing.

⑦ **Structuring of Website**

The technology transfer for the creation of a website was implemented as a two-day-long intensive practical course, as the instructor had to spend time on the final review of the contents of the website, such as data registration, in preparation for the final seminar. However, the participant had no problem understanding the series of technologies explained by the instructor, since as the IT engineer in charge of the creation of the ANAT website he had sufficient technical knowledge of website creation.

However, for a person to be able to maintain an actual website requires plenty of repeated practice of the maintenance procedures such as data registration. Therefore, the instructor advised the participant to create a mock server and a mock website in a private space (*e.g.* on his own PC or external HDD) and to practice the maintenance of a website there.

The website developed in this study will have to be integrated with the ANAT website. The Study Team considers that ANAT will have no problem in completing the integration. The Study Team also expects ANAT to maintain the webpage as a tool to promote the use of geospatial data by adding and updating the data by themselves

⑧ **Promotion of Data utilization/Structuring of a system of use**

When the Study Team visited government organizations to identify their needs for geospatial information and to promote utilization, in most cases the C/Ps accompanied the team. The team considers that this experience has deepened their awareness of the survey methods and of how to facilitate cooperation. Meanwhile, the C/Ps selected the organizations to be visited and made appointments with them using their established human network. Therefore, this activity could not have been realized without cooperation between the Study Team and the C/Ps. From these observations, the Study Team concludes that the activities for the promotion of utilization were very effective thanks to the active participation of the C/Ps.

The C/Ps took an active part in the lectures given at secondary schools and made great achievements in the preparation of teaching materials and provision of lessons, though these activities are not mentioned in the official description of the technology transfer. The Study Team expects that continuous implementation of such activities will promote the utilization of geospatial information in the long term.

As mentioned above, new C/Ps were appointed for this study during the third phase of Work in Senegal. The Study Team has not been able to provide sufficient input to them since their appointment. Therefore, the technology transfer has turned into the unilateral provision of

information from the Study Team without any reaction from the C/Ps. In order to improve this situation, the Study Team has been urging the C/Ps by e-mail to be active even when the team is not in Senegal. However, the situation has not improved much.

Since this study is an important project for the C/P organization, ANAT, a limited number of senior officials have the authority to make decisions on matters concerning this study. Therefore, the involvement of senior officials is essential for the implementation of this study. However, in this study the Study Team has not been able to collaborate with them adequately. This lack of collaboration seems to have led to the problem described above.

Chapter 4 Works related to the Study Reports

4.1 (2) Preparation of the Inception Report (Work in Japan)

A preliminary investigation of the basic policy regarding implementation of the work, working methods (including the method of technology transfer), work items and contents, system of implementation, schedules, etc., was carried out on the basis of existing materials and gathered materials and put together as the Inception Report, for which the approval of JICA was obtained.

4.2 (3) Explanation and discussion of the Inception Report (Work in Senegal)

Having been approved in advance by JICA, the Inception Report was presented to the government of Senegal, and an explanation was given of the content of the survey and the policy for implementation. The content of the discussions was summarized in the minutes of the meeting, and agreed upon. (see Appendix 1). With regard to the survey criteria, fresh talks were held and copies of the minutes of the meeting were exchanged. (see Appendix 2)



Photo 4-1 Signing the minutes of the Inception Report meeting

4.3 (11) Preparation of the Interim Report (Work in Japan)

The situation with regard to work implemented up to the end of January 2012, evaluation of the results of implementation and plans for how the work would progress in the future were recorded in the Interim Report.

4.4 (12) Explanation and discussion of the Interim Report (Work in Senegal)

The “Meeting to explain and discuss the Interim Report”, at which details of the situation with regard to work implemented up to the end of January 2012 and other matters were explained and discussed, was held at the offices of ANAT on September 28th 2012. Those present were two staff members of

the ANAT and three members of the Study Team.

In the explanation and discussion, an item-by-item explanation was given of the situation with regard to the work implemented up to the end of January 2012, based on the Interim Report. An explanation was also given of the interim results of the work, and of the evaluation of the same. Further, an explanation was given of the future policy and plans for the remaining work.

4.5 (19) Preparation of Draft Final Report / Explanation and discussion (Work in Japan / Senegal)

The Draft Final Report on the implementation of the project overall and its results was prepared. The various work manuals using which the ANAT will in its own right from now on organize, maintain and manage the various types of data (geospatial information) were also compiled.

The Draft Final Report mirrors the opinions of various experts gleaned from review meetings held in Japan. The Draft Final Report was explained and discussed in Senegal. (see Appendix 10)

4.6 (20) Preparation of Final Report (Work in Japan)

Based on the results of consultations with the C/Ps, the Draft Final Report was revised, and the reports of work carried out after the consultations on the draft final report (eg., technology transfer in GIS data structuring, technology transfer in website construction, promotion of the effective use of data, etc.) were added to produce the Final Report.

4.7 Report to JICA Senegal Office (Work in Senegal)

The Study Team members prepared a “Start of Assignment” report and an “End of Assignment” report at the start and end respectively of their assignment, and submitted these to JICA Senegal Office. The “End of Assignment” report was accompanied by a report summarizing the work implemented.

