Republic of Senegal
National Agency for Territory Planning (ANAT)

The Study on the Digital Topographic Mapping Project for Northern Senegal

Final Report

March 2013

Japan International Cooperation Agency (JICA)

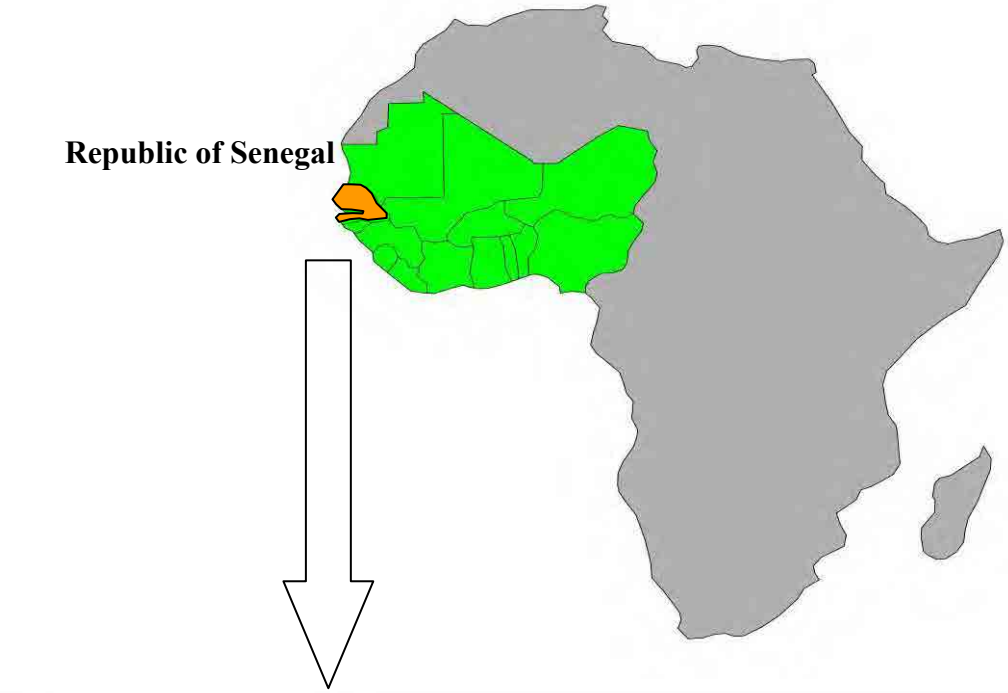
Aero Asahi Corporation
Asia Air Survey Co., Ltd.

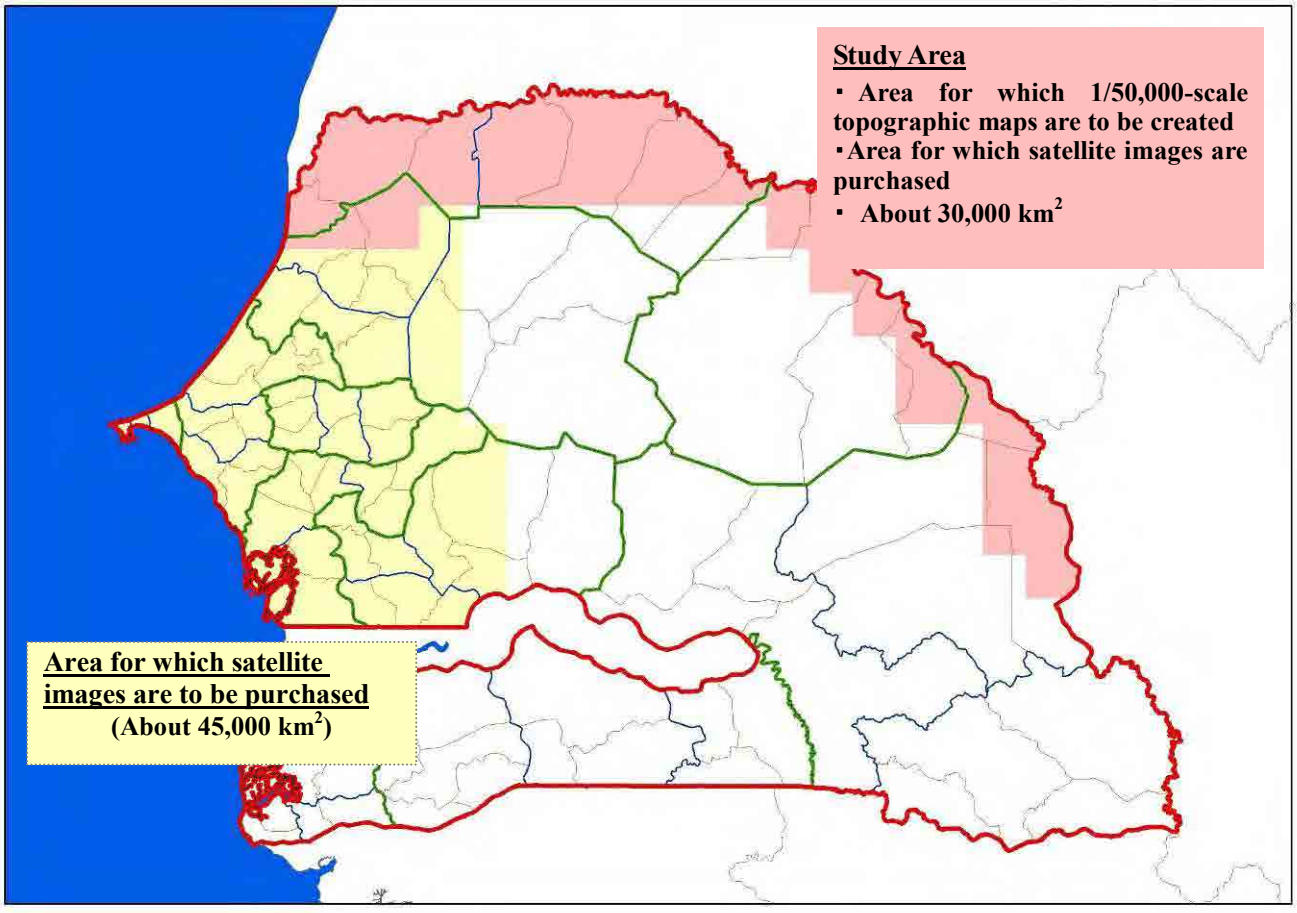
EI
JR
13-113

The Study on the Digital Topographic Mapping Project
for
Northern Senegal

Final Report

Study Area





Study Area and Area for the 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 Minutes of Meeting

Opening Seminar

Consultation of Map 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'Entreprenariat 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 S y stem
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

CONTENTS

Study Area

Photographs of Work in Senegal

Chapter 1 Overview of the Study 1

1.1 Background to the Study 1

1.2 Overview of the Agency of National Land Management (ANAT) 2

1.2.1 Organizational Structure of ANAT 3

1.2.2 Details of Principal Engineers 4

1.2.3 Finance and Budget 5

1.2.4 Past Transfer of Map Creation Technology 5

1.2.5 Changes in Operations Such as Sale of Topographic Maps 5

1.3 Objective of the Study 6

1.4 Study Area and Satellite Images 6

1.5 Proposals 7

1.6 Basic Policies of the Project 9

1.6.1 Basic Technical Policies 9

1.6.2 Basic Management Policies 11

1.7 Study Team Members and Personnel Plan 12

1.8 Staffing Plan 15

Chapter 2 Project Implementation Status and Results 19

2.1 (1) Collection, Sorting and Analysis of Relevant Materials and Information (Work in Japan) 21

2.2 (4) Consultation of Map Specifications (Work in Senegal) 21

2.3 (5) Collection and Sorting of Existing Materials (Work in Senegal) 23

2.4 (6) Purchase of Satellite Images (Work in Japan) 24

2.5 (7) Ground Control Point Survey (Work in Senegal) 25

2.6 (8) Aerial Triangulation (Work in Japan) 33

2.7 (9) Field Identification and Field Verification (Work in Senegal) 38

2.8 (10) Digital Plotting and Compilation (Work in Japan) 54

2.9 (13) Digital Data Structurization (Work in Japan) 60

2.10 (14) Map Symbolization (Work in Japan) 61

2.11 (15) Creation of Data Files (Work in Japan) 64

2.12 (16) Structuring of Website (Work in Japan and Senegal) 64

2.13 (17) Structuring of System of Usage (Work in Senegal) 75

2.14 (18) Seminar for the Promotion of Data Utilization (Work in Senegal) 98

2.15 (22) Creation of Orthophoto Data (Work in Japan) 104

Chapter 3 (21) Technology Transfer 107

3.1 (21) Technology Transfer 110

3.1.1 ① GCP Survey 110

3.1.2 ② Aerial Triangulation 114

3.1.3 ③ Digital Plotting/Digital Compilation 118

3.1.4 ④ Field identification/Field verification 131

3.1.5 ⑤ Digital Data Structurization 132

3.1.6 ⑥ Map symbolization 135

3.1.7 ⑦ Structuring of Website 142

3.1.8 ⑧ Promotion of Data utilization/Structuring of a system of use 143

3.1.9 ⑨ Quality Control 147

3.1.10 ⑩ Map Updating work 149

3.2 Evaluation of the technology transfer 150

Chapter 4 Works related to the Study Reports 159

4.1 (2) Preparation of the Inception Report (Work in Japan) 159

4.2 (3) Explanation and discussion of the Inception Report (Work in Senegal) 159

4.3 (11) Preparation of the Interim Report (Work in Japan) 159

4.4 (12) Explanation and discussion of the Interim Report (Work in Senegal) 159

4.5 (19) Preparation of Draft Final Report / Explanation and discussion (Work in Japan / Senegal) 160

4.6 (20) Preparation of Final Report (Work in Japan) 160

4.7 Report to JICA Senegal Office (Work in Senegal) 160

Chapter 5 Other works implemented 161

5.1 Holding of Kick-Off Meeting (Work in Senegal) 161

5.2 Holding of Opening Seminar (Work in Senegal) 163

5.3 Receipt and inspection of equipment (Work in Senegal, November 30th to December 8th, 2011) 166

Chapter 6 Outputs 169

6.1 Study Reports 169

6.2 Outputs 169

Chapter 7 Use of Digital Topographic Map Data in Future and Recommendations 173

7.1 Use of Digital Topographic Map Data 173

7.2 Recommendations Derived from the Implementation of the Project 174

APPENDICES

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.

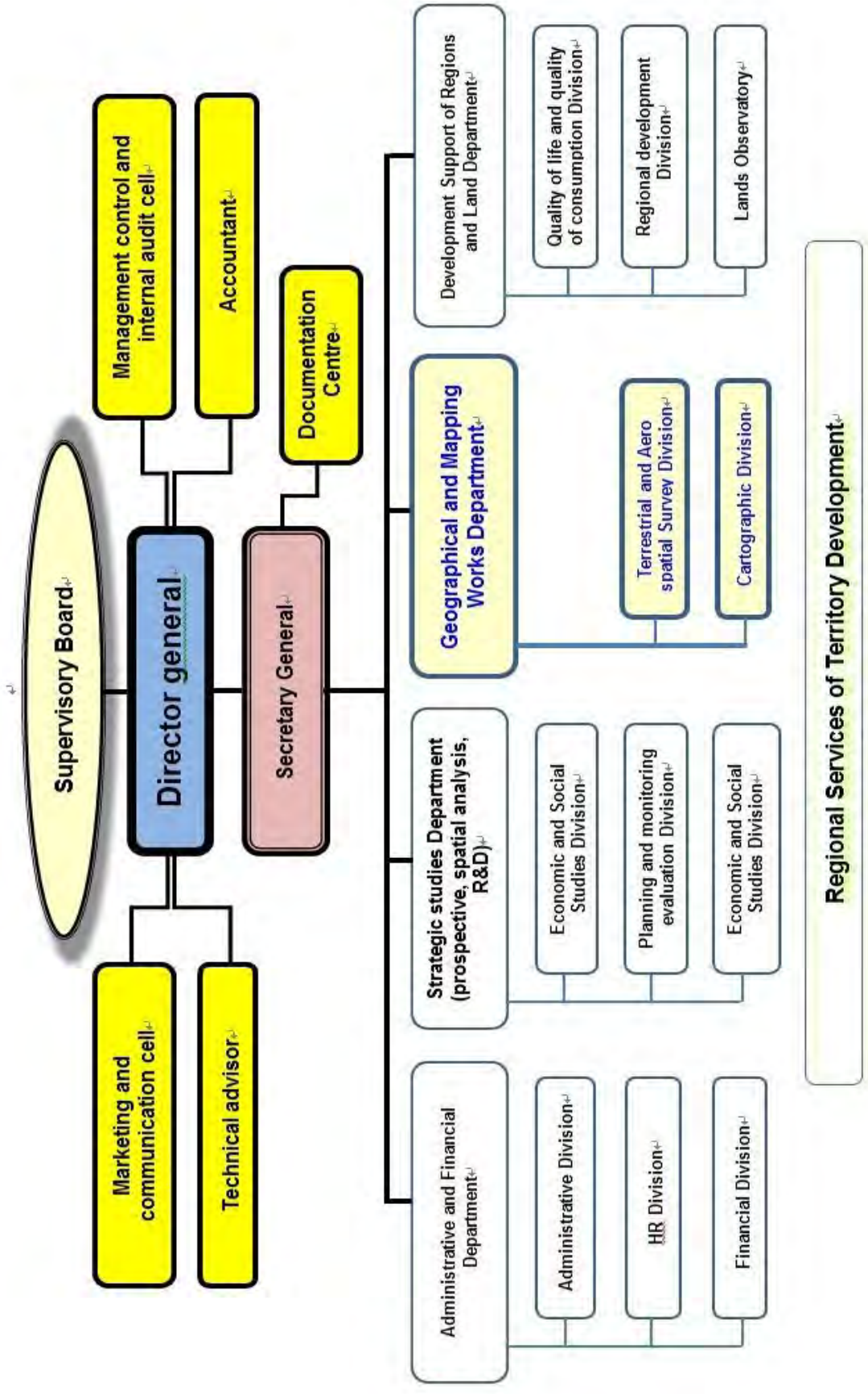
1.2 Overview of the Agency of National Land Management (ANAT)

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.



1.2.2 Details of Principal Engineers

The table below shows the principal staff of ANAT.

Table 1-1 ANAT staff list with photos

	**1. Mr. Youssou NDONG** Director, DTGC		**2. Mr. Abdou Khadre DIATTA** Engineer in Geography and Cartography Remote sensing General manager of this project
	**3. Mr. Mamadou THIAM** Chief of the Division for Cartography Photogrammetrist/Cartographer in charge of map creation (EU2000PM)		**4. Mr. Mouhamadou Moustapha Mbachké NDOUR** Cartographer General engineering
	**5. Mr. Gallaye DIOUF** Chief of Administration Cartographer General engineering		**6. Mr. Ibrahima NDIAYE** Engineer General engineering
	**7. Mr. Ousmane Madiabe DIOUF** Engineer General engineering		**8. Mr. Madikou SARR** Cartographer Topographic map creation
	**9. Ms. Awa NDOYE** Cartographer/Remote sensing General engineering		**11. Mr. Papa Sambar BEYE** Photogrammetrist Ground control points and quality management
	**10. Mr. Demba KEITA** Map Reproduction/Printing		**12. Mr. Sidy CISSE** Cartographer General survey engineering Guinea
	**13. Soleymane SOUARE** Survey Assistant		**14. Ms. Aida NDIAYE** Secretary
	**15. Mr. Ibrahima NDIAYE** Administrative Driver		**16. Ms. Dianke BADHI** Secretary

1.2.3 Finance and Budget

The current government provides ANAT with a budget for labor costs only, and no budget for the implementation of projects. From the beginning of 2012, the profits from the sale of maps have been paid to ANAT. Therefore, ANAT is currently operating using the expenses for project implementation provided by donor nations.

1.2.4 Past Transfer of Map Creation Technology

With regard to map creation technology, in the past the EU has created both topographic maps and standard specifications in a project to create 1/200,000-scale maps. At the time these topographic maps were created, however, the entire aerial triangulation process was carried out by the EU; no ANAT engineer participated in the task. Therefore, the relevant technology was not transferred to ANAT. The EU also newly created 1/2,000-scale topographic maps in 7 cities in Senegal. In this project, too, the aerial triangulation process was conducted by the EU on its own; the technology was not transferred to ANAT. Additionally, the computer operators did not have sufficient basic knowledge of photogrammetric surveys, so that ANAT did not directly benefit from the transfer of various technologies relating to the map creation process, such as digital plotting and compilation.

With regard to GIS data structurization, the Study Team first assumed that ANAT possessed the skills for structuring the 1/200,000-scale topographic maps created with the EU so that they could be used as a GIS database. However, the data in the database was simply divided into data layers and a large portion of it was not in an appropriate format for use with GIS. Therefore, the present project included technology transfer in GIS data structuring to provide skills in regular structuring work.

With regard to Website structuring technology, ANAT has a very simple Website (http://dtgc.au-senegal.com/), which is not maintained or updated at all. Since the management of the Web server is outsourced to Imedia, an external company, ANAT has no experience of Website management. The introduction of a new Website in this project prompted technology transfer that would allow ANAT to manage data and carry out maintenance by itself in the future.

1.2.5 Changes in Operations Such as Sale of Topographic Maps

As mentioned earlier, the sale of topographic maps was removed from ANAT management in 2012. Therefore, ANAT now needs to go through the procedure of submitting an application to ANAT in order to purchase topographic maps. The future prospects for ANAT have become somewhat precarious.

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 km^2 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 km^2 in the Senegal River Basin, including the Saint Louis. The Study Team also supplied satellite images only for an area of about 45,000 km^2 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.

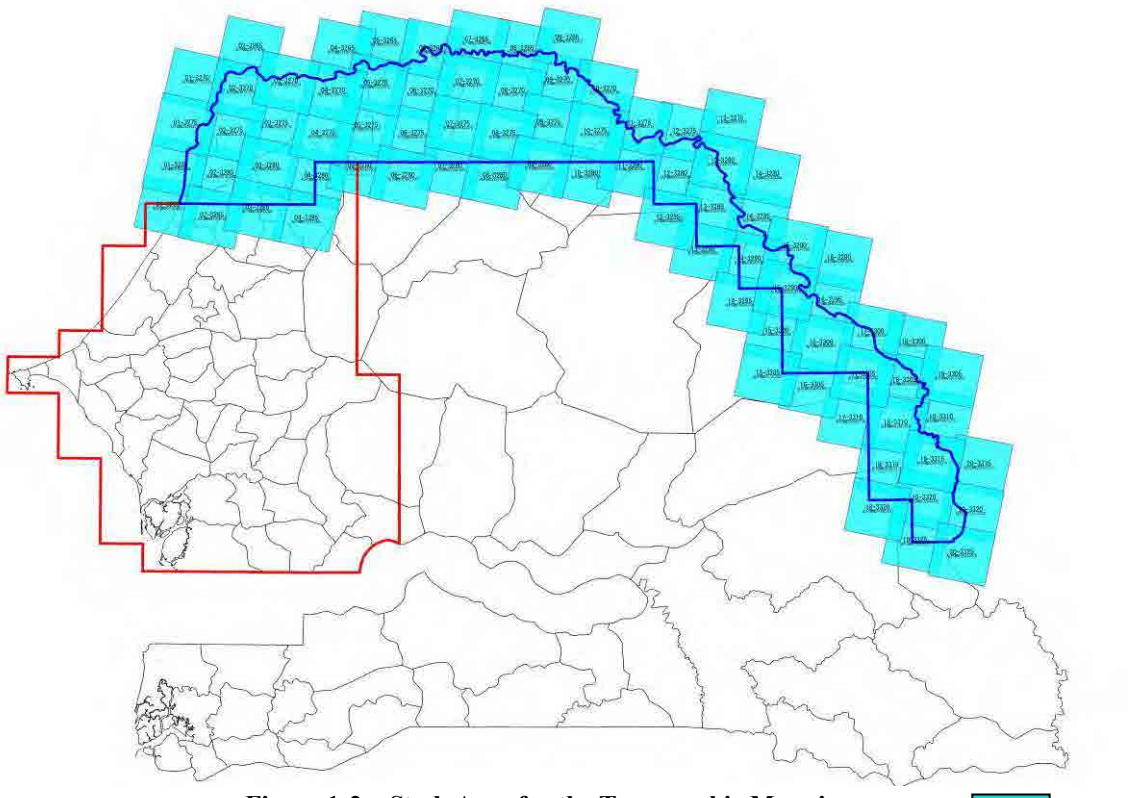


Figure 1-2 StudyArea for the Topographic Mapping
Area for the satellite images to be purchased

1.5 Proposals

The planning for this study was based on JICA Terms of Reference (TOR) and the experience and study results of Aero Asahi Corporation and Asia Aero Survey in a similar area. However, we proposed some changes to how the following work types were implemented, in an attempt to accelerate and facilitate the study.

(1) Creation of pan-sharpen images

Pan-sharpen is the process of combining high-resolution images from multispectral images to create high-resolution multispectral images. This method, which improves the resolution of multispectral images while maintaining colors, is effective for image interpretation. In this study, color images with a 2.5 m resolution were created using orthogonally corrected AVNIR-2 multispectral images and PRISM panchromatic nadir images.

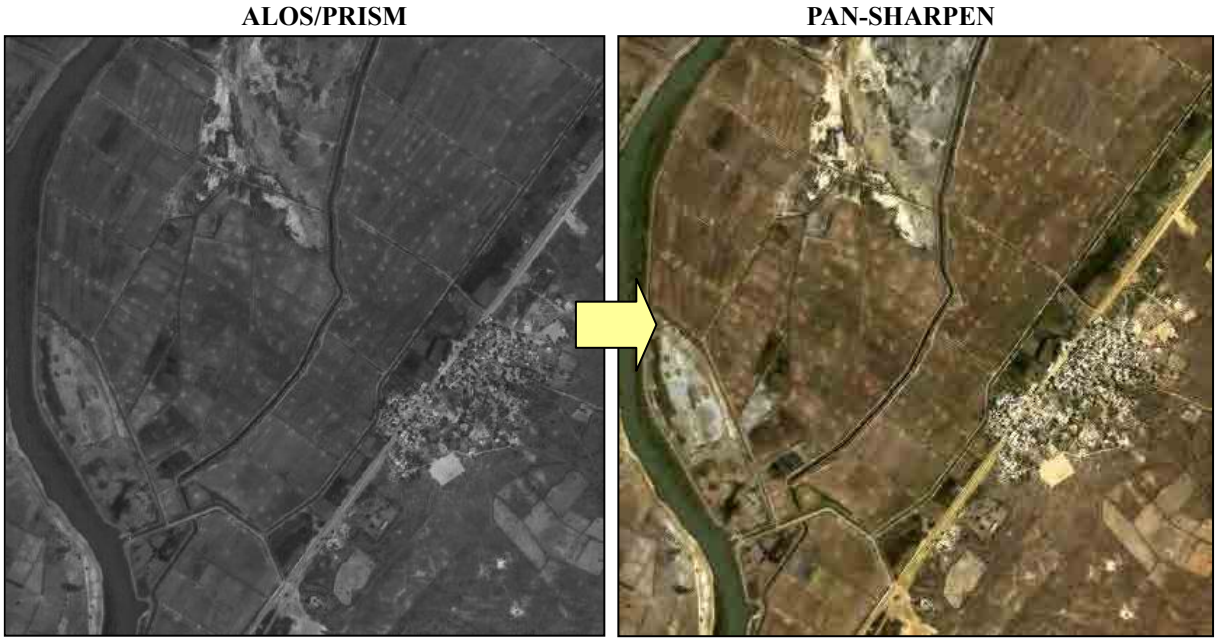


Photo 1-2 Example of pan-sharpen image (ALOS/PRISM & AVNIR-2) showing a suburb of Saint Louis in the study area

(2) Creation of an interpretation key

To deal with the short-term work process and improve the ability of image interpretation during the work in Japan, we proposed that, instead of the conventional field identification method based on photographs, a simple interpretation key in the field be used as an aid for the plotting and compilation work in Japan. An interpretation key provides guidelines indicating how to identify topographic and planimetric features in satellite images, and consists of the major map symbols and corresponding satellite images. The positions of features for which an interpretation key was created were identified using the coordinates acquired using handy GPS receivers, and recorded in the interpretation key

forms (See the section on field identification.)

(3) Digital Plotting work in areas covered by existing maps

A 1991 project implemented in collaboration with JICA created 1/50,000-scale topographic maps covering 4,000km^2 in the western area including Saint Louis which is included in the study area of the present project. Although the TOR states that (1) digital plotting of contour lines on the existing maps, (2) digital plotting of planimetric features on the existing maps, and (3) correction of the existing maps were carried out for this area and the process starts with digital compilation after field verification as with other areas, we proposed that a plotting method adopting for this area, too. This was because, as a result of field identification carried out by us and an inspection of satellite images acquired by sampling, significant secular changes were found in this area; thus it was concluded that it would be more efficient to carry out fresh plotting work rather than to carry out correction work.

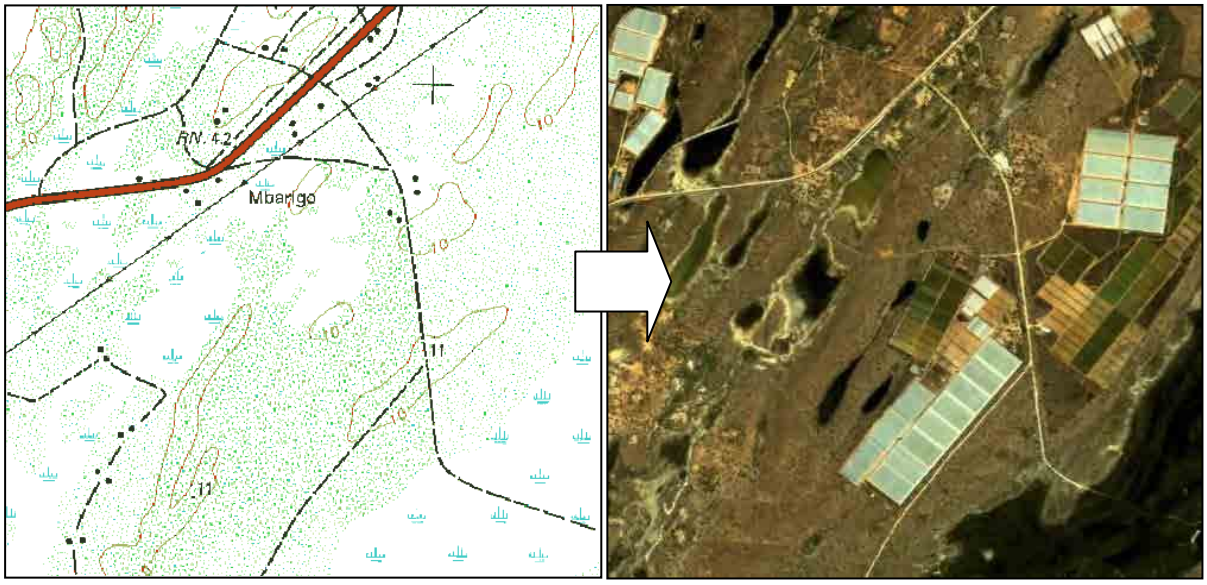


Figure 1-3 Existing 1/50,000-scale topographic map (1991) ALOS pan-sharpen image (2011)

(4) Creation of orthophoto data

Delivery of orthophoto data was not included in this study at its planning stage. However, since this kind of data was useful in photo interpretation in the digital plotting and compilation and in the preliminary interpretation of time-related changes in the technical guidance in the up-dating work, the Study Team created orthophoto data (pan-sharpen images) and added the data to the delivery items.

(5) Setting up a server in Website construction (Use of an open-source system)

The purpose of constructing a Website is to encourage widespread use of the 1/50,000-scale topographic maps that are the output of this study, and thus promote their usage. Therefore, we proposed to and discussed the use of GeoNetwork Opensource, an open-source meta-data catalog created by the UN Food and Agriculture Organization (FAO), UN World Food Program (WFP), and UN Environment Programme (UNEP), as a catalog server to storage the meta-data. The reasons for this proposal were that GeoNetwork Opensource can transmit meta-data compliant with the international standards of the Open Geospatial Consortium (OGC) and ISO, and that it has the function of exchanging catalog information with other catalog servers over the Internet. The details are reported in the later section of this report on the structuring of the Website.

1.6 Basic Policies of the Project

1.6.1 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 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 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.

1.6.2 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 2: Project management taking Islamic culture into consideration

Since Senegal is a country in which Islam is the principal religion, we needed to consider how differences in lifestyles and customs might influence this study. Even during the period of Ramadan (fasting), however, the difference in the amount of work done by ANAT had little impact on project management.

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.

1.7 Study Team Members and Personnel Plan

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

Table 1-2 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)	Structuring of Website
		(17)	Structuring 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)	Structuring 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	Structuring of Website	(2)	Preparation of Inception Report
		(3)	Explanation and Discussion of Inception Report
		(11)	Preparation of Interim Report
		(16)	Structuring of Website
		(19)	Preparation of Draft Final Report
		(19)	Explanation and Discussion of Draft Final Report
		(21)	Technology Transfer (⑦ Structuring 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)

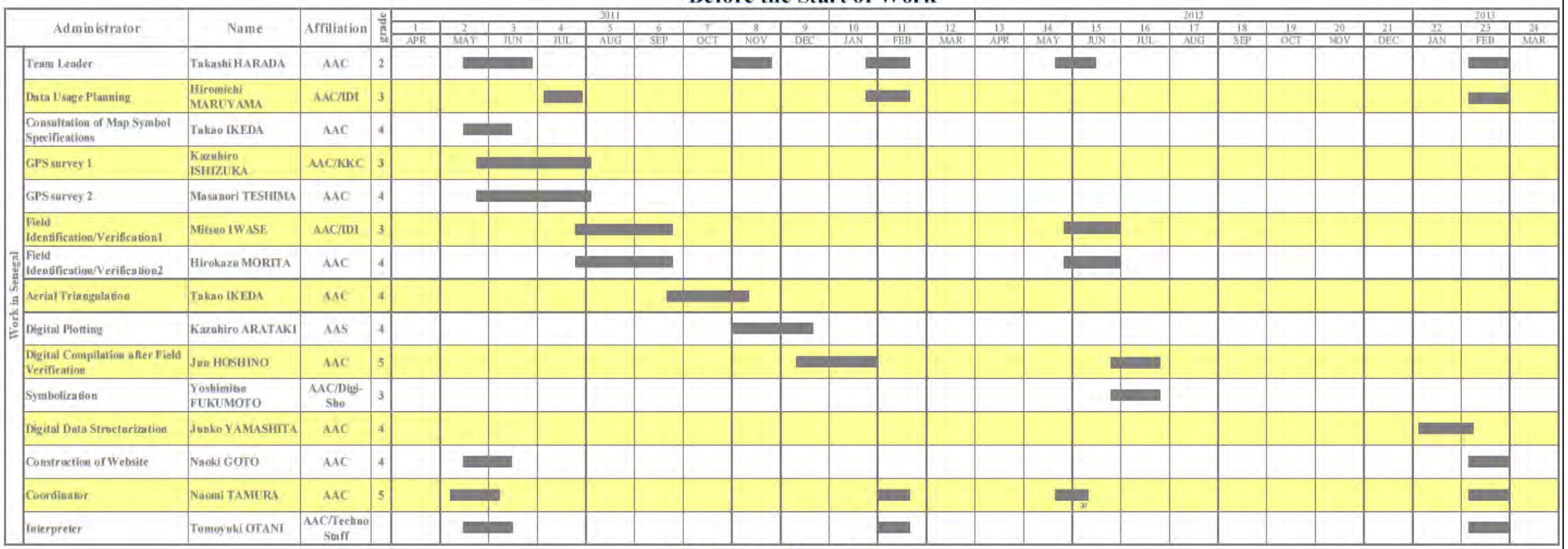
1.8 Staffing Plan

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 1-3 Staffing Plan

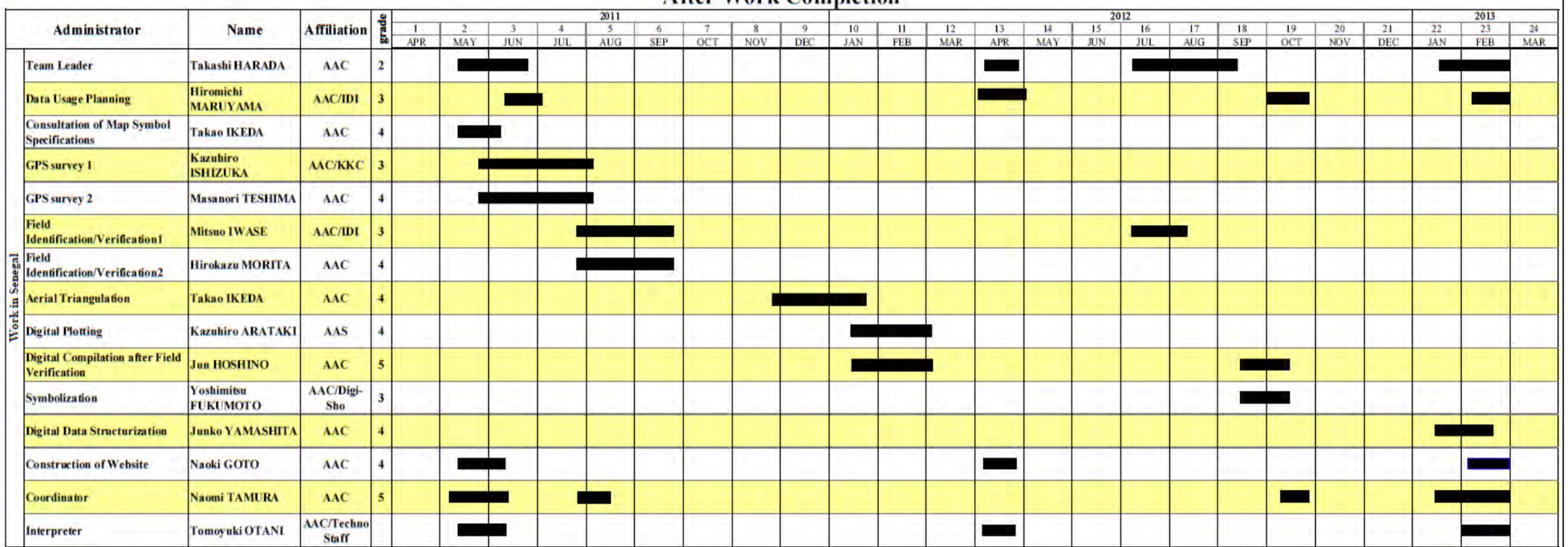
Before the Start of Work

	Administrator	Name	Affiliation	grade
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

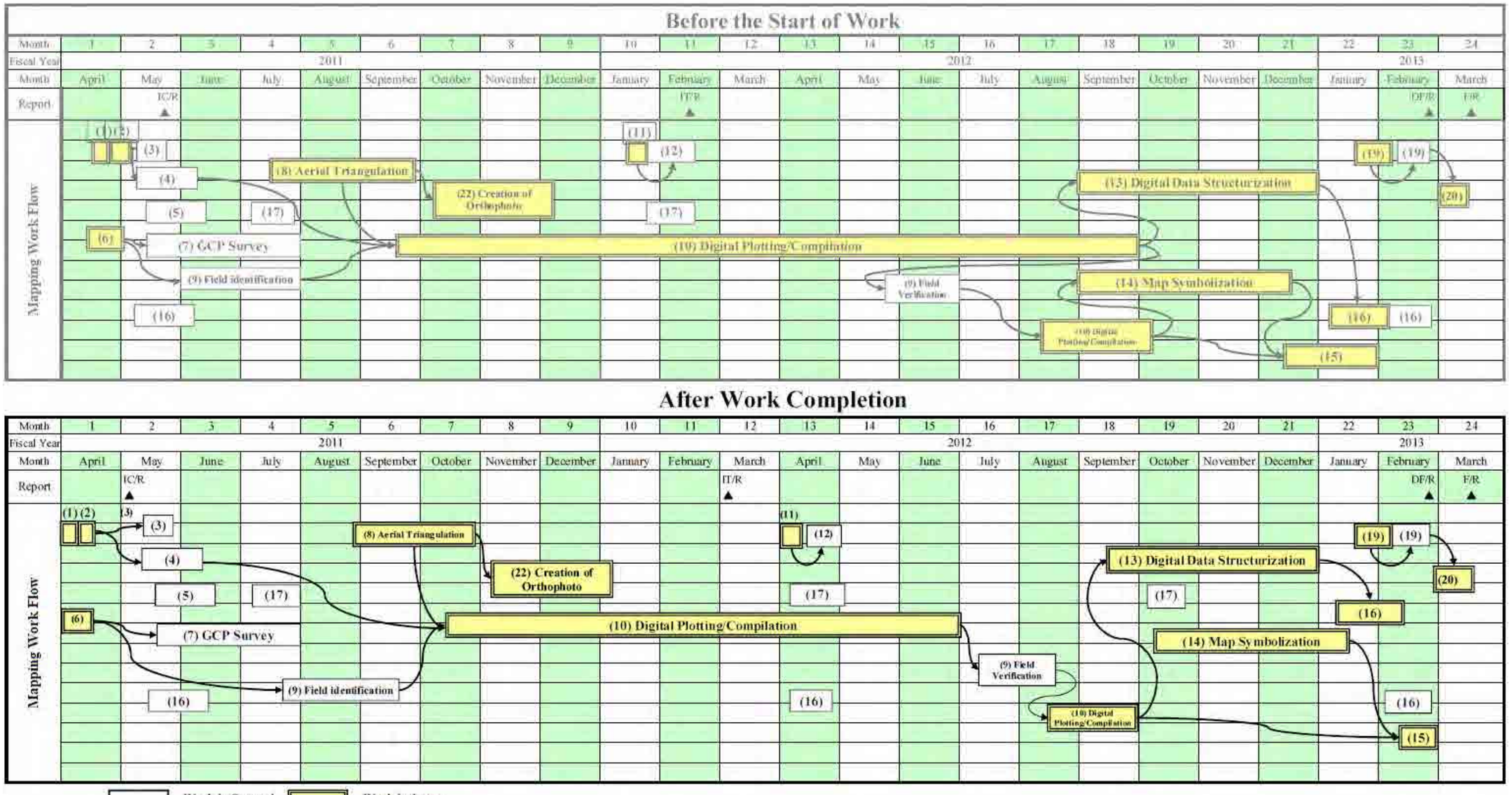
	Administrator	Name	Affiliation	grade
Work in Senegal	Team Leader	Takashi HARADA	AAC	2
	Data Usage Planning	Hiromichi MARUYAMA	AAC/IDI	3
	Consultation of Map Symbol Specifications	Takao IKEDA	AAC	4
	GPS survey 1	Kazuhiro ISHIZUKA	AAC/KKC	3
	GPS survey 2	Masanori TESHIMA	AAC	4
	Field Identification/Verification1	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



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
    a) Items to be acquired
    b) Symbol specifications
    c) Items to be displayed on maps
    d) GIS-structured data types
    e) Handling of attributes and input items in GIS structuring
    f) WebGIS-related items (display items, classifications, etc.)

2. **Check of survey criteria**
    a) Geographic coordinate system - ITRF
    b) Ellipsoid - GRS80
    c) Map projection - UTM 28N (A small 29N range exists in the eastern area.)

3. **Check of area to be mapped**
    a) Check of area to be mapped – The area to be mapped includes the administrative boundaries plus a 2 cm (1 km) band around them.
    b) Handling of blank area – The area outside the national boundaries is to be filled with satellite ortho-images.