Chapter 5 Other works implemented

5.1 Holding of Kick-Off Meeting (Work in Senegal)

Prior to the start of the project, a Kick-Off meeting was held as detailed below.

Venue : ANAT Conference Room

Date : May 16th, 2011

Attendees : From Senegal (ANAT)

Mr. Abdulaye FAYE	Secretary General/ANAT
Mr. Mansour DIOUF	Agent Comptroller/ANAT
Mr. Youssou NDONG	Director of DTGC
Mr. Mamadou THIAM	Chief of Division for Cartography
Mr. Abdou Kahdre DIATTA	Chief of Communication Marketing

From Japan (JICA Senegal Office)

Mr. Shinji UMEMOTO	Chief of Bureau/JICA
Mr. Mamadou NDOME	Representative/JICA

Study Team

Mr. Takashi HARADA	Leader
Mr. Takao IKEDA	Member of Study Team
Mr. Naoki GOTO	Member of Study Team
Ms. Naomi HIRAHARA	Coordinator
Mr. Atsushi ITO	Interpreter

Overview:

This meeting, held with the participation of representatives from JICA Senegal Office, was the first meeting between the Japanese Study Team commissioned to implement the Study on the Digital Topographic Mapping Project for Northern Senegal and representatives of the Agency of National Land Management (ANAT). In the meeting there was a general exchange of opinions on the content of the project and the schedule for its implementation.



Photo 5-1 Kick-Off Meeting



**Photo 5-2 The participants at the Kick-Off Meeting
JICA Senegal Office, ANAT, Study Team**

- Welcoming remarks by the Secretary General of ANAT (Mr. Faye) on behalf of the Director-General of ANAT

Mr. Faye expressed gratitude to the Government of Japan for its support of the ANAT, and welcomed the Japanese Study Team. He also expressed sympathy for the earthquake that Japan has suffered, and for the problems at the nuclear power plant, and said that he expected and hoped that the strengths of the Japanese people would lead to a swift recovery.
- JICA Chief of Bureau (Mr. Umemoto)

After thanking Mr. Faye for his words of support for the Japanese people, Mr. Umemoto went on to say that at the follow-up meeting held in Dakar the government of Japan had reaffirmed its commitment based on the recommendations of TICAD IV, and added that he thought Japan would in the future take further action in the infrastructure sector. In this sense, with the present cartography project Japan would have a significant impact when new policies were drawn up in Senegal, and would make further contributions to the improvement of infrastructure in Senegal.
- Secretary General of ANAT (Mr. Faye)

Mr. Faye confirmed that in 2009 the Government of Senegal hammered out a new policy regarding development of the national land and integrated three institutions (Direction des Travaux Géographiques et Cartographiques [Directorate of Geographic and Cartographic Work], ANAT: Direction de l'Aménagement du Territoire National [National Land Development Agency], DAT: Living Environment Agency) to establish ANAT.
- JICA Chief of Bureau, Senegal Office (Mr. Umemoto)

Mr. Umemoto stated that in this project a high priority would be given to technology transfer.
- Description of the project (Mr. Harada, leader of the Study Team)

After explaining the content of the project, Mr. Harada stated that a kick-off seminar would be held two weeks later in Dakar.

Mr. Umemoto added his hopes that the mass media would be invited to the seminar.

The Secretary General of ANAT expressed a desire that with regard to the project, close communication with the Senegal side would be maintained, and that the content of any press communiqué would be shared before it was made public.

He also expressed the hope that on completion of the project a grant would be made of the equipment and supplies purchased in the project.
- ANAT Agent Comptroller (Mr. Diouf)

Mr. Diouf said that with the acquisition of new technology through the project, the role of the ANAT would expand; he added that in order for the ANAT to accomplish that role, a cooperative partnership between the two countries and the support of Japan after the project was completed would be necessary so as to enable Senegal to gain greater competence.
- Director of DTGC (Mr. Ndong)

Mr. Ndong said that in order to ensure the success of the project the Senegal side would be mobilizing and allocating staff, and also mentioned that the project occupied a special context due to the fact that the Economic Commission for Africa was recommending the preparation of 1:50,000-scale maps. In this sense he hoped that the support of Japan would serve to satisfy the needs of Senegal. The technology transfer was another aspect. It was planned to use high resolution images to prepare the maps; maps covering an area of 30,000km² in Northern Senegal would be prepared, and images covering 45,000km² of Western Senegal would be provided; the cartographic information would be released via the website.

In that sense, he greatly appreciated the fact that Japan has decided to provide support to Senegal through this project, that would set an example for many other African countries. Finally, he said that the project would be implemented as part of the extension of support to Senegal in the field of cartography, and would bolster the competence of the Senegal side.

- Secretary General of ANAT (Mr. Faye)

Mr. Faye said that he was pleased to have been able to attend the kick-off meeting, and he hoped that the project would prove a fruitful one for Senegal. In closing, he said that he would be very pleased if another mapping project for Senegal were to be planned in the future, and a kick-off meeting held for that.