4. **Check of map sheets**
    a) Number of map sheets to be created
    b) Map sheet numbers and names
    c) Coordinates of the four corners of map sheets (Check of maps with extension and data of the area)

5. **Check of marginal information** – The topographic maps created by JICA in 1991 will be used as the basis.
    a) Indicated items
    b) Symbols indicated in the legend – Note that the legend is different from the map symbols (For example, "bridges" are divided into several types in the map symbol specifications but can be indicated as one type in the legend.)
6. **Check of project outputs** – Discussed on the basis of S/W and the TOR
    a) Data format (CAD, GIS, and symbolization)
    b) Type of file for .shp data in GIS data structuring (by item or by major classification, etc.)
    c) Number of copies
    d) Ortho image specifications – Resolution, type of file, etc.
    e) Quality of outputs – Level of accuracy to be applied, etc. (As a general rule, the criteria of the Overseas Mapping (National Base Map) Standard Specifications must be complied with.)
7. **Check and acquisition of existing materials**
    a) Existing 1/50,000-scale maps (3 copies still to be acquired)
    b) Existing maps other than 1/50,000-scale maps
    c) Administrative organization chart and list of local public entities
    d) Road network map (showing management classifications such as Expressways and Classes 1 and 2)
    e) Map of river names
    f) High-voltage cable data map
    g) Radio relay station data map
    h) Demographic statistics data map
    i) Administrative boundary and administrative name data (used to check consistency with

the layers of administrative names in the map symbols; Example of administrative system: in descending order, province, municipality, villages. (See Appendix 6)

j) List of public facility names: National census, etc. (used to check for management of locational information such as BL)

k) Output of national control points (location data map for national benchmarks)

l) Ranges and names of special areas: national parks, forest preservation areas, wildlife reserves, world heritage sites, etc.

8. Technology transfer

a) Scope of OJT – Number of maps, etc.

b) Schedule

c) Adjustment of the number of ANAT engineers

9. Check of standard specifications to be used

The Overseas Mapping (National Base Map) Standard Specifications and the Guideline for the Creation of 1/50,000-scale Topographic Maps Using ALOS Images drawn up by the Geospatial Information Authority in 2009 are used as reference.

10. Check of supplied equipment

a) LPS module structure

b) MicroStation version

c) License validity period, etc.

11. Check items for field identification (Check of contacts for collecting materials No.① to ⑥)

a) Issue of documents requesting the cooperation of municipalities in the study area (Request to ANAT or a higher organization)

b) Assignment of at least four persons (one person to each of four teams) from ANAT for the 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.

- 1/50,000-scale topographic maps (created by JICA in 1991)
- 1/200,000-scale topographic maps (created by IGN France)
- African Mapping Standards (owned by ANAT)
- "Guidelines for the Creation of Topographic Maps Using ALOS Optical Images to Support GIS Infrastructure Development Activities in the Asia-Pacific Region" (created by the Geospatial Information Authority of Japan in 2009), etc.

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	137sheets 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 km^2) 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 as follows:

- Digital plotting was performed using stereo pairs of forward and backward views with good height accuracy.
- For the ortho-photos, perpendicular views were used because buildings and other structures appear less leaned.
- Aerial triangulation was performed using triplet imagery.
- Since the ALOS/PRISM images are panchromatic images, color images for the same range (ALOS/AVNIR-2 images) were also acquired to improve the interpretation accuracy in digital plotting and to create color ortho-photo data (only for the area for which the topographic maps were to be created).

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. The positions of the existing control points in the study area were marked on the Google Earth map based on the WGS84 geographic system coordinates indicated in the description of the point. In particular, 47 GCPs were planned at positions that facilitate pricking on ALOS images (e.g., pedestrian road intersections or the corners of hedges) with reference to the Google Earth images, to facilitate access to the control points through the prior acquisition of the approximate geographic coordinates.

[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. Furthermore, a GNSS observation plan was drawn up taking into consideration the positions of the existing control points and access roads, etc. For the observation plan, consideration was made of observation procedures that would be above all safe and efficient, on account of the positions of the existing control points to be used as known points and the road and weather conditions unique to the study area, and a session plan based on the static method was drawn up. Therefore, the observation plan adopted an observation method of deriving the positions of new GCPs to be set (coordinates and ellipsoidal height) by always using as the known points the two existing neighboring control points (with side lengths of between 30 km and 100 km). Using this observation method made it possible to gain efficient access to the new GCPs, minimize risks during transport, and led to simplification of the observation procedure. Furthermore, the plan makes optimum use of the existing GPS control points as the known points, enabling the check to be run for every session (observation network) based on the two known points.

[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

In accordance with the agreement with the dealer selected by tender (local sales representative SAREDIKA SARL), the Study Team purchased three sets of GNSS receivers (Leica GS10 system and accessories), analysis software (LGO 8.0), net adjustment software, etc., and carried out a delivery inspection and operation check on the equipment.

[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

The Study Team received from ANAT the 1st and 2nd class control point description data created up until FY2008 with the assistance of EU (IGN France), and collected together the following major outputs and topographic maps.

- Control point description of the existing benchmarks (created by the French government in the 1950s)
- 1/200,000-scale topographic maps (FY2005 to FY2008 versions)
- 1/50,000 topographic maps created by JICA in 1991

Through discussion with ANAT, it was determined that the observation teams would comprise the following members.

Table 2-3 Members of observation teams

	ANAT	JICA Study Team	Remarks
Group A	Mr. Ibrihima NDIAYE	Mr. Kazuhiro Ishizuka	Survey at GCPs
Group B	Mr. Madikou SARR	Mr. Masanori Teshima	Survey at known control points
Group C	Mr. Ousmane DIOUF		Survey at known control points

[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

Prior to the GNSS observation, for four days from May 30th the engineers of the Leica sales representative in Senegal gave the Study Team an explanation of and training in the procedure for operation of the receivers and analysis software. During the training period, the Study Team carried out an observation on the rooftop of ANAT and at three existing control points in the neighborhood (RRS01, R001, and B003) and, at the same time, carried out an output check of the existing control points and an operation check of the receivers. Accuracy validation produced good results, as shown in the table below.

Table 2-4 Observation accuracy validation results

Point No./Baseline	Observations	DX (m)	DY (m)	DZ (m)	Session No.
RRS01 – R001	Duplicated Value	1128.418	6713.622	3487.152	151B
	Adopted Value	1128.422	8713.631	3487.155	151A
	Discrepancy	-0.004	-0.009	-0.003	
	Tolerate Limit	0.020	0.020	0.030	
RRS01 – B003	Duplicated Value	6975.981	20720.509	-1846.369	151B
	Adopted Value	6975.991	20720.504	-1846.364	151A
	Discrepancy	-0.010	0.005	-0.005	
	Tolerate Limit	0.020	0.020	0.030	
R001 – B003	Duplicated Value	5847.568	14006.871	-5333.509	151B
	Adopted Value	5847.569	14006.871	-5333.510	151A
	Discrepancy	-0.001	0.000	0.001	
	Tolerate Limit	0.020	0.020	0.030	

[GNSS Observation]

As a general rule the GNSS observation was carried out simultaneously at two existing control points and one new GCP, completing the observation of a total of 47 GCPs. The standard observation

duration was set at one hour or longer, and the timing of the observation was coordinated and determined by the three observation teams via mobile phone communication. As a result, an average of two GCPs per day were observed, as planned. With favorable weather and good GNSS observation conditions (number and position of satellites), the observation was carried out with a PDOP (Position Dilution Of Precision), one of the indexes of observation accuracy, as good as three or less for the most part.

Note: PDOP* A unit less index that indicates the relationship between an error in the receiver position (observation point) and an error in the satellite position. The smaller value is the better condition. Normally, the value is around 2, but may rise to 5 or above if the satellites are poorly positioned or only a few satellites can be used due to obstructions. Any value larger than 7 is considered to be undesirable.

Photo 2-3 Antenna used during observation

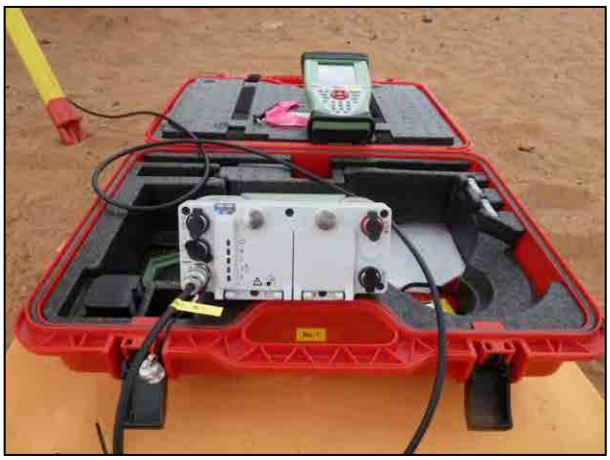


Photo 2-4 Receiver and controller

On the other hand, three GCPs (DTGC10, DTGC29, and DTGC37) adjacent to existing points at a distance of about 50 to 100 meters were observed through simultaneous observation between one known point and the GCPs for about 30 minutes. Exceptionally, no GNSS observation of DTGC20 was carried out because an existing point can be used as is as a GCP. The coordinates of the two eccentric points for the GCP were calculated using the compass method.

The final observation map is shown in the figure below.

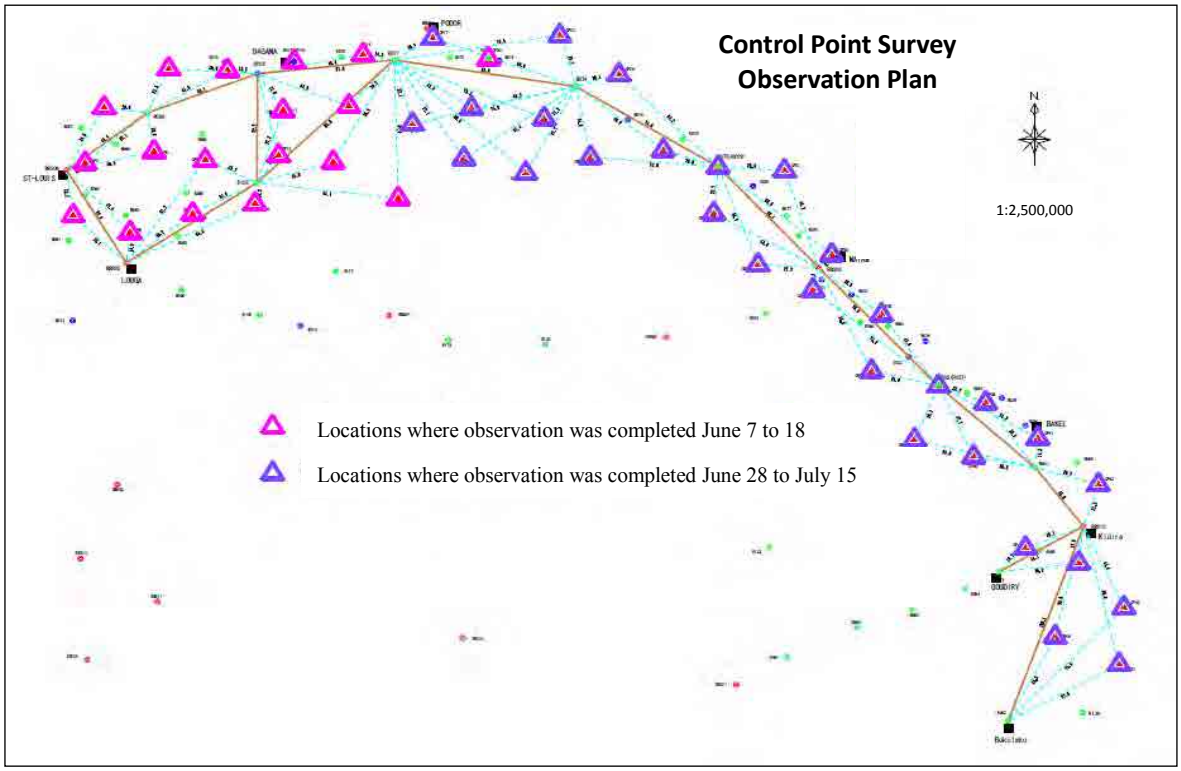


Figure 2-1 GNSS Observation map

[Baseline Analysis]

After the observation was completed, the Study Team downloaded the observation data for known points and GCPs (data stored on SD cards) to the analytic PC, entered the coordinates of the known points, checked for closed traverse errors in baseline vectors according to the observed values, and checked the 3D locational accuracy. The analytic process was carried out using LEICA's LGO (Leica Geo Office 8.0). Note that each observation session was checked by applying, *mutatis mutandis*, the limit values specified in Article 42-D of "GNSS Observation A (3)" of "Working Rules for Public Survey Work Regulations" of Japan. All the check results were within the limit values and good results were obtained, as shown in Figure 2-2 below. (Figure 2-2 was created based on the check calculation table for accuracy control of GCPs.)

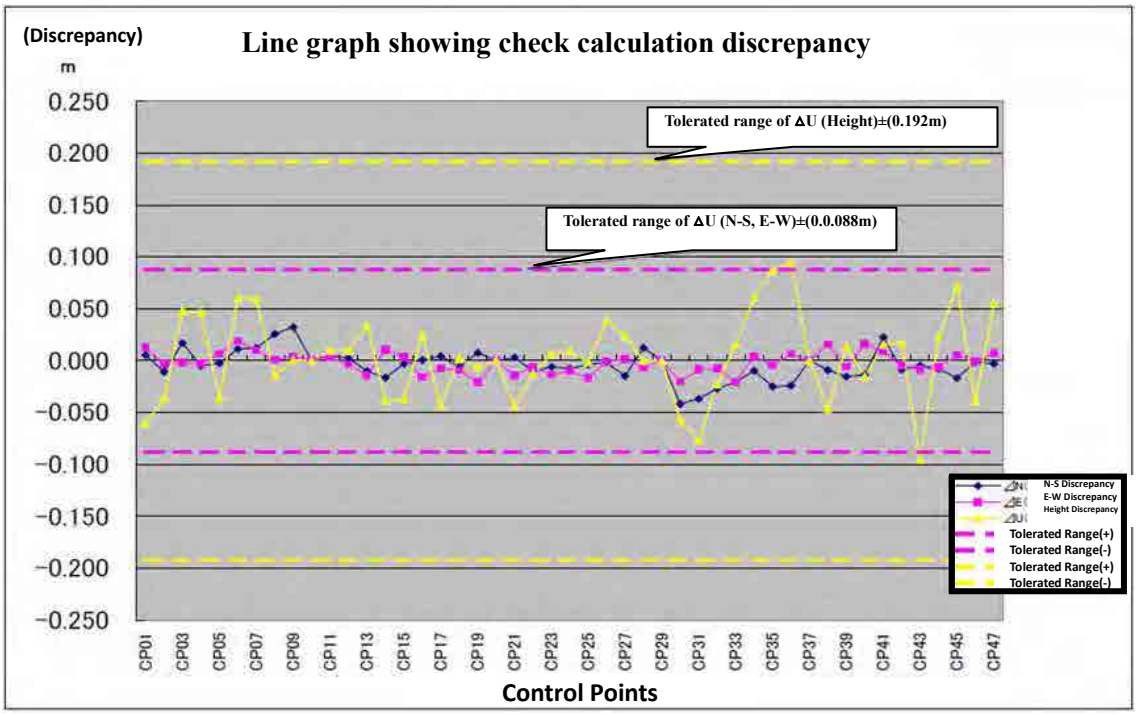


Figure 2-2 Graph showing discrepancy from check calculation

[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.

[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.

Photo 2-5 Pricked corner of hedge (CP03)

Photo 2-6 GCP being surveyed (CP03)

Photo 2-7 Example of pricking position on ALOS image (CP 03)

[Validation of Elevation from Existing Benchmarks]

The existing benchmarks used in this project were the 1st and 2nd-class benchmarks set up in the survey site by France in the 1950s. Many of the benchmarks in the field, however, have been lost and could not be validated. Therefore, three existing benchmarks with good positional conditions were selected to validate the elevation. The GNSS simultaneous observation and direct leveling were carried out using the existing control points or GCPs and the existing benchmarks, and the results were validated through comparison with the elevation outputs calculated from EGM96*. The difference turned out to be within 40 cm, as shown in the table below, demonstrating that the orthometric height from EGM96 can be used for the elevation in this observation, as planned.

Table 2-5 Existing benchmarks used to determine elevation

Name of existing benchmark	Measured elevation (m)	Elevation obtained from EGM96 (m)	Difference from measured elevation (m)	Location of existing benchmark
Mle53	10.474	10.572	+0.098	Mpale Station
M5	16.564	16.960	+0.396	Matam
M38	85.495	85.641	+0.146	Koutenabe Station

Note) EGM96*: Earth Gravitational Model 1996 is the result of a collaboration between the National Imagery and Mapping Agency (NIMA), the NASA Goddard Space Flight Center (GSFC), and Ohio State University.

[Consideration]

The field work started in mid-June 2011 in the northwestern area, using Saint Louis as a base, and continued until mid-July, moving in a southeastern direction through Richard Toll, Podor, Ourossogui, Matam, Kidira and Goudiry. As the field work moved from the northwestern area along the coast to the inland area, then along the Senegal River to the southeastern area, the temperature rose and the precipitation gradually increased, enabling us to experience first-hand the changes in climate and vegetation distribution. Although a tropical sandstorm (*harmattan*) was encountered during the field work, the day's observation had ended and the observation teams were able to take refuge. Furthermore, the mobile phones of the three teams were extremely useful in communicating the start times for GNSS observation. In the inland area far from the antenna towers of telephone stations, however, the mobile phones did not work at all and the observation teams had to move to an area where mobile phone coverage was available in order to regain communications.

In the field, on the other hand, the observation teams sometimes encountered relatively long distances between known points and GCPs, requiring travel times of as much as five hours. Sometimes, the observation teams encountered obstacles such as sand dunes and dried-up mountain streams. However, thanks to the close communications with ANAT, access information acquired in the nearby villages, navigation using the handy GPS system into which the approximate coordinates of the GCPs had been entered in advance, the work progressed as scheduled.

Photo 2-8 Daily meeting

Photo 2-9 All members of GCP teams

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 km^2 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 km^2, 234 ALOS/PRISM images (78 scenes x triplets) were used.

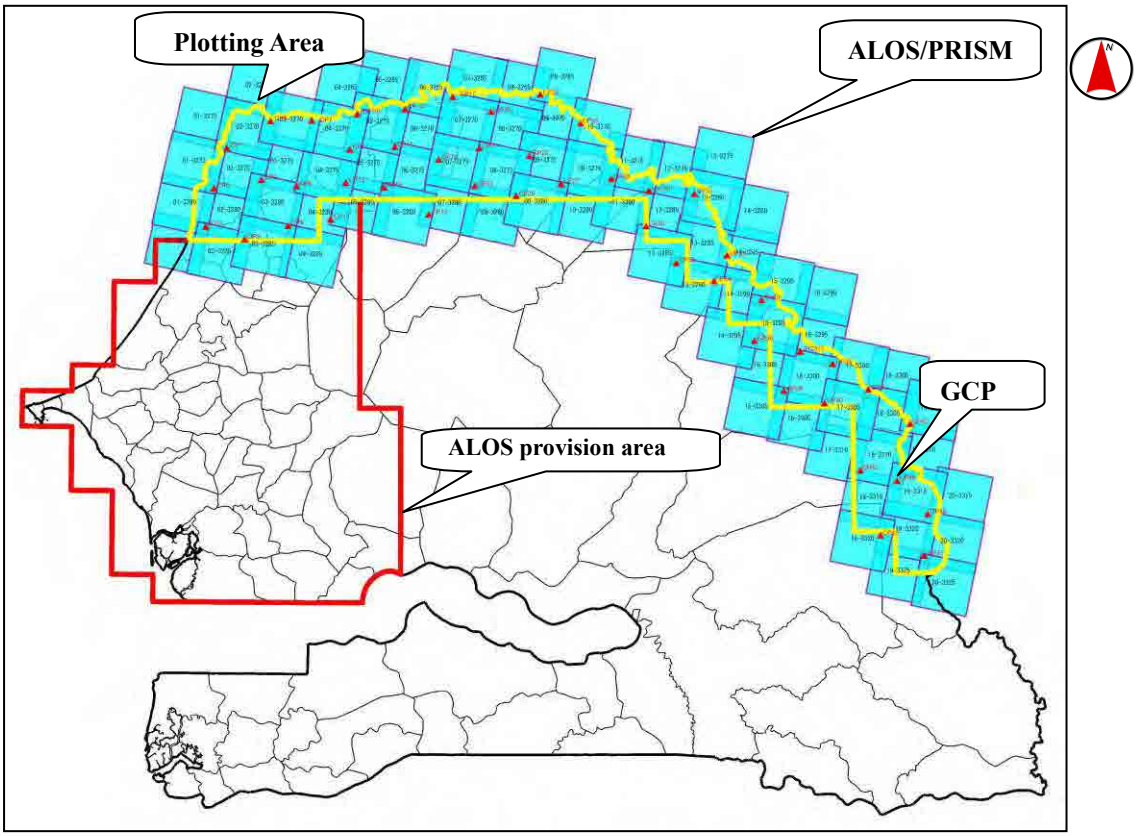


Figure 2-3 Layout of ALOS/PRISM scenes

[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:

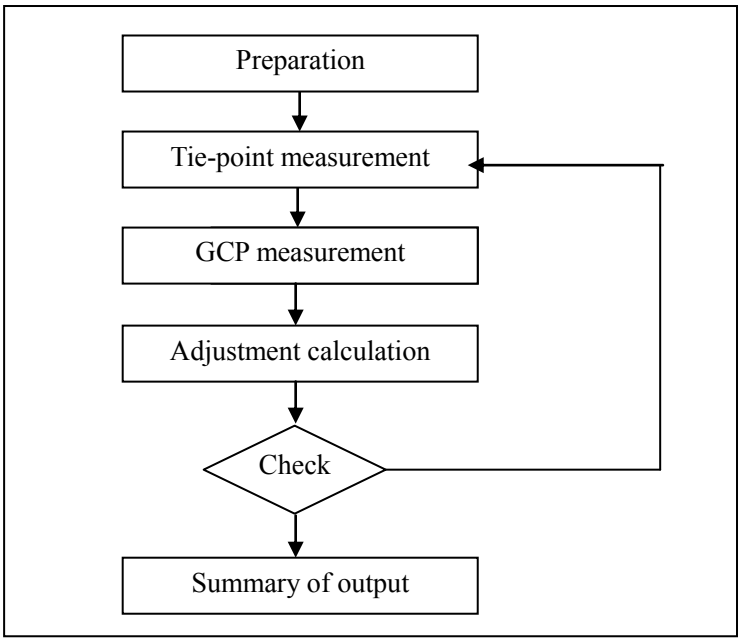


Figure 2-4 Flow of technology transfer in aerial triangulation

[Content of Work Implemented]

a) Preparation

For the ALOS/PRISM images, a unique ID is assigned to each scene. In the area marked with a red line in the figure below, for example, "alpsmn254603275" is the scene ID, of which "254603275" consists of the number of satellite flyovers and the frame number, with the first five and last four digits identifying the Path and Row, respectively.

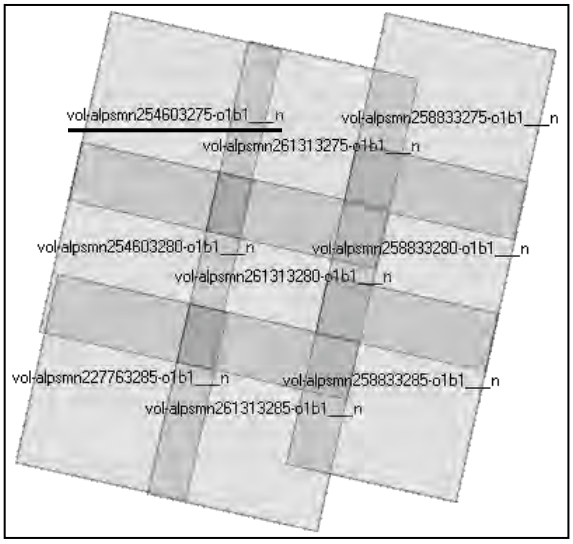


Figure 2-5 ALOS: ID numbers

However, management of the images is not easy; the location of a path cannot be easily identified from the number, and the frame numbers are different for the triplets. Before the implementation

of aerial triangulation, therefore, the scene IDs were changed to numbers that could be more easily managed in this project. The naming rules were as follows:

- A scene ID shall be "Path number (2 digits) – Frame number (4 digits) – Line of sight (N, F, or B)." An image file name shall have the suffix "_original-scene-ID" to facilitate later checking.
- Path numbers start at "01" in the west, with numbers assigned to subsequent paths in ascending order.
- Original numbers are used for the frame number, with the same number as the nadir view being used for the forward and backward view.

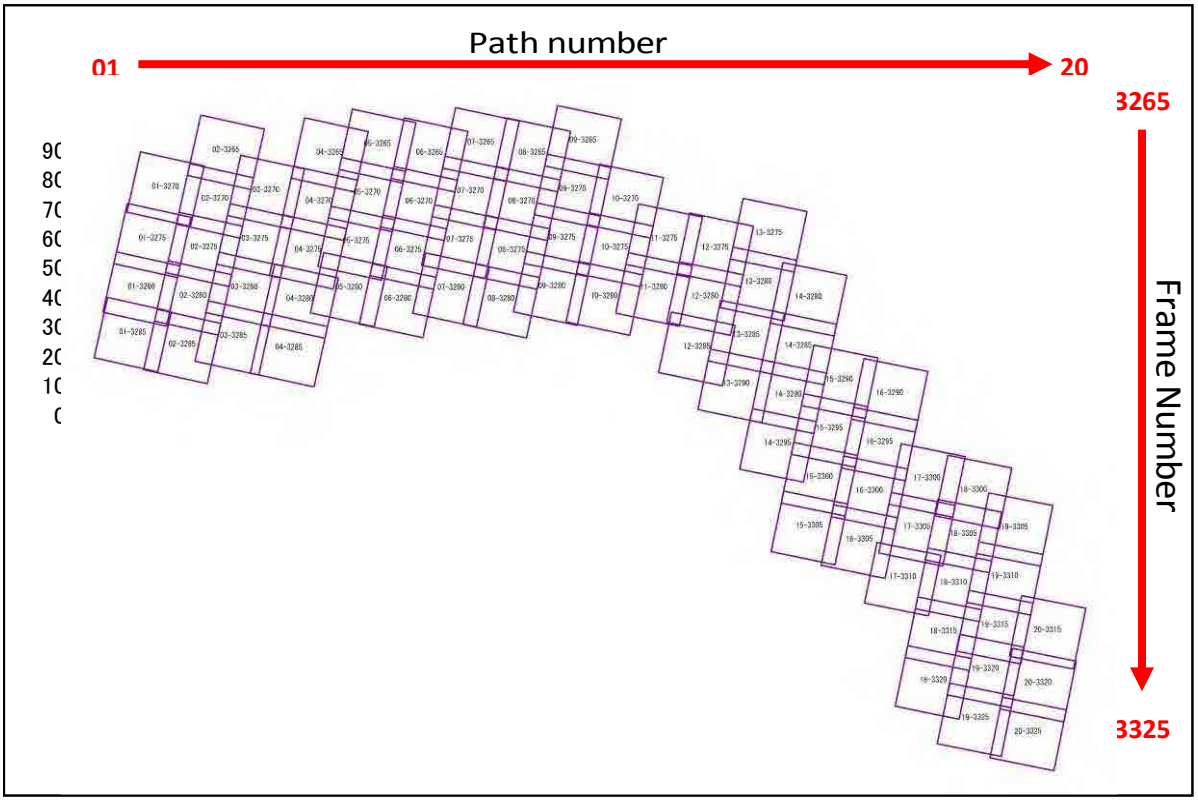


Figure 2-6 ALOS: Paths and Rows

b) Tie-point Measurement

LPS has the function of automatically acquiring tie-points (points that connect photos). In this process, the Study Team first carried out automatic processing and later checked those points with large residual errors and missing points, made corrections or carried out additional measurements as required, and acquired the image coordinates of the tie-points. With the tie-point allocation at "5 x 5," automatic acquisition was conducted. The accuracy of automatically-acquired tie-points depends on the accuracy of the RPC model and the geometric accuracy and radiometric accuracy* of the images. The success rate for this process was around 50%, not a very good result with regards to accuracy. There are two possible causes for this:

First possible cause: A large part of the target area is savanna with few distinctive planimetric features, so that the probability of the same point being identified on the

software was low.

Second possible cause: The RPC model was not accurate enough in some scenes.

When the check calculation was carried out on each scene for this reason as well as for the purpose of factor analysis, a large residual error was confirmed in the forward-view images with a pointing angle of "+1.2". In the scenes that included this image, the standard deviation of intersection residual error exceeded 2.0 pixels. There is a clear difference between this and the standard deviation of intersection residual error of 0.5 pixels in images with a pointing angle of "-1.2." This tendency was confirmed in all the images in the target area. Although the cause of this cannot be identified, it may possibly be due to errors in the data merging process, as a scene in an ALOS/PRISM image is a merged image of those acquired from multiple CCDs; or due to errors in CCDs when the images are acquired; or errors in the creation of the RPC model. Tie-points were added manually to the positions where they were missing.

Note) Radiometric accuracy * Correction due to sensor sensitivity

c) GCP Measurement

Using the GCP detail register acquired in GCP measurement, the GCP image coordinates were measured. Since the GCPs were selected with consideration given to the overlapping of images, up to 12 images were measured per point. In some images, measurement was not possible due to clouds, and objects could not be identified because the photographs were taken at different times. However, it was possible to ensure the minimum necessary number of view directions and measurement images for all the points, which were measured and used in the adjustment calculation.

d) 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 2-6 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.

e) 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 km^2: 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

[Work Schedule]

(See attachment (1), "SCHEDULE FOR FIELD WORK.")

[Work Team Members]

The following ANAT members participated.

Mr. Mamadou THIAM

Mr. Madikou SARR

Mr. Mouhamadou NDOUR

Mr. Moctar DIAGNE

[Purpose of the Work]

The purpose of the work was as follows.

- In the field, to collect and check various items of geographic information required for subsequent work (digital plotting and digital compilation).
- To create interpretation samples (interpretation keys) for use in image interpretation training, to facilitate digital compilation.
- To enable ANAT to understand and master the technology for creating and correcting topographic maps independently, to aid the continued development of geographic information in Senegal.

[Points to Note in Survey Implementation]

The points noted in implementation of the survey were as follows.

- **Compliance with the Overseas Mapping (National Base Map) Standard Specifications**

  The map symbol applied to the field identification work was the "Senegal Map Symbol

Specifications" compliant with the "African Mapping Standards." This document was created for application to analog topographic maps, and so this work was carried out in line with the Overseas Mapping (National Base Map) Standard Specifications and Map Symbol Specifications created for the work (digital topographic map creation), determined through prior discussion.

- Use of Satellite Images

  The ALOS (Daichi) pan-sharpen images, high-resolution images with a ground resolution of 2.5 meters enabling stereoscopic views of the target area, were used.

- Effective Use of Existing Maps, etc.

  Effective use was made of the existing map information, including the 1/50,000-scale topographic maps created in the 1950s and 1990s and the 1/200,000-scale topographic maps created in 2007.

[Survey Procedure]

- **Acquisition of Satellite Images and Existing Maps**

  In preparation, the following work with regard to satellite images and existing maps was carried out.

  - Rasterization of existing maps (Creation of preliminary photo interpretation sheets for field identification)
  - Creation of image-mosaic for individual map sheets from satellite images

- **Acquisition of Data** (Created in 2008: Data Owned by ANAT)

  The following existing data was acquired before the start of the field work.

  - Road network maps
  - River name maps
  - Public facilities (administrative organizations, schools, medical institutions, etc.)
  - Special areas (national parks, forest preservation areas, etc.)
  - Administrative boundaries and place names
  - Etc.

- **Confirmation of Map Symbol Specifications to Be Used**

  The map symbol specifications to be used in the field work were confirmed based on the map symbols and acquisition criteria (draft) determined in the discussions on map specifications.

- **Preliminary Photo Interpretation Work**

  Before the start of the field identification, preliminary photo interpretation was carried out indoors using the documents and data collected, image data, etc.

Photo 2-10 Training in study team office

Photo 2-11 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 (start and end of assignment reports, attached) were submitted to the JICA Senegal Office.

[Details of Field Identification Implementation]

The field identification, which refers to the work of surveying and confirming in the field the relevant items of the map symbols and place names required for the creation of topographic maps, was carried out mainly by the ANAT. The Japanese Study Team carried out technology transfer related to the work implementation on an OJT basis. At the same time, data on items appropriate to the interpretation key was acquired. The survey was conducted by acquiring data using digital cameras (with GPS function) to supply locational information (coordinates) for subsequent work (Data count: About 2,000 points).

Photo 2-12 Photography using GPS camera

Photo 2-13 Feature coded after being photographed using GPS camera

Photo 2-14 Interview survey of residents (1)

Photo 2-15 Interview survey of residents (2)

Photo 2-16 Interview survey of residents (3)

Photo 2-17 Writing data on field identification photos

- **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.

- **Principal Conditions of Field Identification**

- Administrative boundaries, place names, roads and rivers

  The boundaries and place names were taken from the database created in 2008 and owned by ANAT. It was determined that the place names would be checked again in the field verification in the second year.

  Road classifications, such as national roads, regional roads, departmental roads, tracks, etc.,

can be distinguished through interpretation with reference to the interpretation key at the time of digital plotting. The distinction between paved and dirt roads and the naming of rivers were determined with reference to the database owned by ANAT.

- Railroads

  Railroads can be distinguished easily because they have a distinctively linear form in the images.

  Although the railroad to Saint Louis is out of service at present, it was surveyed in consideration of the likelihood of its being restored in the future.

- Urban areas, various public buildings, etc.

  Urban areas were surveyed carefully and compared with the ANAT data because of the concentration in particular of public buildings, hospitals, and schools (universities and technical colleges).

  In Saint Louis, too, the detailed data of city plans was used. However, because of the large number of planimetric feature symbols to be displayed, it was recognized that in subsequent compilation work it would be necessary to sort through the symbols to determine which to adopt and which to discard.

- Cities, towns, villages and settlements

  In the work area covered by the current project, the city of Saint Louis, located at the mouth of the Senegal River, is the largest urban area; other municipalities are also concentrated along National Road No.2. In the inland savanna region are scattered many districts and villages, each inevitably with its own school, mosque, and clinic. This meant that a significant amount of time was spent in acquiring the data. In particular, villages located on islands in the Senegal River could not be easily surveyed because of the difficulty involved in crossing the river when the water was high after rain.

- Vegetation, forests, etc.

  It is easy to interpret the images of the Saint Louis region, of which a large part is savanna, and of the scattered villages, which are surrounded by large areas of cultivated land such as tomato and peanut fields. Over the savanna are distributed many baobab trees; too many for them to be used as landmark objects. Near Richard Toll in the north lie sugar cane fields and rice paddies. Near Podor and Matam along the Senegal River (near the border with Mauritania), there are many rice paddies, possibly because of the abundance of water. Near Bakel (near the border with Mali), the terrain is hilly and large numbers of bushes were observed. All of these can be distinguished using the interpretation key.

- Water facilities, etc.

  Wells, elevated tanks, bridges, etc. needed to be verified in the field. In particular, elevated tanks make good landmark objects, so that care was taken during the field identification not to overlook them.

➢ **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. (See Figure 2-7.)

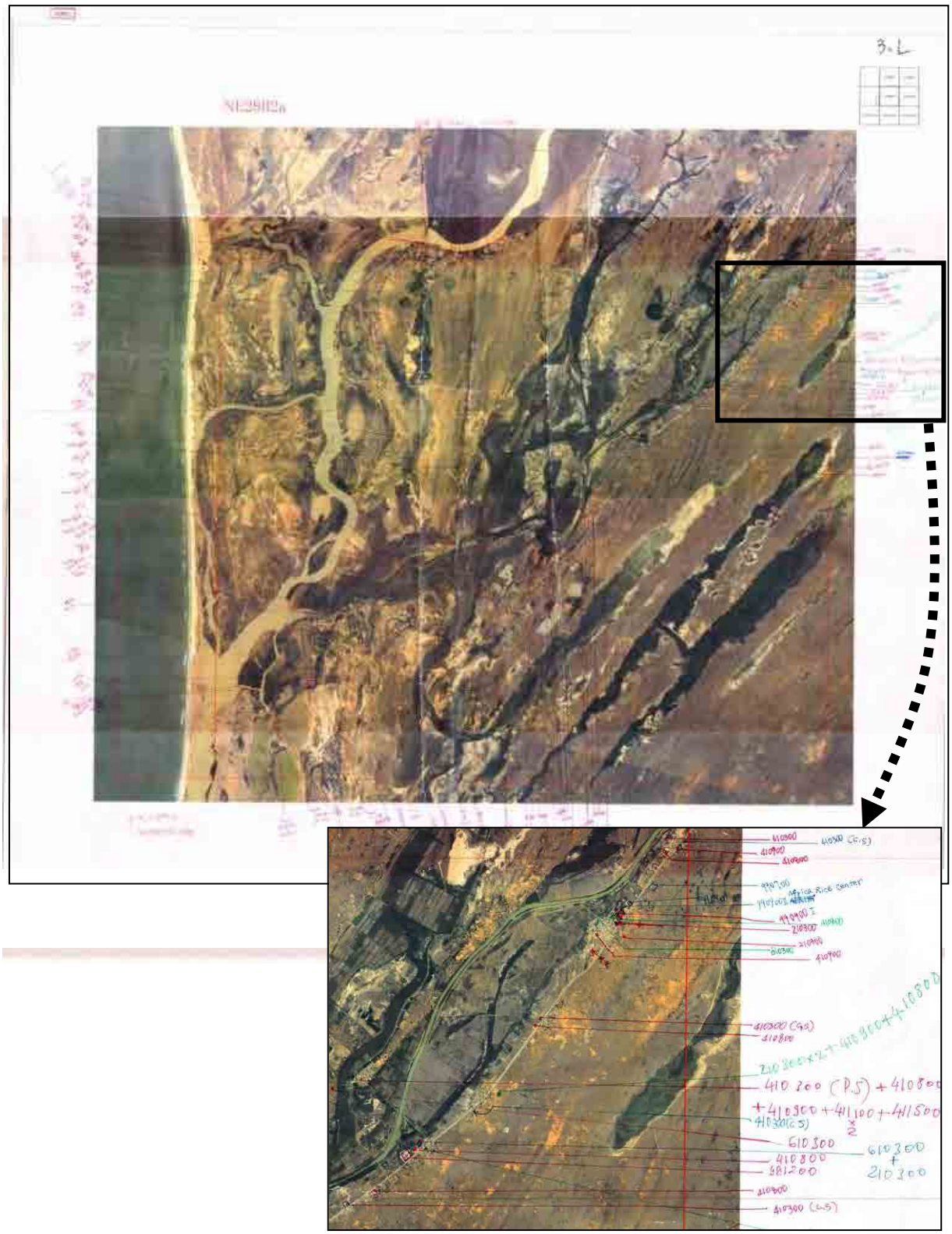


Figure 2-7 Organization of field identification results sorted out

➢ **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 2-7 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