5.2 Holding of Opening Seminar (Work in Senegal)

At the start of the project, in order that the products of the survey be put to full use a seminar was held as detailed below, reviewing the topographic maps to be prepared, promoting their use and presenting examples of their application (in the structuring of a GIS database, etc.).

- Date June 21st 2011
- Venue Hotel Meridian President, Dakar, Senegal



Photo 5-3 Representatives from the Embassy, JICA Senegal Office, ANAT, Road Management Agency, etc.



Photo 5-4 Participants in the seminar



**Photo 5-5 Description of the project
(Study Team)**



**Photo 5-6 Explaining data utilization
(Study Team)**

As to content, the seminar took the form of a presentation by the Study Team on the preparation of topographic map data from satellite images and the use of that data to prepare GIS-structured data; the seminar also placed emphasis on the practical application of the products of the project. The event program for the seminar is shown below.

**SEMINAR ON THE DIGITAL TOPOGRAPHICAL MAPPING
PROJECT OF THE NORTHERN SENEGAL
(Project of National Map Infrastructure of Senegal)
Hotel Meridian President - Dakar
Tuesday 21 June 2011
Program**

Registration of Guests end at : 9h15m

Start 09h30 : Under the Chairperson of Madame the Minister in charge of Land Planning

09h30 – 9h35 : Welcome address of Director General of ANAT

09h35 – 9h45 : Speech of JICA Resident Representative

09h45 – 09h55 : Speech of General Secretary of OMVS

09h55 – 10h00 : Speech of the Chairman of GICC-Senegal

10h00 – 10h15 : Speech of the First Secretary of Japanese Embassy

10h15 – 10h30 : Speech of Madame the Minister of Land Transportation, Railway Transportation
and Land Management

10h30 – 11h00 : Coffee break

11h00 – 11h15: Presentation of the project : Study team, project planning and detail of activities

11h15 – 11h30 : Data usage and dissemination of the project outputs

11h30 – 11h55 : Discussions

11h55 – 12h00 : Closing speech of Madame the Minister in charge of Land Planning

End presentations: 12h 00

12h 00 – 13h 00 : Lunch

Below is the list of the principal guests invited to the seminar.

Table 5-1 List of guests

No.	People invited
01	The General Director of National Agency for Investment Promotion and Major Projects - The APIX Dakar.
02	The chief of the Delegation of the European Union in the Republic of Senegal - Dakar.
03	Mr. Adama Ndouvégué SONOGO, General Secretary of the OMVS
04	Mr. Resident Representative of the World Bank in the Republic of Senegal - BM, Dakar
05	The Chief of Cooperation of the Canadian International Development Agency in the Republic of Senegal - CIDA
06	The Chief of the general corp of Defence Staff.
07	The Governor of the region of Matam
08	The Governor of the Region of St. - Louis
09	The Governor of the Region of Tambacounda
10	The President of the Regional Council of Matam
11	The President of the Regional Council of St - Louis
12	The President of the Regional Council of Tambacounda
13	The General Director of the National Institute of Pedology
14	The General Director of Planning
15	The General Director of the SAED
16	The General Director of the French Development Agency in Senegal - FDA
17	The General Director of the Society for Development and Promotion of the Coasts and tourist areas of Senegal – SDPCO
18	The General Director of the Agency for Road Management - AGEROUTE, Dakar.
19	The General Director of Agency of the State Information Technology - ASIT, Chairman of the Inter - Institutional Cooperation and Coordination in Geomatics - Senegal - (IGCC)
20	The General Director of National Agency for Local Government - Dakar
21	The General Director of the Centre for Ecological Monitoring - CSE, Dakar.
22	The General Director of Millennium Challenge Account, MCA - Senegal
23	The General Director of CEREEQ, Dakar Hann
24	The General Director Affairs and Territorial Administration of the Ministry of the Interior-Dagat, Dakar.
25	The Director of Debt and Investment - DDI, Ministry of Economy and Finance - Dakar.
26	The Director of the Economic and Financial Cooperation - DEFC Ministry of Economy and Finance - Dakar.
27	Mr. Director of the Cadastre - Directorate General of Taxes and (DGID)
28	The Director of Urban Planning and Architecture - Dakar
29	The Director of Environment and Sustainable Development - OMVS
30	The Director of Agriculture - Dakar
31	The Director of Land Transport - Ministry of Land Transport, Rail Transport and Planning, Dakar.
32	The Director of Roads - General Directorate of Infrastructure - Department of International Cooperation, Air Transport, Infrastructure and Energy
33	The Director of Mines and Geology
34	The Director of Water, Forest and Hunting and Soil Conservation.
35	The Director of Reform and Educational Planning - Ministry of Education