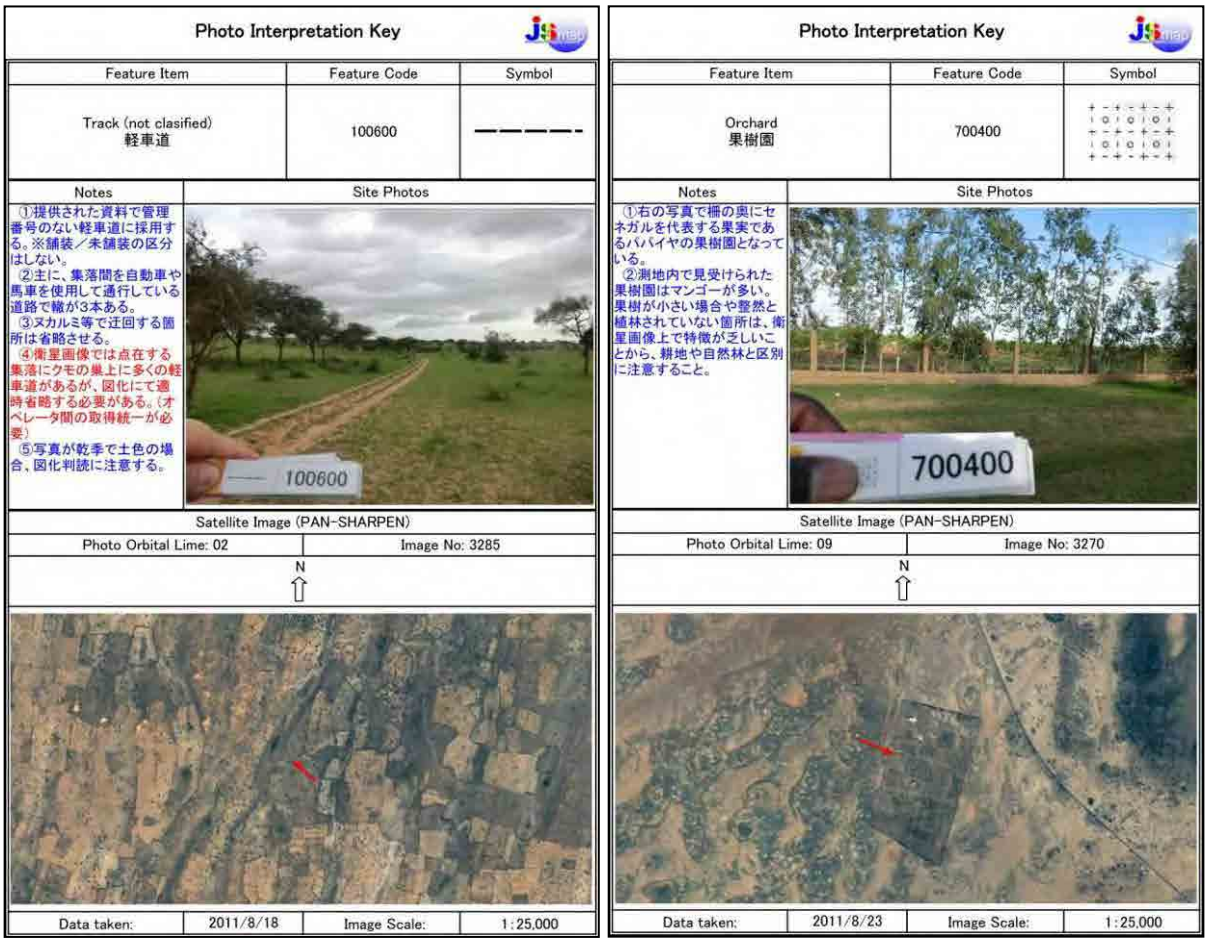


Figure 2-8 Examples from the interpretation key

[Consideration]

- Scale of Field Identification Photos

  The 1/50,000-scale satellite images used as the photos for field identification in this project seemed a little too small. However, the use of existing maps compensated for this inconvenience in the survey work.

- Traveling Time

  Considerable time was required for traveling within the study area, e.g., between villages or from the accommodation to the study area. In planning the field verification work, selection of the accommodation needs to take into consideration ease of mobility (e.g., planning to stay at a location close to the study area).

- The Need for a Field Verification

  To improve the accuracy of the digital plotting work, it is necessary to be very familiar with the geography of the study area. Although it is true that the interpretation key is helpful, the characteristics of the geography and topology outside Japan are very different from what they are in Japan. In addition, care was needed in the interpretation of the satellite images during digital plotting, as they were a mixture of images taken in the rainy and dry seasons. Particular attention had to be paid to the vegetation and water systems around where the photo images joined. For this reason, the field verification is necessary.

- Map Symbols, etc.

  Some of the map symbols were in the "draft" stage when the field identification was implemented. For example,

  - Whether an annotation for high schools is required,
  - Whether telephone office are required (few were seen in the field), and
  - The problem of durability, etc. in the digital world.

  The criteria for determining whether certain data should be acquired can be seen as "whether it is regarded as attribute data." In addition, the method of annotating the names of municipalities, proper names, etc. needed to be discussed and re-examined.

- Capability of ANAT

  ANAT was familiar with the creation of maps, and generally performed well. The Study Team considers that they will be able to cope with the implementation of work by themselves in the future. However, they will be able to make work plans and implement the work more efficiently if more detailed technology transfer is provided, as the choice of map symbols will be different depending on the scale.

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 km^2 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

[Work Team Members]

The work was carried out by the ANAT engineers under the management and guidance of the Study Team. The work team members are listed below.

Mr. Abdou Khadre DIATTA (Project manager)

Mr. Mamadou THIAM

Mr. Madikou SARR
Mr. Ousmane Madiabe DIOUF
Mr. Abdou Gallay DIOUF

[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.

[Particular Points in Survey Implementation]

1) Annotation of Village Names

   Since there is no reliable material for village names, the annotation of unknown village names was carried out by directly interviewing local residents. As the main language spoken in the project area (Pulaar, spoken by residents of Mauritanian origin) is unintelligible even to the ANAT staff, care was taken in the spelling of village names. In some cases, one of the counterparts (C/Ps) was able to communicate in Wolof during the survey. Additionally, as a general rule the village name was left as is even if there were no houses on the map.

2) Roads

   Tracks (pistes) were adopted with an emphasis on plotting interpretation.

3) Vegetation

   In some places, rice paddies and sugar cane fields were confused in the interpretation but corrected in the field verification.

4) Ramadan

   The Islamic month of Ramadan lasted for about one month from mid-July. Since the ANAT staff and drivers began to look increasingly more tired partly due to the heat, the Study Team gave heed to their physical condition, for example, wrapping up the day's work earlier than usual.

5) Work Plan

   Since the work area is a swath of land along the Senegal River, it was judged to be desirable that the maps be allocated efficiently to the C/Ps so that the maps they were in charge of were adjacent to each other. Therefore, the Study Team instructed the ANAT staff to discuss the matter and draw up an efficient work plan.

6) Survey Procedure

i) Preparatory (preliminary) work using digital plotting blanks

- Reconfirmation of places unidentified or misidentified in the plotting work

ii) Acquisition of geographic information data in the field

- Map symbols (to be added or removed)
- Village names (ditto)
- Uninterpretable road data (trails recorded on handy GPS receivers)

iii) Data storage and organization

- Acquisition of locational information using GPS-ready digital cameras : HDD filing
- Acquisition of track information using handy GPS receivers : HDD filing
- Scanning (digitalization of photos for field work) : HDD filing

[Details of Survey Implementation and Work Method]

1) Overview

This work is the task of once more going into the field after the digital plotting and compilation to fill in gaps in the map symbol, place names, etc., required for topographic maps by surveying and confirming them once more. It was done mainly by ANAT, and the Study Team carried out technology transfer related to the implementation of the work as OJT. The plan was for a survey of all 54 maps and the survey was 100% completed owing to favorable weather despite it being the rainy season, with the exception of one day during the work period when the work was influenced by rain.

2) Altered Map Symbols

Although the "Senegal Map Symbol Specifications" in compliance with the "African Mapping Standards" were used, medical facilities (clinics) were changed from two classifications (*Hôpital* and *Dispensaire*, i.e., hospital and clinic) to four classifications (*Hôpital, Centre de Santé, Poste de Santé*, and *Case de Santé*, i.e., hospital, health center, health post, and health hut).

3) Principal Survey Status

The discrepancies, defective KMZ photos, additional map symbols and changes that arose in the digital plotting and compilation process were indicated with a leader line and the symbols shown below. The survey was conducted by resolving these.

Table 2-8 Instructions for field verification

Symbol	Code	Description	Remarks
―	9901	Delimiting line, leader line, etc.	
A	9902	Unknown symbol	
B	9903	Unknown vegetation	
C	9904	Unknown range	
D	9905	Unknown shape	
E	9906	Unknown location	
F	9907	Unknown annotation	
G	9908	Unknown feature	

A Unknown symbol

Example: An unknown feature due to an obvious mistake in showing the feature layer tag photographed in the field identification

Example: The feature layer tag photographed in the field is not enough to identify the symbol because of the more detailed classification of medical facilities.

Required action: (1) After Altered verifying in the field, post the feature layer number tag again and photograph it using a GPS camera.

(2) Write the layer number carefully on the field verification sheet.

B Unknown vegetation

Example: Important vegetation that is unidentifiable in the plotting and must be checked

* The number of field verification locations was reduced because, basically, vegetation is considered to be of low importance.

Required action: (1) After verifying in the field, post a feature layer number tag again and photograph it using a GPS camera.

(2) Write a layer number carefully on the field verification sheet.

C Unknown range

Example: The range of a large-scale graveyard, plantation, etc. for which plotting interpretation cannot be performed. There are expected to be few instances of this.

Required action: (1) After verifying in the field, (carefully) draw the range directly onto the field verification sheet.

D Unknown shape

Example: The range of a river or road for which plotting interpretation cannot be performed. There are expected to be few instances of this.

Required action: (1) After verifying in the field, (carefully) draw the range directly onto the

field verification sheet.

(2) Identify the road form, etc. from the log information downloaded after completion of the work from the GARMIN GPS receiver that has been turned ON at all times during the work.

E Unknown location

Example: Although the feature layer is indicated on the enlarged photo in the field identification, the KMZ does not exist and the location is unknown.

Required action: (1) After verifying in the field, post the feature layer number tag again and photograph it using a GPS camera.

(2) Write the layer number carefully on the field verification sheet.

F Unknown annotation

Example: Although the administrative name (village name) was transcribed from the 1/200,000-scale map, the village at the plotted location has no name.

Example: Although the administrative name (village name) was transcribed from the 1/200,000-scale map, there is no village at the plotted location.

Example: The notation transcribed from the 1/200,000-scale map is unclear.

Required action: (1) After verifying in the field, write the layer number and annotation in the margin of the field verification sheet.

(2) Enter the layer number and annotation in the Excel file.

G Unknown feature

Example: Although the plotting interpretation found a building or site that looks like XX, it is not included in the field identification materials.

Example: Other materials (such as existing maps, Google Map, photos) show a building or site that looks like XX, it is not included in the field identification materials.

Required action: (1) After verifying in the field, post the feature layer number tag again and photograph it using a GPS camera

(2) Write the layer number carefully on the field verification sheet.

(3) For a feature that need not be displayed on the map, draw an X on the field verification sheet.

1) Administrative boundaries, place names, etc.

Administrative boundaries and place names were surveyed using the materials and information from ANAT, and the ANAT staff confirmed them with the residents.

2) Various public buildings, etc.

Regardless of whether any problems were noted, the survey was repeated in urban areas

where public buildings, hospitals and schools (universities and technical colleges) in particular are concentrated. For schools in particular, the Study Team once more checked with the residents whenever possible as some had a school building and some had classes in the open air (enclosed only by a straw fence).

3) Villages

In the inland savanna region, a large number of villages were scattered. Many of the inhabitants of these migrate according to the season. Although the reference materials show the names of these villages, in many cases there were no houses, or only abandoned houses there. However, on the advice of the ANAT the annotations of the village names were left on the map as a general rule, as the residents may return to live there again.

4) Roads

- In the plotting there were a number of places where tracks (Piste) were broken, but the tracking function of the handy GPS receiver was used to acquire road data and correct such places on all the maps.
- The Study Team received instructions to refer to the road type materials (1/200,000-scale map) loaned from the ANAT when classifying the road layers of the plotted roads. When the two sets of data were actually overlaid, however, major roads such as the national roads were consistent in location and form, but the departmental roads, tracks, etc. were not consistent with regard to location or shape, or whether the road was actually there; so that it was difficult to determine the classifications of the plotted roads. The Study Team printed out road maps showing these two sets of data overlaid on each other, showed them to ANAT, and held repeated discussions with them. As a result, with regard to these roads an agreement was reached with ANAT that priority would go to the new 1/50,000-scale data to be created.

[Impressions]

At the time of the field identification, the survey period had to be extended due to delays in the work, and it was feared that the same might happen again. Fortunately, however, the work was cancelled due to rainfall on only one day.

Since there is no definitive manual, knowledge of and experience in photogrammetric survey technology form the basis of the field identification and field verification work, in addition to which the characteristics of the region must be fully understood. For this reason, communication with the local residents is important, and the local language plays an important role, which means that the competence of the ANAT members has a significant impact. In this project, all the participants had extensive experience, and both the engineers and drivers showed good teamwork in doing their work, which is a major reason why the study was completed with no real problems, thereby successfully leading on to the subsequent work processes.

[Other]

- Work area was quite some distance from the capital city, Dakar:
  The work area was a swath of land along the Senegal River. The major cities in this area include Saint Louis, at a distance of about 200 km from Dakar; Matam (Ourossogui), about 600 km; and Tambacounda, about 500 km. Just travelling to the work area consumed a considerable amount of time and effort.

- Work during Ramadan:
  The work this year, like the field identification last year, coincided with the period of Ramadan. Muslims wait until sunset before they eat, and naturally this leads to their staying up till late at night. Consequently, they are tired the next day, which leads to a fall in efficiency. We felt keenly, therefore, that Ramadan must be taken into consideration when drawing up a work plan.

- The need for Japanese 4WD vehicles capable of traveling on sandy soil:
  Four-wheel-drive vehicles are naturally the most appropriate for surveying a large savanna area. However, we must fully expect that even such vehicles may get stuck in sandy soil or marsh. In this project, too, a car got stuck in sandy soil but was able to be extracted without too much trouble because an iron plate to provide traction was ready at hand.

- Regional hotels:
  There are small hotels and cottages at key points, with some variation in facilities, sanitary conditions, etc. However, due attention must be paid to the heat, anti-mosquito measures and blackouts. In this project, there were fewer mosquitos than expected and only one blackout (During the field identification, there were several nights of blackout).

- Regional security:
  There was apprehension about the regional security conditions because little information could be acquired. As the study area is near the national border, it was feared that there could be conflicts with other ethnic groups. Contrary to expectations, however, all the local residents were kind to us and survey life in the regions was peaceful.

- Measures against malaria:
  The most troublesome thing in Africa is sickness. In particular, there is the danger of contracting malaria when one's physical strength is diminished, and one cannot be too careful. Since the Anopheles mosquito, the malaria carrier, is nocturnal, particular care is needed at night. The most effective measure, in addition to mosquito coils, is mosquito netting, which was used in this project, too. Attention must also be paid to sleep and food

(nutrition) because a person in a bad physical shape is more likely to get the disease. In this project, none of the engineers (team members, C/P members, and drivers) fell ill from malaria or any other illness.

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-sharpen 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 km^2
- 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'

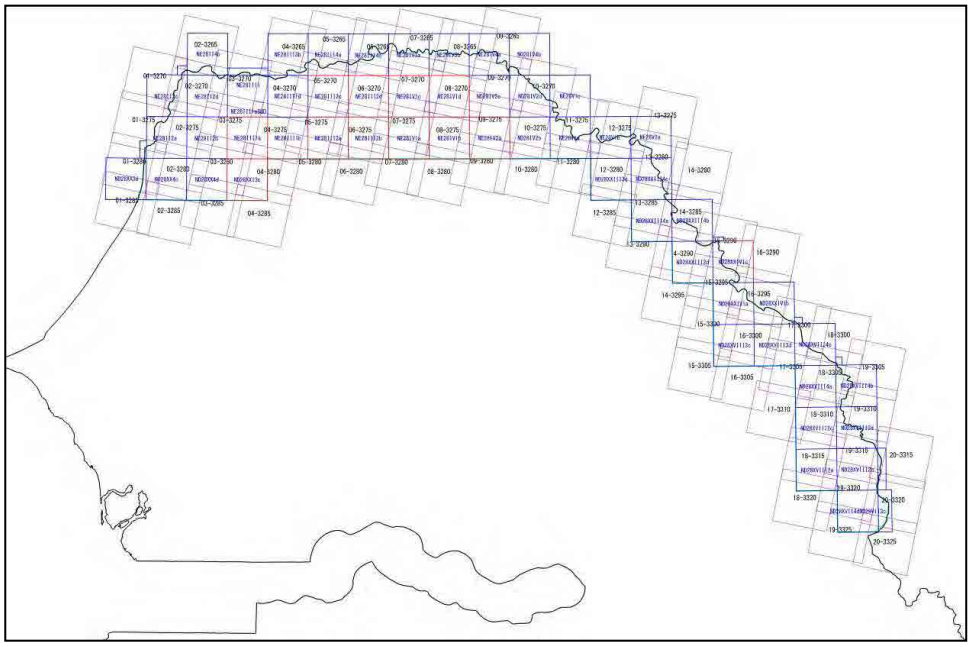


Figure 2-9 Index map for digital plotting and compilation sheets

[Equipment Used]

Digital plotter : LPS (Leica)
: Summit (DAT/EM)
: Zukameijin (Asia Air Survey)

[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-sharpen ortho images
  Pan-sharpen 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 km^2
  - Number of maps to be compiled : 54
  - Map framework : East-west 15' (about 26.8 km), north-south 15' (about 27.7 km)

- Equipment Used
  - CAD used for compilation : MicroStationV8 (Bentley)

- 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)

  The plotting interpretation result and field identification photos were referred to check for misinterpretations and omissions and to make sure that features acquired using the kmz data were included.

  2) Existing maps (1/50,000)

  The existing maps were used mainly to adjust anomalies between the input annotations and the acquired features.

  3) Existing data (SHP files)

  The existing maps and the existing data were used to edit symbols, annotations and administrative boundaries.

  4) Road type data

  The types of principal roads were verified using the reference materials.

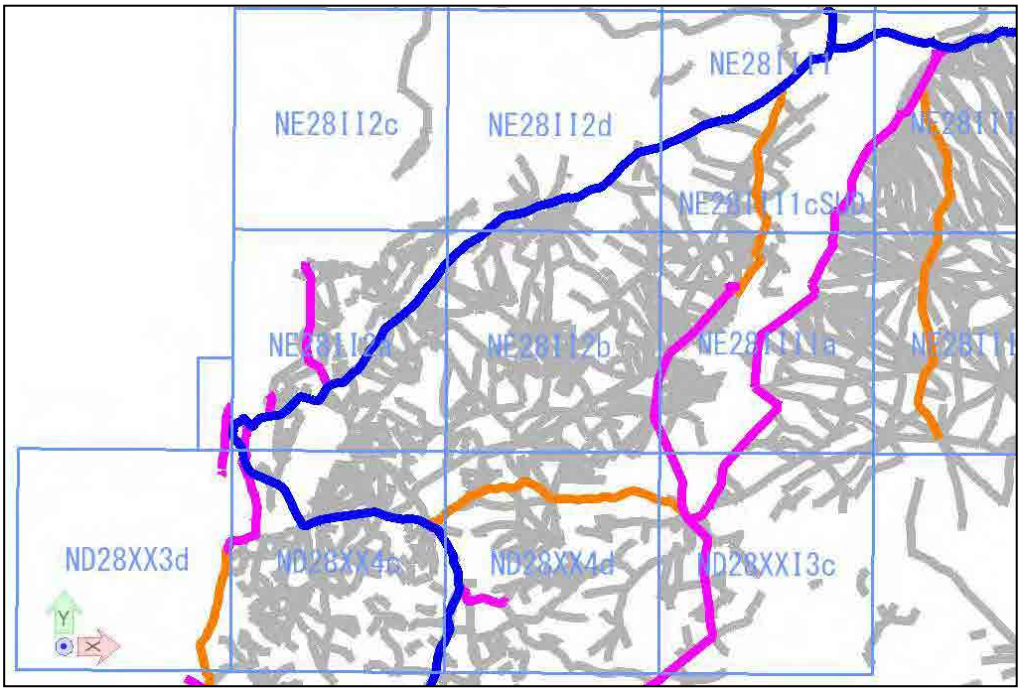


Figure 2-10 Road type data

5) Range and names of villages

Based on the plotting data and using the existing maps and data, the range of villages was acquired and their names recorded.

6) Field verification items

Places with discrepancies in the relationship between the digital compilation results and other materials were marked with symbols of items to be verified in the field verification. Places where a symbol alone was not enough to indicate the purpose of the field verification were marked with notations.

- Digital Compilation Results

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

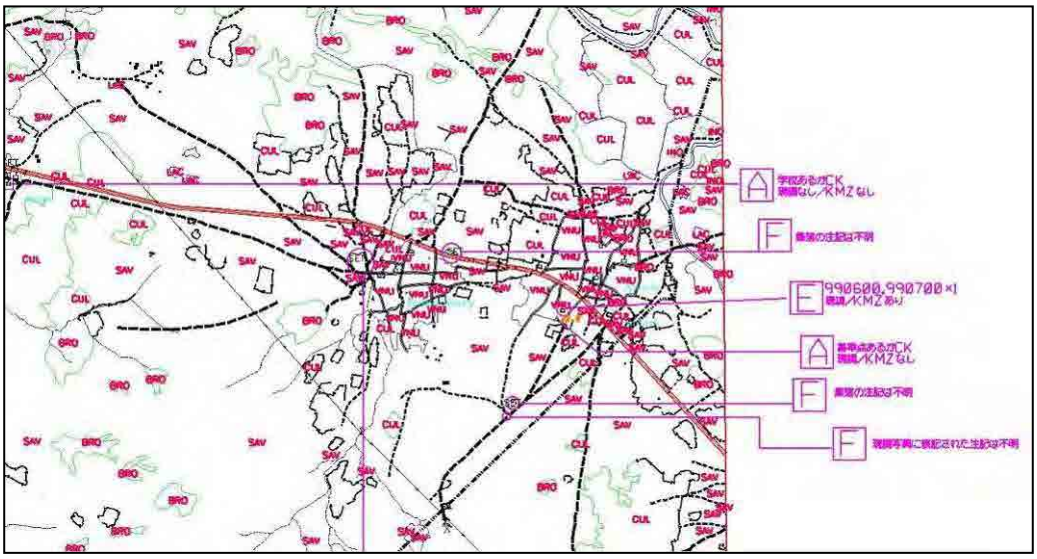


Figure 2-11 Digital Compilation Results

[Digital Compilation after Field Verification]

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

➢ Specifications

- Compilation scale : 1/50,000
- Compilation area : 29,477 km^2
- Number of maps to be compiled : 54
- Map framework : East-west 15' (about 26.8 km), north-south 15' (about 27.7 km)

➢ Equipment Used

CAD used for compilation : MicroStationV8 (Bentley)

➢ Digital Compilation after Field Verification

The digital compilation after field verification was carried out using the field verification results.

1) Road track data (for identifying village names)
2) Field verification results

➢ Details

1) Reflection of road track data (for identifying village names)

The tracks of vehicles moving in the field during the field verification were recorded by GPS receivers. The data surveyed on these tracks including the names of villages was used to enter village names that were previously unknown.

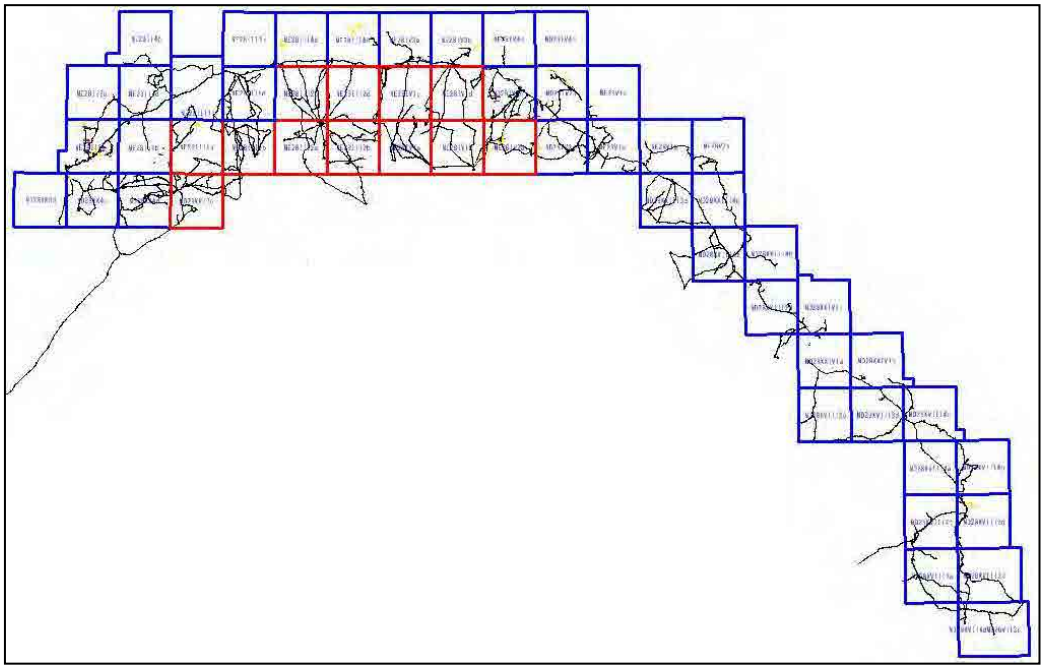


Figure 2-12 Road track data

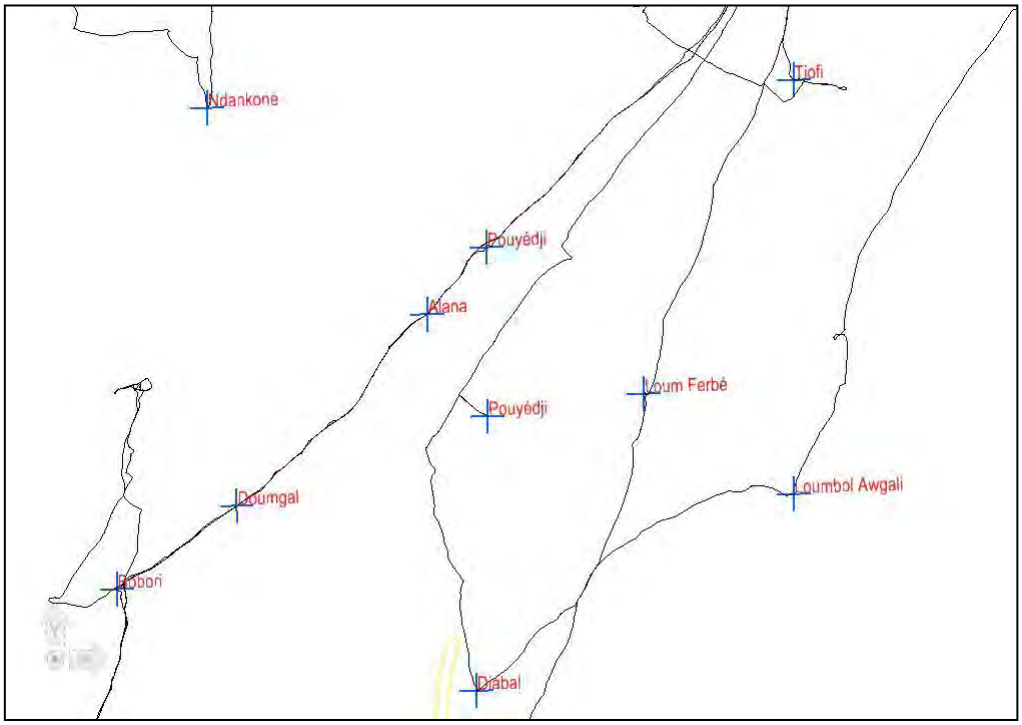


Figure 2-13 Road track data (enlarged)

2) Entry of other field verification content

Features were corrected in line with the results of verification of the checkpoints in the digital compilation.

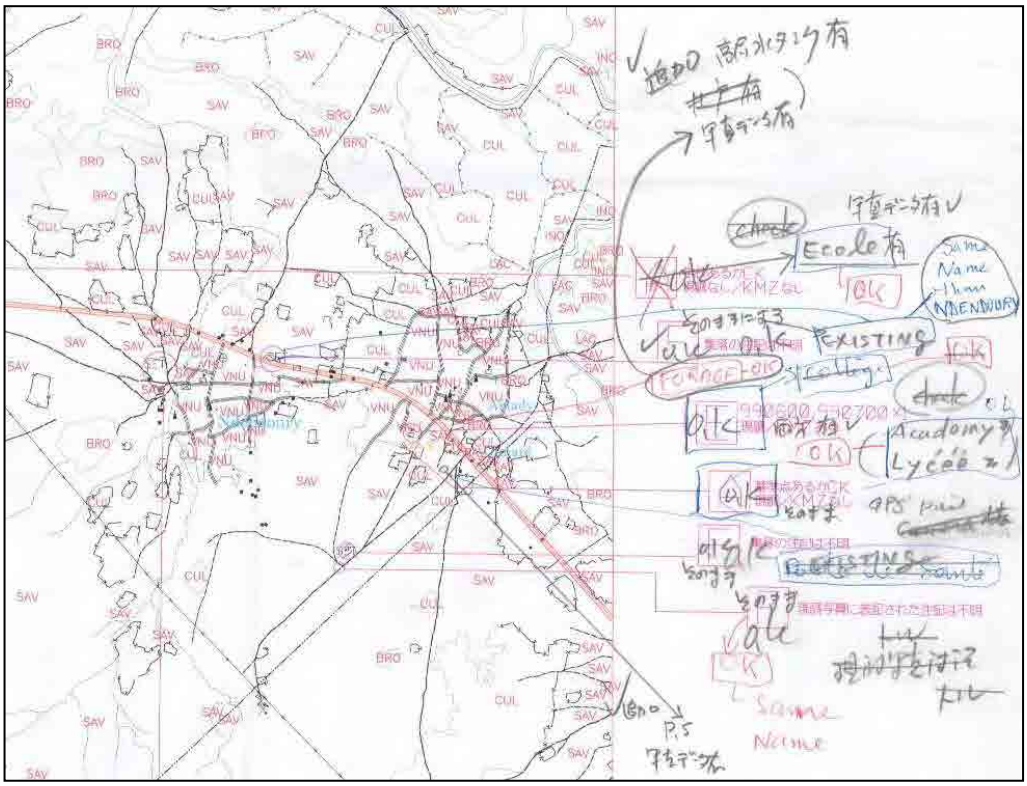


Figure 2-14 Results of verification of checkpoints

➢ Results of Digital Compilation after Field Verification

The digital compilation after field verification data was created in Bentley MicroStation V8 (DGN format).

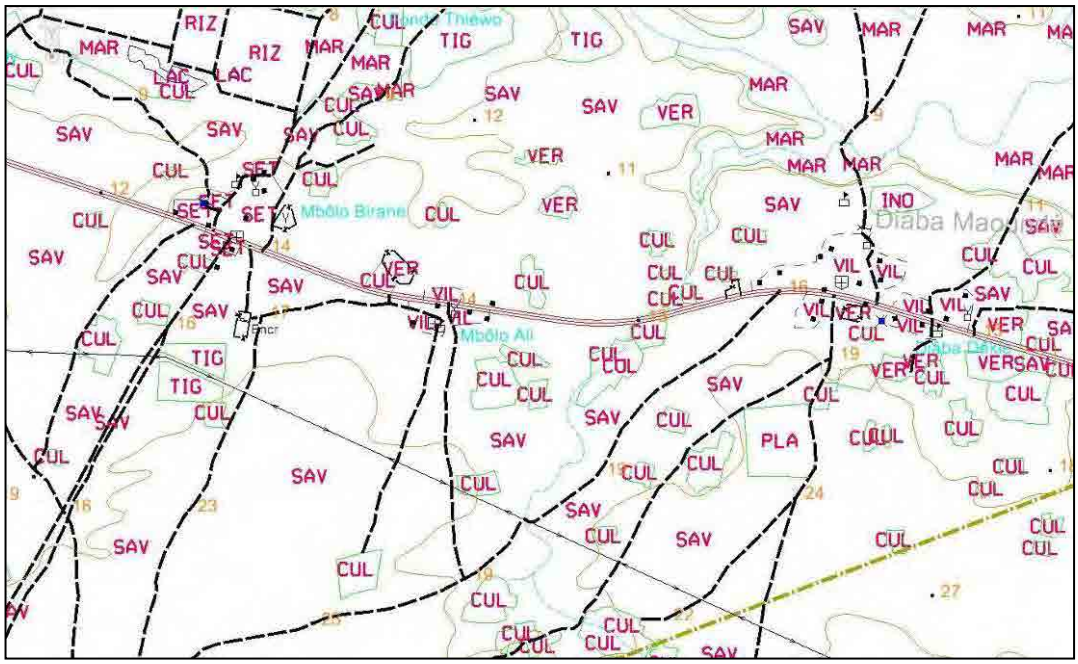


Figure 2-15 Results of digital compilation after field verification

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.

- Line connection : Checking and amending of disconnecting part of line edge
- Undershoot : Checking and amending of a part of line miss-reached to the other lines
- Overshoot : Checking and amending of a part of line intersects with the other line

- Node processing : Processing generated node at the line intersection of line crossing
-

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. Since a polygon is structured by other object elements, point elements, which specify the field objects such as savanna, cultivated land and or so within territory created polygon, must be acquired. After creating a polygon, visual checking for the items mentioned below such as matching of these objects classification.

- Duplication of polygon : Existence of duplication with other polygon
- Gap of Polygon :Existence of gap of adjacent polygon at the interspace of polygon
- Classification Alignment : Existence of polygon without allocation of field objects

[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.

Specification

- File format : SHAPE file
- Attribute Information : Name, classification code. Others (refer to symbol specification)
- Data Plat Unit : Department unit (9 plat)
- File Unit : 1 SHAPE file per 1 symbol
- Geodetic Coordinate System: ITRF2000
- Projection : UTM（Zone28North）
- Reference Ellipsoid :GRS80
- Coordinate Unit : Meter

2.10 (14) Map Symbolization (Work in Japan)

➢ Specifications

- Map symbolization scale : 1/50,000
- Map symbolization area : About 30,000 km^2
- Number of maps symbolized : 54
- Map framework : East-west 15' (about 26.8 km), north-south 15' (about 27.7 km)

- Equipment Used

- CAD for map symbolization	: MicroStationV8 (Bentley)
	: Bentley MAP (Bentley)
- Creation of symbolized map data	: Adobe Illustrator (Adobe)

- 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

- Details

1) Structurization for map symbolization

The data was processed to create geometric structures according to the map symbol specifications in order to conduct map symbolization and create the GIS data.

① Line connection and node generation

The connection of the features to be linked was checked and corrections were made as required. Nodes were generated at the intersections of features required to create planes.

② Plane creation

Lines to be used for features requiring plane creation were selected, and the planes were created.

2) Creation of marginal information

Using the old maps as reference materials, a marginal information plate was created based on the results of discussions with ANAT.

3) Map symbolization

Features were symbolized according to the map symbol specifications.

- Map Symbolization Results

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

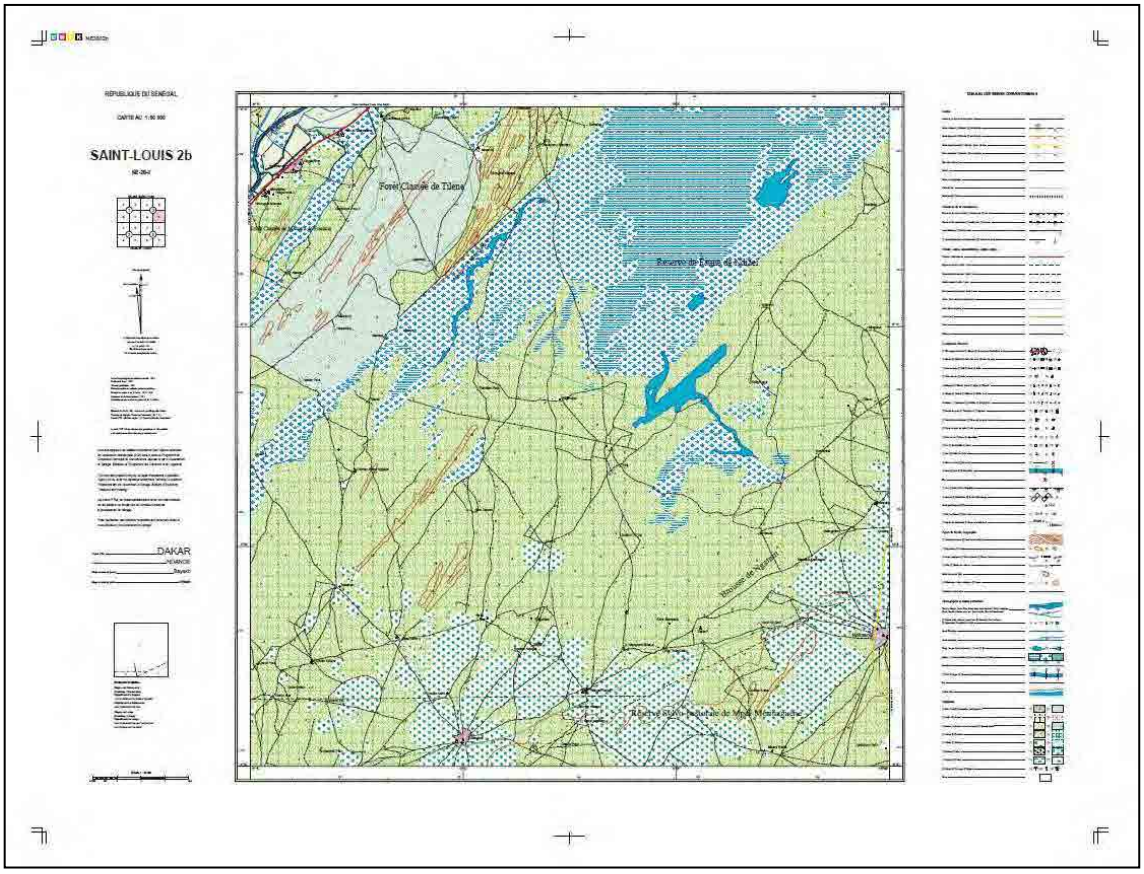


Figure 2-16 Topographic map with symbolization completed

[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 2-9 Quality Control Sheet

Sample quality control sheet			Digital plotting,Data compilation/Symbolization			Quality control sheets			Checked Date :	20/Jul/2011	
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	NE28II2a		50,000	619.605K㎡		AERO ASAHI CORPOARATION ASIA AIR SURVEY CO., LTD.					
Item	**Missing**	**Error**	**Item**	**Missing**	**Error**	**Item**	**Missing**	**Error**	**Item**	**Missing**	**Error**
Roads			**Building symbols**			**Vegetation**			**Marginal information**		
Classification	0	0	Classification	0	0	Form of boundary	0	0	Sheet Name/No.		
Form	0	0	Position	0	0	Classification of symbol	0	0	District name		
Road institutions			**Accessory objects**			**Annotation**			Neat & Grid Line		
Tree row	0	0	Classification of symbols	0	0	Administration name			Coordinates Value,etc.		
Railways			Position of symbols	0	0	Park name			Scale Bar/Map symbol		
Classification	0	0	Form of lines	0	0	River , Lake name			Sheet index		
Form	0	0	**Geodetic points**			Building name			Sheet History		
			Classification	0	0	Place ground name			Planning / Executing Org.		
Electric , Telephone supply			Value	0	0	Road name			Others		
Classification	0	0	**Contour Lines**			Railway name			Connection between adjacent sheets		
Form	0	0	Classification	0	0	Geodetic points name				0	0
Administrative Boundaries			Value	0	0	Government office name					
Classification	0	0	**Natural features**			School neme					
Form	0	0	Classification	0	0	other annotation					
Fences			Form	0	0						
Classification	0	0	**Water features**								
Form	0	0	Classification of symbol items	0	0						
Buildings			Position of symbol items	0	0						
Classification	0	0	Form of line items	0	0						
Form	0	0	Flow direction	0	0						

For each of the planimetric features, the number of omissions, mis-entries, 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. Regarding the data file separation was topographic map data of each sheet and GIS basic data of each department unit. In addition, 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. The team has implemented the Website structuring work both in Japan and Senegal as described below.