36	The Director of the Management and Planning of Water Resources. (MPWR)
37	The Director of the Laboratory for Teaching and Research in Geomatics - LERG, ESP - Cheikh Anta Diop University of Dakar.
38	The Executive Secretary of the National Local Development - PNDL Dakar.
39	The Leader of the National Health Information - Ministry of Health, Dakar.
40	Mr. Moussa DIENE Technical Advisor, Ministry of Land Transport, Rail Transport and Regional Development
41	Mr. Tidiane KANE Technical Advisor, Ministry of Land Transport, Rail Transport and Regional Development
42	Mr. Samba Commander FALL, Permanent Secretary of the National Border Management
43	The Coordinator of the National OMVS
44	The leader of the Faculty of Arts and Humanities at the University Cheikh Anta Diop, (Geography Section)
45	Mr. LO Ale President of the Union of Associations of Local Elected
46	Project Leader Mr. Databases Urban - IGN FI
47	President of the National Order of Surveyors of Senegal

5.3 Receipt and inspection of equipment (Work in Senegal, November 30th to December 8th, 2011)

Prior to the technology transfer in digital plotting and compilation, the equipment procured by JICA was received and inspected. The inspection completed, work began on assembling the equipment for which the JICA Senegal Office had first completed type and quantity checks. The assembly work was carried out by the supplier, **NeraTech Senegal**. In the case of the assembly of special equipment such as the PLANAR however, the work was carried out with the Study Team engineers offering advice.

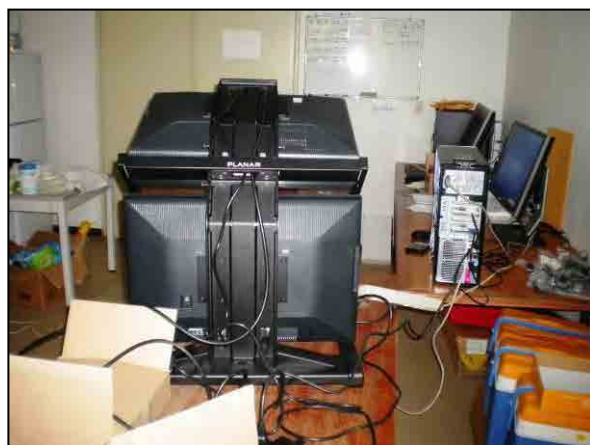


Photo 5-7 Assembly of the equipment (PLANAR)



Photo 5-8 Assembly of the equipment (Scanner)

With regard to the work of checking that the equipment was working properly, the use of specialist software (LPS, etc.) that the suppliers could not operate meant that confirmation of the software was done by the Study Team. Below is a list of the equipment that was brought in.

Table 5-2 Itemized list of equipment

No.	Item No.	Item	Qty
1	CAD software	MicroStation Perpetual License 1 year Support and Maintenance included	2
2	CAD software module	Bentley Map Perpetual License 1 year Support and Maintenance included	2
3	GIS software	ArcGIS Desktop version 10 1 year Support and Maintenance Included	1
4	do module	ArcGIS Desktop Extension Spatial Analyst version 10 1 year support and Maintenance included	1
5	do module	ArcGIS Desktop Extension 3D Analyst version 10 1 year support and Maintenance included	1
6	do module	ArcGIS Desktop Network Analyst version 10 1 year support and Maintenance included	1
7	Aerial triangulation/plotting/compilation software	LPS Core - 1 year support and Maintenance included	1
8	Maintenance charge	LPS Stereo - 1 year support and Maintenance included	1
9	LPS plotting software	PRO600 Fundamentals 1 year support and Maintenance included	1
10	Automatic DEM generation software	LPS ATE - 1 year support and Maintenance included	1
11	DEM editing software	LPS LPS Terrain Editor 1 year support and Maintenance included	1
12	TopoMouse	TopoMouse, Rev D, Optical and USB	1
13	Adobe Acrobat V.9	Adobe Acrobat 9.0 Professional Extended	1
14	Illustrator (for symbolization)	Adobe Illustrator CS5	1
15	Image processing software	Adobe Photoshop CS5 Extended for Windows	1
16	Office	Microsoft Office Standard 2010 – License – 1PC	1
17	Anti-virus software	Virus Buster Professional – 2 years license	1
18	3D hardware for aerial triangulation / plotting	Planar SD Series SD2620W Stereoscopic Widescreen LCD Monitor – 26” – 1920x1200 – 12ms – 0.287mm – 800:1 – 67lbs – 1 year warranty	1
19	Graphics card	nVIDIA Quadro FX 4800– 1.5GB GDDR3 SDRAM 384bit – PCI Express 2.0x16 – DVI-I	1
20	Monitor for planner	Dell 24 inches Widescreen monitor MONITOR Dell 24 inch UltraSharp 2408WFP Widescreen, Adjustable Stand, VGA/DVI	2
21	Workstation	Dell Precision T5500 Workstation - Six Core Intel Xeon Processor X5675, 3.06GHz, 12M, L3, 6.4GT/s, FPWS T5500 - 12GB DDR3 ECC SDRAM Memory, 1333MHz, 6X2GB - 1GB nVIDIA Quadro 600, Dual Monitor, 1DP and 1DVI - Integrated Intel chipset SATA 3.0GB/s controller - C9 All SATA Hard Drives, RAID 1 for 2 Hard drives(Total of 3.0GB SATA) - 1.5GB SATA 3.0GB/s, 7200 RPM Hard Drive with 32MB DataBurstCache - Windows 7 professional, No Media, 64-bit, Fized Precision, English - Windows 7 Label, Optiplex, Fixed Precision, Vostro Desktop - Cyberlink Power DVD 9.5, No Media, 16X DVD+RW - No Resource CD for DELL Optiplex, Precision and Latitude Systems - Dell Hardware limited warranty – 3 years	2
22	Uninterruptible power supply	APC SMART-UPS T500 USB & serial – 230V – 1500VA - UPS lead acid – 8 output connector	2
23	A3 printer for printing outputs	HP Officejet 7000 Wide Format Printer – Printer – color – ink-jet – A3 Plus – 600 dpi x 600 dpi – up to 33 ppm (mono)/up to 32 ppm (color)– capacity:150 sheets – USB, Ethernet, 32 MB RAM	1
24	do Ink cartridge	HP 920XL – Print cartridge – 1 x black	3
25	do Ink cartridge	HP 920XL – Print cartridge – 1 x cyan – 700 pages	3
26	do Ink cartridge	HP 920XL – Print cartridge – 1 x magenta – 700 pages	3
27	do Ink cartridge	HP 920XL – Print cartridge – 1 x yellow – 700 pages	3
28	Large-size scanner	HP Designjet HD Scanner – Roll scanner – Roll(42”)– 600 dpi x 600 dpi – 10Base-T/100Base-TX/Hi-speed USB 204	1

		lb, 1 year warranty	
29	Large-format printer	HP Designjet T7100, 42" large-format printer – color – ink-jet Print Resolution: 2400 dpi x 1200 dpi, Memory: 32GB Virtual Hard Disk: 160GB, Networking: USB, 1000Base-T, Power: AC 120/230V, Weight: 412 lbs	1
30	Paper roll for printer	Water resistant and resistance rolled paper	2
31	Paper roll for printer	Coated paper Roll	5
32	Paper roll for printer	HP – Bond paper – Roll(42" x 150ft)– 80g/m2	5
33	Printer head	Printer head (yellow)	6
34	Printer head	Printer head Gray/Dark Gray	6
35	Printer head	Printer head Cyan/Magenta	6
36	Printer head	Printer head Black	6
37	Printer head	Printer head Dark gray	6
38	Ink cartridge	HP – Print cartridge yellow	6
39	Ink cartridge	HP – Print cartridge Cyan	6
40	Ink cartridge	HP – Print cartridge Magenta	6
41	Ink cartridge	HP – Print cartridge Black	6
42	Ink cartridge	HP – Print cartridge Light Gray	6
43	Ink cartridge	HP – Print cartridge Dark gray	6

Chapter 6 Outputs

6.1 Study Reports

The reports submitted at each stage of the work are listed below. The only output under this agreement is 4) Final Report: **(2) Outputs** 4) and 5) are appendices.

Table 6-1 **Survey Reports**

No.	Title of report	No. of Japanese copies	No. of English copies	No. of French copies	Government of Senegal	
					No. of English copies	No. of French copies
1)	Inception report	10	15	15	10	10
	Submission	At start of survey				
2)	Interim report	10	15	15	10	10
	Submission	12 months after start of survey				
3)	Draft final report/Main	—	15	15	10	10
	Summary	—	15	15	10	10
	Japanese précis	10	—	—	—	—
	Submission	22 months after start of survey				
4)	Final report / Main	—	15	15	10	10
	Summary	—	15	15	10	10
	Japanese précis	10	—	—	—	—
	Submission	Within one month of receipt of comments on Draft Final Report				

With regard to the work specifications and work manual, 5 copies are to be prepared in French and submitted to the ANAT as appropriate.

6.2 Outputs

The following outputs are submitted. The number of copies is as noted below.

Table 6-2 **Outputs**

No.	Title of output	Unit	Quantity	Remarks
1)	Pretreated satellite images	Set	1	1 set to the Senegal Government
2)	Field identification results	Set	1	1 set to the Senegal Government
3)	Aerial triangulation results	Set	1	1 set to the Senegal Government
4)	Digital data files			
①	1:50,000 topographic map data	Set	2	1 set to the Senegal Government
②	1:50,000 GIS base data	Set	2	1 set to the Senegal Government
5)	Orthophoto data	Set	1	1 set to the Senegal Government

6)	Web distribution system for ②	Set	1	1 set to the Senegal Government
7)	Final Report	Set	1	
8)	Report on Quality Management	Set	1	Instead of undergoing investigation in the topographic mapping process, a report giving a description of the contractor's quality control will be submitted.
9	Book-let	Set	100	

*The list below shows the institutions to which the booklets are to be delivered

Table 6-3 Provisional list of the recipient institutions of the booklet on the Digital Topographic Mapping Project in Northern Senegal