【Policy for the structuring of the Website】

While the Website to be constructed in this study is to be equipped with the functions to introduce the 1/50,000-scale topographic maps to its users and to allow users to download the maps and display them on screen (to enlarge, reduce and change a display area by dragging the mouse and to show/hide a specific layer), it is not to have the analytic functions of the GIS or an on-line sales function.

The Website is to be created by combining several open-source systems which can be used as free software packages.

【First Phase Work in Senegal: May - June 2011】

The Study Team verified the state of the infrastructure development on the Senegalese side and the various types of equipment owned by the ANAT and collected data required for a study on the contents to be provided on the Website in the first phase work in Senegal.

In this fieldwork, the Study Team confirmed the conditions of the facilities of the ANAT by inspecting the facilities and conducting interviews with staff members and also conducted a survey of the computer stores and data communication service providers in Dakar City. The team decided to use the results of the study to establish a policy on the hardware to be used for the structuring of the Website, technologies to be used in the software composing the Website and the contents of the site.

The table below shows the items and descriptions of the study.

Table 2-10 Study items and descriptions

Study item	Description
System	A study on the various types of equipment in the Agency of National Land Management.
Data management	A study on the management of data and other contents of the Website
Social environment	A study on such items as the state of infrastructure development concerning the social environment in Senegal

The Study Team confirmed the existence of the basic conditions required for the structuring of the Website in Senegal in this study. However, the team found that the current conditions in Senegal do not meet the standards of developed countries for such items as the availability of the communication network, communication speed and the reliability of power supply. Therefore, specific consideration was required for the selection of the contents of the Website. The data capacity of the Website appropriate for the above-mentioned conditions was among the subjects of the consideration. In addition, the counterpart organization of this study, the ANAT, did not have an expert in data processing. For these reasons, the Study Team concluded that not only the contents but also the technologies to be used and the functions to be installed on the Website should be limited to simple and basic ones.

Meanwhile, the Study Team concluded that they should have discussion on the selection of the server and the establishment of the Website approximately one year after the commencement of the project as

the team expected a concrete figure of the size of the data to be put on the Website to emerge by then.

【Second Phase Work in Senegal: April 2012】

During the second phase work in Senegal, the Study Team held discussion with the counterpart (C/P) organization, the ANAT, on the contents to be provided on the Website on the basis of the results of the study conducted in the previous work in Senegal and finalized the specifications of the contents.

The Study Team explained how the contents of the Website, including its design and functions, should work on the Website to the C/Ps using the draft plan which the team prepared in advance and discussed the specifications for the contents with the C/Ps. The C/Ps approved most of the contents of the draft plan after the discussion. However, the ANAT made requests mentioned below on the draft plan.

- The expression, "DTGC," shall be replaced with "ANAT" depending on the works.
- A message from the Director General of the ANAT shall be added on the page, "About ANAT".
- All the legend information shall be displayed on the page, "Geospatial Information: Printing Map Data Download".
- French shall be used on the entire Website.
- A page, "Topographic and Geodetic Survey," shall be added to the Website.
- A function to display metadata shall be installed on the Website.

The Study Team revised the draft plan for the contents of the Website by incorporating the above-mentioned requests and held discussion on the revised plan with the ANAT side. After the discussion, the ANAT side approved the contents of the Website in the revised plan.

The Study Team also studied the specifications of servers for the Website structuring to confirm the compatibility of the servers with the technologies to be used on the Website and its contents.

It had been decided before the second phase work in Senegal to create the Website using a server rented from a private company on the basis of the results of the previous studies. Immediately after the arrival in Senegal of the Study Team for the second phase work in Senegal, the ANAT informed the team of the server hosting service provided by the ADIE (*Agence de l'Informatique de l'Etat*: State Agency of Informatics), which had been developing an Internet network in the government, in the work meeting. Therefore, the Study Team studied the facilities of this agency before studying rental servers from private companies.

The table below shows the items confirmed in the study and the findings of the confirmation.

Table 2-11 Confirmation items and results

Confirmation item	Confirmation result
Location of the ADIE	The office of the ADIE is located in a newly developed area outside the city about 20-minute drive from the ANAT.
Contents of the server service	■ The Server of the ADIE is installed in a newly constructed solid building. ■ The office of the ADIE has backup-batteries and a private electric power generation system as backup power sources. ■ The building is equipped with an air-conditioning system for

	the temperature management. ■ The door to the room in which the server is installed has a lock.
Specifications for the hardware	Although the ADIE has one server installed in its office at present, it plans to install additional servers. The following show the specifications of the existing server. ■ OS: Linux ■ CPU: Details unknown (reportedly a high-performance CPU) ■ HDD: 113 GB (on the server itself) and 160 TB (in the external memory composed of SAN: storage area network) ■ Memory: 16GB ■ Server software: Apache ■ Communication speed: 20 MB (There is a plan to increase the speed up to 100 MB.)
Acquisition of a new domain	One has to apply for the acquisition of a new domain.
Charge on the use of the server	There will be no charge for the server hosting fees with the use of "xxxx.gov.sn" as a domain name.
Maintenance of Websites	The ADIE does not upload or maintain contents of any Website. In principle, the only service which the ADIE provides is provision of a storage site of a Website. The ANAT will have to bring archive data including the map data and upload it to the site by them.

The result of the confirmation suggested that the conditions of the installation and the use of the servers of ADIE are favorable for creating a Website of the ANAT. The confirmation also revealed that the ADIE provided server-hosting services to other Senegal government offices. After having taken these facts into consideration, the Study Team recommended the use of the ADIE server for the structuring of the Website to the ANAT.

[Third Phase Work in Senegal: January - March 2013]

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. Then, the team explained to the ANAT engineer in charge of the website how to operate and maintain the website, and transferred the technologies required for the operation and maintenance of the website, as preparation for his presentation on the website in the final seminar.

The activities carried out in the final review were as follows:

- Updating of the texts and image files on each page,
- Registration of structured data and configuration of the settings to display the information in the list of planimetric features,
- Adjustment of the symbols represented on maps
- Preparation of metadata
- Registration of data for download (in Shape file and PDF file formats).

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

【Work in Japan】

The Study Team is creating the Website following the pre-determined specifications in the following order:

1. Creation of a draft layout of each Webpage;
2. A study on data to be put on the Website;
3. A study on functions to be installed on the Website;
4. Creation of a page frame of each Web page; and
5. Implementation of the Website

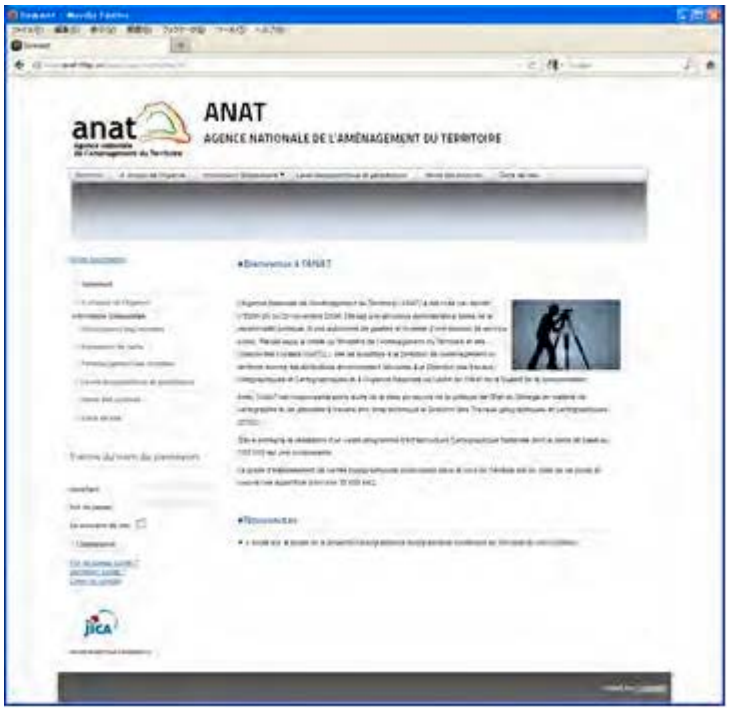
The table below shows the technologies used in the software components of the Website and the details of the contents.

Table 2-12 Items and description of the Website

Item	Description
Data to be put on the Website	■ Structured data (Shape file format of ESRI) ■ Topographic map data (PDF file format of Adobe)
Data browsing	■ The GIS function allows Website users to display structured data by layer, move through the data and display enlarged and reduced data.
Data download	■ Password authentication protocol is required for the data download. ■ The administrator of the Website issues passwords in a user registration system.
Software composition	■ GeoServer Ver2.2.2 (Mapping engine) ■ OpenLayers (Web client library) ■ Joomla! Ver2.5.8 (Content management system)

It was finally decided to create the Website on a rental server of a private company rented by the ANAT, instead of the ADIE server, whose use had been approved provisionally in the second work in Senegal. However, as it had later been revealed during the course of the work that it was impossible to create WebGIS on the server concerned, it was decided to rent another rental server of a private company and created the Website on this server.

The outlines of the page compositions of the webpages on the Website are shown on the following pages.



■ Top page

Brief introduction of the ANAT and the DTGC and new information will be displayed on this page.

■ A page to explain important matters

The policy and the points of note on the management of the site will be described on this page.

■ About the ANAT and the DTGC

Introduction of the ANAT and the DTGC, description of their activities and the greeting messages from their representatives will be displayed on this page.

■ On the spatial information (structured data)

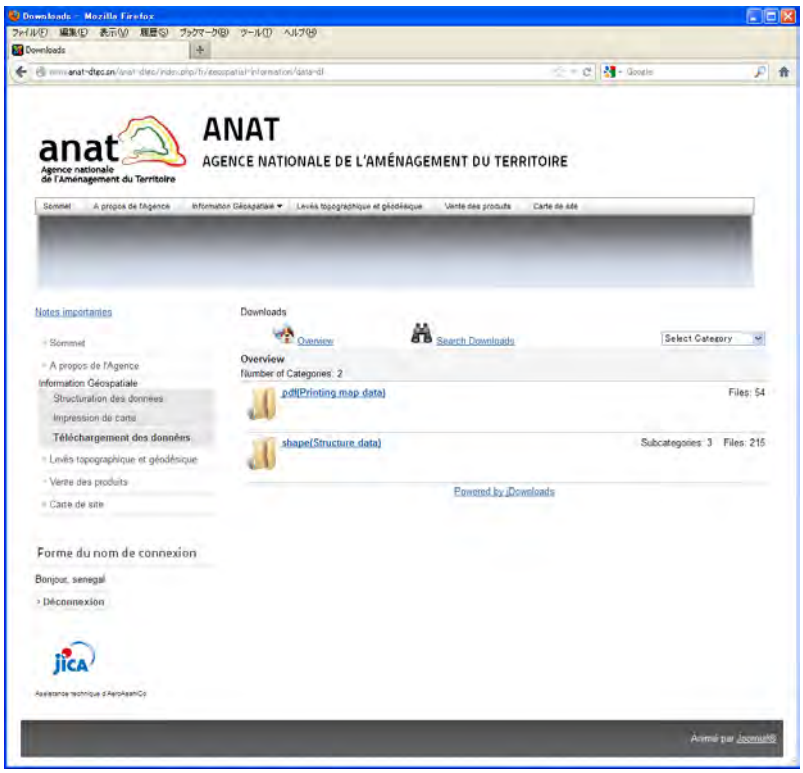
To display the structured data (in Shape file format of ESRI) for browsing.

■ On the spatial information (structured data)

For the downloading of the structured data (in Shape file format of ESRI).

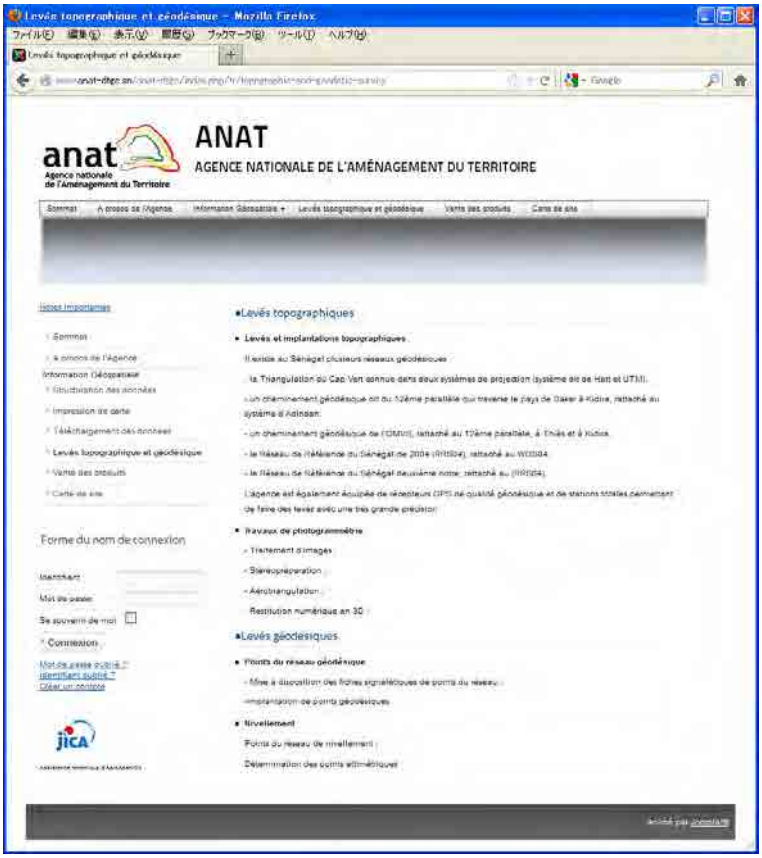
■ On the spatial information (topographic map data)

The availability of the topographic map information (in PDF file format) will be displayed on this page.



■ On spatial information (Data download)

A page allowing the download of structured data (in the ESRI Shape file format) and geographic map data (in the Adobe PDF format)



■ On topographic and geodetic surveys

The service activities in the topographic and geodetic surveys will be described on the page.

■ On the existing maps

Information on the creation and sales of various types of the existing maps will be provided on the page.

■ Site map

A site map of this Website.

Figure 2-18 Composition of 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 procedure required for creating new products easier and more transparent for persons or organizations intending to do using or modify converting the acquired topographic maps 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) Seminar for the Promotion of Data 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) Internal 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 measures for responding to 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 Data Utilization/Structuring of System of Usage**."

To achieve outputs (1), (2) and (4) above, it was determined that the activities listed in Table 2.13-1 should be carried out.

Table 2-13 Outputs and corresponding activities relating to the structuring of a system of usage and the promotion of utilization

Output	Activities
1. Internal 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. Examples of actual use shall be gathered and made public.	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 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 2.13, the work in Senegal was implemented in four phases, in accordance with the schedule shown in Table 2.14

Table 2-14 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 Study Team prepared a draft internal rule on the approval of secondary use of the above-mentioned digital topographic maps and digital orthophotos (Document 5). The team will have to urge the ANAT to authorize the rule in accordance with its internal procedure so that this draft rule can be enforced as an official internal rule.

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.
- The Study Team asked the C/Ps to give lessons on topographic maps at junior secondary schools. The purpose of this activity was to make the C/Ps aware of the impact of the educational activities concerning topographic maps on young people by observing students of junior secondary schools who do not use the maps in their daily life listen to the lecture earnestly. This activity marked the beginning of the practical activities for expanding the range of the use of the maps.

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

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. 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 1-4 in Table 2-13 has been achieved.

(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 2-15. 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 ANAT 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 2-15 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	4,000	15,000	

maps (former series)			
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 2-16 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 2-16 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 maps (paper) (Former series)	7					2	9
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 2-19). 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.

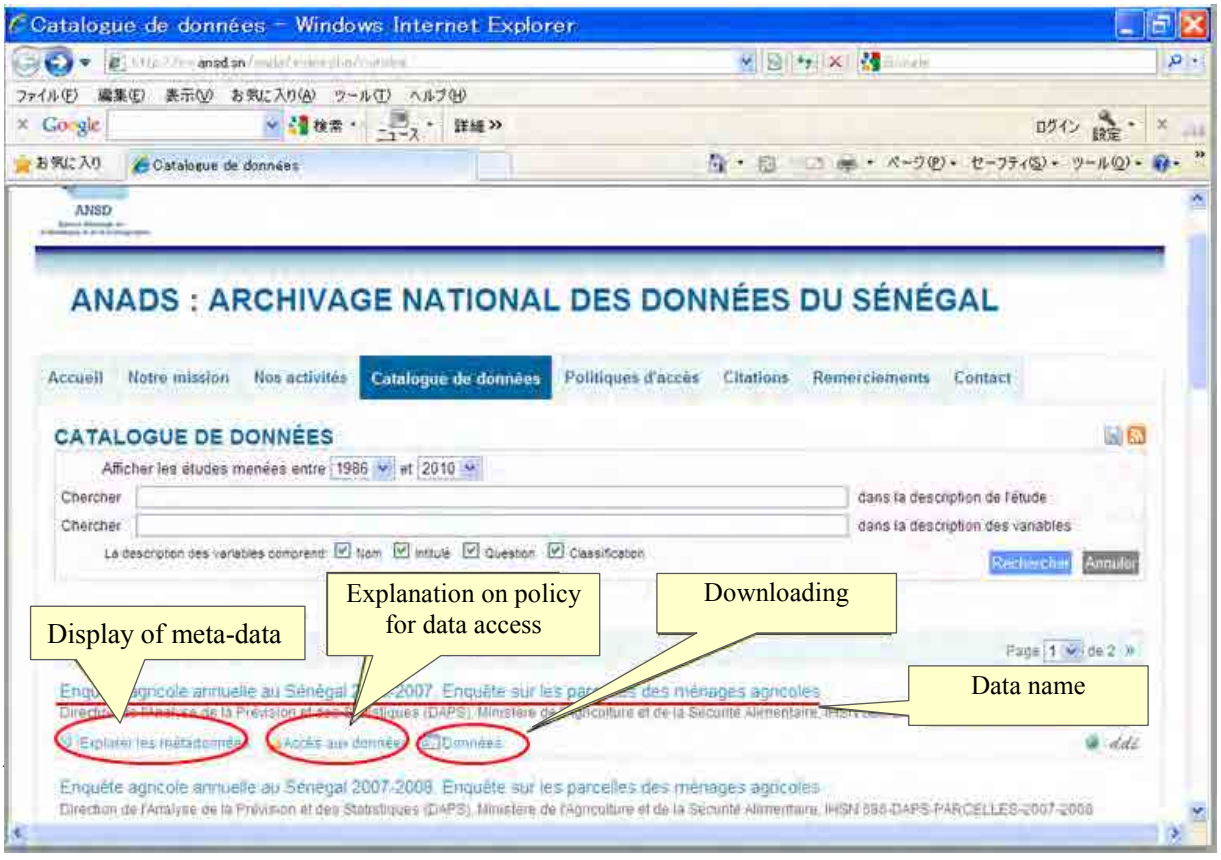


Figure 2-19 Statistical data archive site of the Statistics and Demography Agency

(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 2-17. 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 2-17 Pricing and handling of copyright for maps created by national mapping organizations in major countries

Country	Pricing	Copyright handling	Recent changes
Japan	・ Amount equivalent to cost (printing and distribution) + copyright ・ Free download of basic map information	・ 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.	・ Free supply of Fundamental Geo Spatial Data was started in 2008.
U.S.	・ Free download of digital maps ・ Supply of paper maps for the amount equivalent to cost (printing and distribution)	・ Products made by the federal government are copyright-free. ・ No restriction is imposed on secondary use.	
U.K.	・ Fair price setting according to the Competition Law	・ Strict copyright control is imposed. ・ Data is supplied and secondary use permitted by license agreement.	・ Free supply of many kinds of data was started in 2010 (OS Open Data). ・ The complex license agreement has been simplified.
France	・ 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	・ Aerial photos are copyright-free (but orthophotos are copyrighted). ・ Data is supplied and secondary use is permitted by license agreement.	・ Basic map information RGE is available for free download for public and educational purposes.
Germany	・ 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	・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 products 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 products, 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 Project Outputs End User License," "Procedure for the Supply of Project Outputs," and "Price Calculation of 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 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 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 2-18).