	Executive Office of the President	(Affiliated institutions)			Number of copies
1	Executive Office of the President	ADIE State Agency of Informatics 2			3
	Ministries and agencies of the central government	(Affiliated institutions)			
2	Ministry of Foreign Affairs				1
3	Ministry of Interior				1
4	Ministry of Economy and Finance	DGID General Directorate of Tax and State Property	ANSD 2 National Agency of Statistics and Demography		4
5	Ministry of Justice				1
6	Ministry of Armed Forces				1
7	Ministry of Environment and Conservation	CSE Ecology Monitoring Center 2			3
8	Ministry of Housing, structuring and Hydraulics	DGPRES Directorate of Management and Planning of Water Resources 2	DUA Directorate of Urban Planning and Architecture		4
9	Ministry of International Cooperation, Air Transport, Social Infrastructure and Energy	AGERROUTE Road Work and Management Agency	CEREEQ Experimental Center for Research and Study of Equipment		3
10	Ministry of Public Service and Employment				1
11	Ministry of Mines, Industries and Small and Medium-sized Enterprises	DMG Directorate of Mines and Geology			2
12	Ministry for Gender and Cooperation with African Women and Foreigners				1
13	Ministry of Labor and Professional Organizations				1
14	Ministry of Family Affairs, Women's Groups and Child				1

	Protection				
15	Ministry of Maritime Economy				1
16	Ministry of Higher Education, Universities, Academic Centers and Regional Scientific Research				1
17	Ministry of Agriculture	INP National Institute of Pedology 2	Directorate of Agriculture		4
18	Ministry of Education for Pre-school, Elementary and Intermediate Level Education and National Languages	Section in charge of the School Mapping			2
19	Ministry of Health and Disease Prevention	SNIS National Service for Health Information			2
20	Ministry of Decentralization and Local Governments	DCL Directorate of Local Government			2
21	Ministry of Youth				1
22	Ministry for Handicrafts, Tourism, Private Sector and Informal Sector				1
23	Ministry of Urban Planning and Sanitation				1
24	Ministry of Culture and Recreation				1
25	Ministry of Animal Husbandry				1
26	Ministry of Transport, Railways and Regional Development	ANAT Agency of National Land Management/ Directorate of Geographic and Cartographic Works 5			6
27	Ministry of Technical Education and Vocational Training				1
28	Ministry of Commerce				1
29	Ministry of Communication, Telecommunication and Information and Communication Technology	ARTP Telecommunication and Post Regulation Agency			2
30	Ministry of Senegalese Abroad				1
31	Ministry of Sports				1
32	Ministry of Social Actions and National Integration				1
33	Ministry of Institutional Relationship				1
34	Ministry of Women's Entrepreneurship and Microfinance				1
35	Ministry of Public Hygiene and Livelihood Improvement				1
36	Ministry of Environmental Protection, Rural Development, Reservoirs, Dams and Fish Farming				1
37	Ministry of Renewable Energy				1

38	Public organizations	(Affiliated institutions)			
39	SONES National Water Company of Senegal				1
40	SAED Senegal River Delta and Senegal and Falémé River Valleys Land Development Corporation				1
41	Local Governments	(Affiliated institutions)			
42	Saint Louis Region	Dagana Department	Podor Department	Saint Louis Department	4
43	Louga Region	Louga Department			2
44	Matam Region	Kanel Department	Matam Department	Ranéroú Department	4
45	Tambacounda Region	Bakel Department	Kédougou Department		3
46	International Organizations	(Affiliated institutions)			
47	OMVS Senegal River Basin Development Authority				1
48	Universities				6
49	Mass media organizations				10
	Japan	(Affiliated institutions)			
50	Embassy of Japan				1
51	JICA 3	JICA Senegal Office 2			5

* A copy of the booklet is to be delivered to an organization with no number attached to its name.

Total

100

Chapter 7 Use of Digital Topographic Map Data in Future and Recommendations

7.1 Use of Digital Topographic Map Data

*** Spread of the use**

As the number of governmental, public and international organizations using the GIS has increased in Senegal, there is a great need for the use of digital topographic maps in a variety of areas including water resource management, health, agriculture, environment, education and urban planning. Under such circumstances, GICC, an organization consisting of the governmental institutions concerned with the use of the data, established by the Government of Senegal is developing infrastructure called “GéoSénégal” to promote the use of geospatial information with assistance from the Government of Canada.

Since digital topographic maps are fundamental and indispensable components of GéoSénégal, GICC has great interest in the topographic maps of Northern Senegal to be created in this project. There is also high expectation for the use of these maps in the implementation and planning of development projects along the Senegal River which flows through Northern Senegal. The outputs of this project include ALOS pan-sharpened orthophotos, as well as the digital topographic maps. An interview survey has revealed that the some interviewees consider that the need for orthophotos is greater than that for topographic maps in the sectors such as the agriculture and environment ones since a large number of activities in these sectors are implemented in areas with limited numbers of artificial planimetric features. The orthophotos created in this project are expected to be used frequently in these sectors. Moreover, the combined use of the topographic maps and orthophotos is expected to further enlarge the scope of their use.

A system which allows Internet users to browse the digital topographic maps on the Internet was developed in this project. There is a remarkable improvement in the accessibility to the Internet in Senegal and it is not very difficult for ordinary Senegalese to have access to the digital maps created in this project. Therefore, an increase in the number of the users of the topographic maps is expected even among the ordinary citizens in the long run.

*** Problems and tasks**

While there is high expectation for the expansion of the use of topographic maps in Senegal, as mentioned above, there are also problems to be solved. Three specific problems are discussed below. Firstly, there is a need to establish a geodetic reference system and to develop a network of geodetic control points which can be used in the GNSS surveys. This need arises from the fact that effective use of digital topographic maps requires efficient data creation without spending much effort in establishing control points, and data creation with the standards identical to other available geospatial information so that data can be processed in an integrated fashion. A geodetic reference system compatible with GNSS surveying has been in use in Senegal since 2004. A system similar to this was

used in this Project, but it was different from the system used in the creation of 1/200,000-scale topographic maps in 2005. Although this difference creates no practical problem, a situation in which use of multiple geodetic reference systems creates confusion should be avoided. The control points based on the previous geodetic reference system will have to be transformed to those based on the new system and triangulation points and benchmarks shall be established with a density required for the creation of topographic maps without major difficulties in the development of the network of geodetic control points.

The second problem is the shortage of basic data. While 1/50,000-scale digital topographic vector maps of a 30,000 km² area in Northern Senegal were created in this project, such maps of the other areas of the country are not available. Therefore, many organizations have to rely on wasteful methods, such as digitization of the existing 1/50,000-scale topographic map sheets, when they require digital topographic vector maps of the area outside the project area in their work. Since these maps were created many years ago and are based on the old coordinate system, they do not represent the current field conditions correctly or cannot be overlaid on other maps. For these reasons, it is not possible to use them as basic maps. Therefore, it is urgently required to create digital topographic vector maps based on the established geodetic reference system of the other areas of Senegal, and Western Senegal around Dakar City where a high concentration of people and business activities is found, in particular.

The third issue is enforcement of the rules on appropriate price setting and the secondary use. The Study Team worked on the preparation of the internal rules on price setting and the approval for secondary use in this project. The provider of geospatial information will have to enforce them in a way acceptable to geospatial information users, which may require revision of the rules. However, such revision should not just take the form of a submission to users' demands. As some ill-informed users insist on free provision of geospatial information with no consideration to the costs required for the creation and maintenance of the information, the provider of the information will also have to implement information campaigns aimed at those users.

7.2 Recommendations Derived from the Implementation of the Project

The Study Team created the 1/50,000-scale digital topographic maps and ALOS pan-sharpened orthophotos of Northern Senegal in this project. The team also transferred the technologies required for the creation of topographic maps from ALOS optical images with the provision of the ALOS images of Western Senegal and implemented activities to promote the use of the project outputs. After the completion of this project, the C/Ps will have to take practical measures for the promotion of the use of these outputs and to utilize the transferred technologies for the maintenance and updating of the project outputs and creation of additional digital topographic maps and orthophotos of other areas in Senegal. The Study Team recommends the following to the Senegalese Side in order for them to achieve the goals set in the preceding sentence.

1. Recommendations for Project Management

* Strengthening of organizational capacity

The ANAT used to be responsible for the national survey administration under the direct supervision of the Ministry of Equipment and other ministries. When this project began, it was a part of the ANAT. The Study Team has often found the organizational capacity of the ANAT still not strong enough to respond to the ever-changing situation even after the team provided them with technical assistance, even considering only although the period of about two years has passed after transferred to the present organization structure.

The fact that the DGTC, as the national survey institution at present, has not been able to give approval for or make decision on matters promptly is an example of the weakness in the organizational capacity. In other words, approval given by the Director of the ANAT is not final and approval as a final organizational decision requires approval of the Director General of the ANAT. This time-consuming approval system could have a negative impact on not only the project management, but also the development of the national spatial data infrastructure (NSDI).

Shortage of human resources is another factor contributing to the weak organizational capacity. The ANAT has less than 20 technically-capable staff members at present and most of them are in their forties. Therefore, the Study Team considers that the ANAT has an urgent need to employ new staff members for the strengthening of its organization. The team expects that a considerable period of time will be required for the creation of topographic vector maps of just Western Senegal if these maps are to be created under the current organizational structure. If one intends to complete a certain project in a short period of time, one has to develop the structure required for it. The Government of Japan has to have full understanding of the state of the organizational structure before providing assistance in order for its outcome to be sustained firmly.

* Project Implementation in accordance with Implementation Schedule

The C/P organization was often found taking temporary measures, instead of working systematically in accordance with the schedule, in this project. This was one of the reasons why the Study Team could hardly expect any progress in the project implementation while its members were not in Senegal, while the project progressed well with the presence of the Study Team in Senegal. The lack of progress in the project implementation could also be accounted for by the following reasons. When this project was being implemented, the C/P organization was involved in three international cooperation projects supported by Japan, the EU and Canada simultaneously. The absolute number of the staff members of the C/P organization was too small for the simultaneous involvement in the three projects. Moreover, there was a bottleneck for the progress of the project as a very limited number of staff members among the small number of staff members had to handle unproportionately heavy workloads. The Study Team considers it possible to respond to the above-mentioned circumstances to a certain degree by formulating a project implementation schedule and estimating the amount of work to be implemented prior to the project implementation. However, the C/P

organization has not been able to formulate such a schedule.

Improvement of the circumstances from those mentioned above and constant implementation of various projects, including the creation of topographic vector maps of Western Senegal also mentioned above, require an organizational management system in which annual project implementation schedules are prepared with the priorities of projects and available resources taken into consideration, implementation reports are prepared at the end of every fiscal year and the progress of project implementation is evaluated. The establishment of such an organizational management system requires strong leadership and, thus, the change in the attitude and the capacity to act of senior staff members involved in the organizational management.

* Improvement of the organizational structure

The importance of estimating the amount of resources required for the maintenance and updating of the topographic maps before the implementation of a map creation project has already been mentioned above. It is worried to take a long period of time for the C/P organization with the current structure to create topographic vector maps of Western Senegal alone, although the exact time required for the map creation can only be estimated after the amount of resources required for it has been estimated. Therefore, if the Government of Senegal seeks completion of the map creation in a short period of time, it will have to improve the organizational structure accordingly.

If it is difficult to improve the organizational structure for certain reasons, projects shall be implemented in a way that project implementation can be managed with the existing organizational structure. The Government of Japan will have to have full understanding of the state of the organizational structure of the C/P organization before providing assistance in order for the outcome of the assistance to be sustained firmly.

* Improvement of publicity activities with the creation of the Website and establishment of a copyright system associated with the creation of the website

The possibility of providing the final outputs of this project to a wide variety of users on a website is considered as a component of this project. With regard to this point, the Study Team recommends the following two points:

- Improvement of publicity activities

Frequent updating of the homepage for the transmission of information on the latest data usage methods is considered, in particular, as a possible measure for the improvement of publicity activities. As the general public does not seem to have recognized the existence of the ANAT or the significance of its services yet, increasing the number of new users of the geospatial information data in the area of infrastructure development in the education, health, environment and development sectors will lead to the creation of a source of revenue for the ANAT from the sale of the geospatial information data.

1. Establishment of a method to collect copyright fees (for the secondary use) of the geospatial information data

Reference material published in 2003 shows that the basic copyright fee of 150,000 CFA and 50 CFA per map sheet were charged for the use of analog data (in the case of the use of printout maps) and the basic copyright fee of 500,000 CFA (with a discount of 20 to 30 % applied for research and academic use) was charged for digital data. The internal rules on the secondary use and price setting prepared in this project should be enforced appropriately. Meanwhile, the Study Team expects the expansion of the use of the outputs of this project not only in infrastructure development, but also for the creation of thematic maps (by outsourcing), such as maps for tourist and recreational activities and road maps.

1. Technical Recommendations

*** Development of the National Spatial Data Infrastructure (NSDI)**

Development of the NSDI is the establishment of the data creation technologies and a system which enables use of the spatial data which has been created and owned independently by various administrative organizations and private companies. The development is by all those organizations and companies as social infrastructure and it is a global trend.

In the case of Senegal, the ANAT, the national survey institution, the Directorate of Urban Planning and Architecture, the Directorate of Tax and Public Properties and other government offices involved in transport, sanitation and power transmission have independently created data. These directorates and offices established “The National Map Committee (NMC)” (chaired by the Director of the ANAT, which was inactive in 2003). The development of the NSDI is in progress under another committee, the GICC. Considering this situation, the Study Team thinks that the ANAT should play a key role in re-activation or re-organization of the NMC within the framework of the GICC.

*** Completion of the creation of geospatial information data with self-help effort using the technologies acquired in the technology transfer**

Data creation with a self-help effort using the technologies acquired in this project and technical training is an important obligation for Senegal as a developing country. The Study Team considers that the ANAT has an urgent need to employ new staff members to strengthen its organizational capacity in order to fulfill this obligation.

*** Promotion of technical cooperation within the Western Africa Region**

If a measure is found for the transfer of the technologies acquired by the C/Ps in this project from them to their counterparts in the neighboring countries, such a measure is expected to contribute to the upgrading of the level of the technologies in the Western Africa Region in a cost-efficient way. The most obvious advantage of this measure is elimination of the “language barrier” and the ease of communication realized by the adoption of this measure is expected to have beneficial effects on both

trainers and trainees. The Study Team requests the Japanese authorities to begin a study for the formulation of a project based on this approach promptly.

The Western Africa Region requires development of an international network of control points for the GNSS and the adoption of the World Geodetic System urgently. Senegal will have to take the lead in these international efforts.

* Creation and Revision of 1/50,000-scale topographic vector maps of Western Senegal

As mentioned in 7.1, the creation of digital topographic vector maps of Western Senegal is required urgently and should be implemented immediately from the ALOS images provided and with the technologies transferred in this project.

* Development of a model for sustainable maintenance of the topographic maps

The digital topographic maps of Northern Senegal created in this project will have to be maintained and the map creation project will have to be extended to other areas in the country. Implementation of these activities will require input of money, equipment and human resources. The ANAT will have to estimate the costs and the amount of input of resources required for them appropriately, then secure the required budget and resources and maintain the topographic maps systematically.