Photo 2-18 Meeting with ANAT executive director (From left to right, the director-general, secretary general, Mr. Maruyama, DTGC director)

The draft rules (Document 5) defined the project outputs to be covered (Table 2-18), 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 2-18) and it was assumed that no fee would be collected for a license for secondary use.

Table 2-18 Proposed prices of project outputs Unit: FCFA

Percentage of maintenance costs (Ratio to prices) / Project outputst type	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-sharpen ortho images (CD-R)	2,500	2,800	5,000	7,500
1/50,000-scale pan-sharpen 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 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 structuring 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). A technical cooperation project for the establishment of this NSDI supported by the Government of Canada is in progress (for the period between January 2009 and July 2013) and the seven working groups established in accordance with the government ordinance are working on the establishment of the NSDI (Table 2-19).

Table 2-19 Activities of the working groups of the GICC

Name of the working group	Main activities
National Geospatial Information Planning	・The working group is to formulate a plan aiming at the establishment of the optimal and sustainable framework for the management of natural resources and the environment in the territory of Senegal with the establishment of standards for the geospatial information and the foundation for human resource development in the area of geospatial information. ・The principle of the use of geospatial information shall be incorporated harmoniously in the economic and social management system in order to achieve sustainable development of the country.
Education and Training	・The group is to develop a training program which provides the members of the organizations concerned and the GICC with the same knowledge on geospatial information in order to develop capacity of the experts in the areas essential for the implementation of the geospatial information plan. ・The training course for policy makers and training trainers was already implemented on January 16th, 2012.
National Geospatial Information Database	・The aim of the group is to create a database which enables combined use of different types of geospatial information by integrating the existing geospatial information data in such a way that the geospatial information can be utilized in the optimal condition. ・The group is studying policies on the definitions of the methods for the use of the database, ways to ensure its sustainability and delivery of the data through intranet and the Internet.
Geospatial Information Inventory	・The group is to create awareness of the availability of geospatial information in Senegal and the standards, formats, reference coordinate system, cost and rights of use of the information among public organizations, the private sector and the people. ・The group is to create awareness of the projects on geospatial information (projects for education and training, acquisition of satellite imagery and data acquisition).
Senegalese Geodetic Reference System	・The groups is to integrate the existing control points and instruct data users to use the new coordinate system when they implement surveys in order to promote the use of the national geodetic reference system established in 2004.
Publicity	・The group is to extend the use of geospatial information in the central and local government offices.
Pilot Project	・The group is to formulate pilot projects.

The assistance is being promoted using the framework of GICC such as those work groups stipulated by the ordinance to cover the geodetic reference system, the national geospatial information plan and popularization of the national geospatial information plan. The relevant government organizations that are currently engaged in activities through these work groups are shown in the table below.

Table 2-20 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 2-21. 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 2-21) were interested in the structuring 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 2-21 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	・ 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	・ 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	・ 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	・ 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	・ 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)	・ 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	None	・ Questionnaire survey on the number of villages. The directorate intends to count	Visited on July 4, 2011

Organization name (○ indicates an organization wanting to use the provisional data)	Introduction of GIS (Software/Number of users)	Overview	Remarks
(Direction des Collectivités locale)		the number of villages using maps and municipal boundaries.	
Directorate of Cadastre (Direction de Cadastre)	Unknown Owning two LPSs	・ 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	・ 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	・ 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	・ 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	・ Urban planning, urban management and structuring 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/Erdas	・ 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 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))	ArcGIS Five	・ The public corporation for agricultural promotion of the Senegal and Faleme rivers, which was established in 1965.	Visited on April 23, 2012
○ 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 project outputs and thus contribute to the promotion of their

use through the accumulation of examples of the use of project outputs 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).

- Ecology Monitoring Center (Centre de Suivi Ecologique, CSE)
- Senegal River Delta and Senegal and Falémé River Valleys Land Development Corporation (Société d'Aménagement et d'Exploitation des terres du Delta et du fleuve Sénégal et de la Falémé, SAED)
- Guiers Lake Water Authority (Office du Lac de Guiers)
- Ministry of Health (Ministère de la Santé et de la Prévention)

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

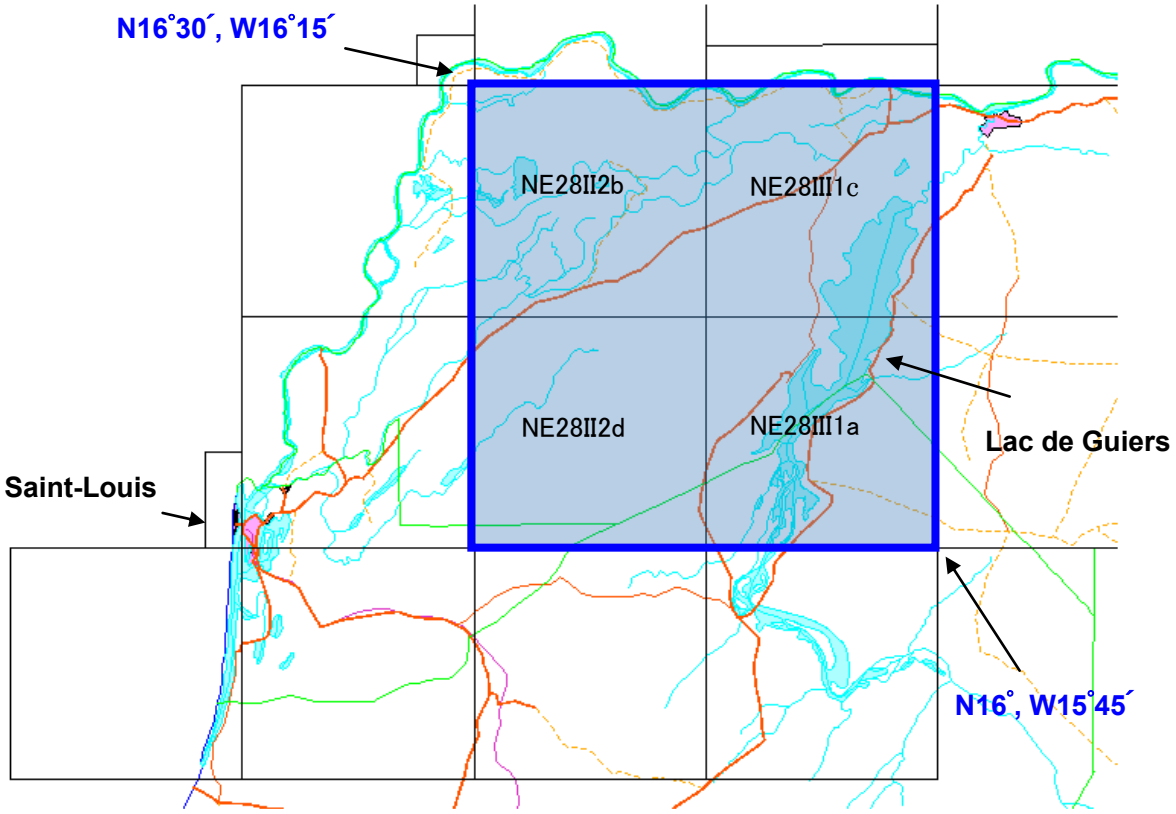


Figure 2.20 Range of loaned interim outputs (area enclosed in blue frames)

Figure 2-19 Loaned pan-sharpen 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. The themes for the cases of the data use were as follows:

- Guiers Lake Water Authority (OLAG): A risk map of the pollution caused by agricultural activities near Guiers Lake
- Ecology Monitoring Center (CSE): Detailed land cover classification using the ALOS orthophotos
- Ministry of Health (Ministère de la Santé et de la Prévention): Coordination in progress
- Senegal River Delta and Senegal and Falémé River Valleys Land Development Corporation (SAED): Distribution of farmers and types of vegetables which they grow

(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 Project outputs. 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 structuring, 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 was 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 JSMAP?" 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 2-20 "Geomatics Day" seminar

Photo 2-21 DTGC 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 2-22 Exhibits

Photo 2-23 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

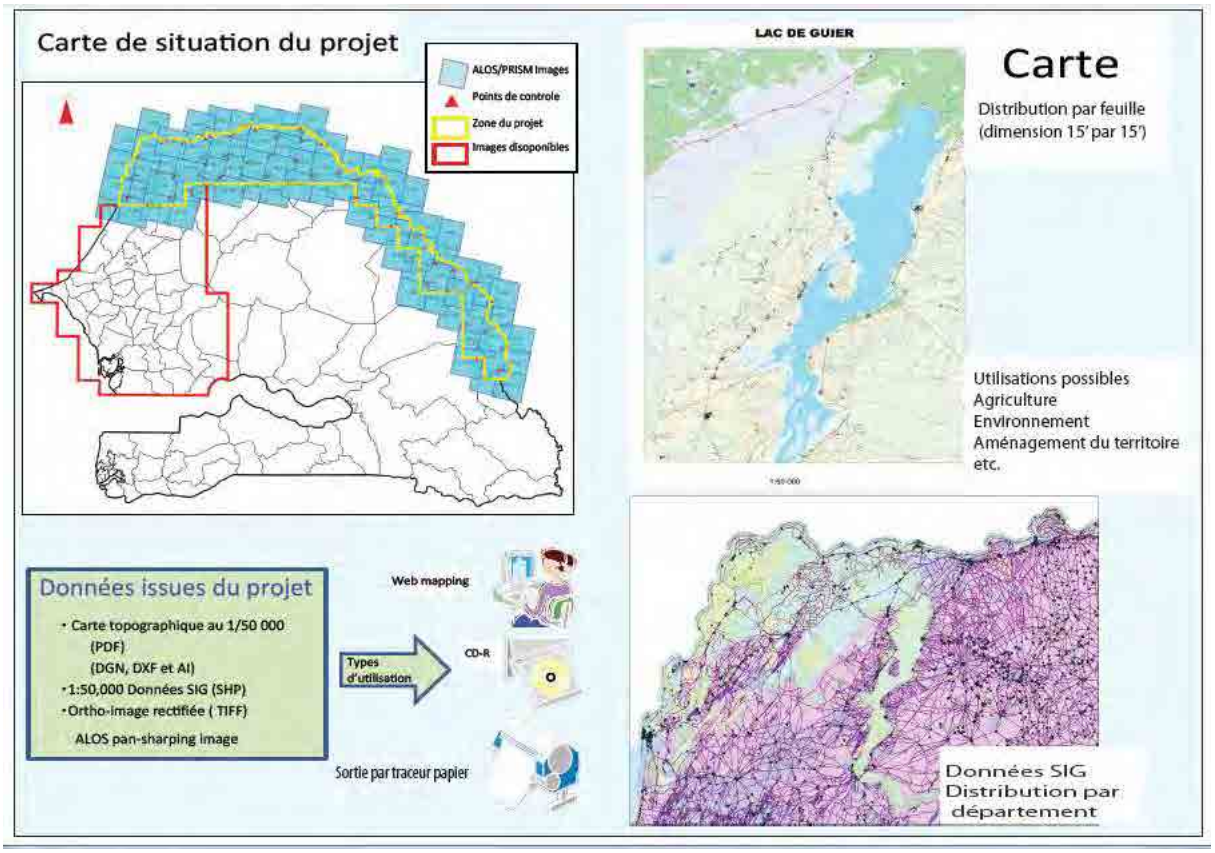


Figure 2-21 Page from the pamphlet presenting the outputs of JSMAP created by the C/Ps

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 2-22 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 distribution of copies to colleges and secondary schools	A pamphlet will be created which explains JSMAPs and 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)

<u>* Interview Survey of Ordinary Citizens and Young People</u>

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.

<u>* Interview Survey at Ministry of Education</u>

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 3ème 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 2-24 Classroom where a visiting lesson was given

Photo 2-25 Visiting lesson (right, ANAT staff member: Left, secondary school teacher)

Photo 2-26 ANAT staff member delivering a lecture

Photo 2-27 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 2-23 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 2-28 Students listening to the presentation on maps

Photo 2-29A 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 2-30 Final Seminar

[Program of the Seminar for Senior Officials]

SEMINAIRE DE FIN DU PROJET DE CARTOGRAPHIE TOPOGRAPHIQUE NUMERIQUE DANS LE NORD DU SENEGAL
« JSMAP »

Hôtel King Fahd Palace, Dakar
Mardi 19 février 2013

Programme

09h00 - 09h20 : Mise en des invités

09h30 : Démarrage du Séminaire sous la Présidence du Directeur général de l'ANAT représentant le Ministre de l'Aménagement du Territoire et des Collectivités locales

09h30 à 10h20 : Allocutions d'ouverture
09h30 à 09h40 : allocution du Gouverneur de Matam au nom des Gouverneurs invités
09h40 à 09h50 : Allocution du Chef de Bureau de la JICA
09h50 à 10h05 : Allocution du Chargé d'Affaires ad interim de l'Ambassade du Japon
10h05 à 10h20 : Allocution de Monsieur Mamadou DJIGO représentant le Ministre de l'Aménagement du Territoire et des Collectivités locales

10h20 à 10h30 : Inauguration du site de diffusion par internet : JSwebMAP
par Monsieur le Chargé d'Affaires ad interim de l'Ambassade du Japon
et
par le représentant du Ministre chargé de l'Aménagement du Territoire

10h30 à 11h00 : Pause café

11h00 à 12h20 : Introduction de JSMAP et ses applications
11h00 à 11h10 : Présentation des grandes lignes du projet JSMAP par le Chef de projet
11h10 à 11h25 : Cartographie comparative des parcours pastoraux par interprétation d'images
Landsat et ALOS par le Centre de Suivi Ecologique
11h25 à 11h40 : Apport du SIG à la santé : cas du projet JSMap par le Service de l'Information
sanitaire du Ministère de la Santé.
11h40 à 11h55 : Cartographie des zones à risque de pollution agricole: Office du Lac de Guièr
11h55 à 12h10 : Utilisation des données JSMap dan s le système de suivi-évaluation de la SAED par la SAED.
12h10 à 12h20 : Promotion de l'utilisation des produits JSMAP par l'ANAT

12h20 à 12h50 : Discussions

12h50 à 13h00 : Mot de clôture par le Directeur général de l'ANAT représentant le Ministre chargé de l'Aménagement du Territoire

13h00 à 14h00 : Déjeuner

Table 2-24 List of invited guests

1	Director General of Investment Promotion and Major Projects (APIX S.A.), Dakar
2	Chief Representative, JICA Senegal Office
3	Chief of the Delegation of the European Union in the Republic of Senegal - Dakar.
4	Director of the National Information Agency
5	Director of the Senegal River Basin Development Authority (OMVS)
6	Mr. Resident Representative of the World Bank in the Republic of Senegal
7	Chief of Cooperation of the Canadian International Development Agency in the
8	Chief of the general corp of Defence Staff.
9	Director General of the Millennium Challenge Account - Senegal
10	Director of the Municipal Development Agency
11	Director of the Rural Development Agency
12	President of the National Order of Surveyors of Senegal
13	Director of Debt and Investment - DDI, Ministry of Economy and Finance
14	Governor of the region of Matam
15	Governor of the Region of St. - Louis
16	Governor of the Region of Tambacounda
17	President of the Regional Council of Matam
18	President of the Regional Council of St - Louis
19	President of the Regional Council of Tambacounda
20	General Director of the National Institute of Pedology
21	General Director of Planning
22	General Director of the SAED
23	General Director of the French Development Agency (AFD) - Senegal
24	General Director of the Agency for Road Management (AGEROUTE)
25	General Director of the Centre for Ecological Monitoring (CSE)
26	Director of the Experimental Center for Equipment Research and Studies (CEREEQ)
27	General Director Affairs and Territorial Administration of the Ministry of the Interior
28	General Director of the Economic and Financial Cooperation (DCEF), Ministry of
29	Director General of the General Directorate of Taxes and State-owned Property
30	President of the Executive Council of Urban Transport of Dakar (CETUD)
31	Director of the Municipal Development Agency (ADM)
32	President of the National Office of Sanitation of Senegal (ONAS)
33	Chairperson of Dakar Regional Council
34	Director of Reform and Educational Planning, Ministry of Education

35	Leader of the National Health Information , Ministry of Health
36	Director of Urban Planning and Architecture
37	Chairman of the Executive Council of Urban Transport of Dakar (CETUD)
38	Director General of the Directorate of Land Transport, Dakar
39	Director General of the Directorate of Civil Protection (Fire Fighting)
40	Director General of the Directorate of General Affairs and Facilities, Ministry of Land
41	Director of Land Transport
42	Mr. Director of the Cadastre - Directorate General of Taxes and State-owned Property
43	Director of Roads
44	Executive Secretary of the National Local Development (PNDL)
45	Director of Mines and Geology
46	Director of Water, Forest and Hunting and Soil Conservation.
47	Director of the Management and Planning of Water Resources
48	Director of the Laboratory for Teaching and Research in Geomatics - LERG, ESP -
49	Coordinator, Senegal, the Senegal River Basin Development Authority (OMVS)
50	Leader of the Faculty of Arts and Humanities at the University Cheikh Anta Diop,
51	Mr. LO Ale, President of the Union of Associations of Local Elected
52	Project Leader Mr. Databases Urban - IGN FI
53	Director General of the Directorate of Local Governments (DCL)
54	Director General of the Directorate of Land Development Strategy
55	Director General of the Directorate of Assistance for Rural Development
56	Head of the Department of Geography, Gaston Berger University, Saint-Louis
57	Project Manager of the National Project on the Geographic Information Technology of
58	Head of the Department of Civil Engineering, Thiès University
59	Ziguinchor Regional Office, National Agency for Land Development
60	Kolda and Sédhiou Regional Office, National Agency for Land Development
61	Fatick, Kaolack and Kaffrine Regional Office, National Agency for Land Development
62	Saint-Louis Regional Office, National Agency for Land Development
63	Louga Regional Office, National Agency for Land Development
64	Matam Regional Office, National Agency for Land Development
65	Thiès and Diourbel Regional Office, National Agency for Land Development
66	Dakar Regional Office, National Agency for Land Development
67	Tambacounda and Kédougou Regional Office, National Agency for Land Development

[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 JSMAP. 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.

[Program of the Technical Seminar]

Atelier technique interne ANAT du Projet de Cartographie topographique numérique dans le Nord du Sénégal

Salle de conférence de l'ANAT sise à la DTGC
Mercredi 20 février 2013

Programme

09:30 Ouverture

Allocution d'ouverture : Directeur Général de l'ANAT

09:40 – 11:20 Introduction de JSMAP et ses applications

09:40 – 10:00 Affichage WebMap et système de téléchargement: Ing. IT, ANAT

10:00 – 10:10 Transfert de technologie dans le projet: Equipe JSMAP

10:10 – 10:30 Transfert de technologie (Travaux sur le terrain):Diatta ANAT

10:30 – 10:50 Transfert de technologie (Aérotriangulation, Traçage stéréo et compilation): Awa Ndoye - ANAT

10:50 – 11:20 Discussion

11:20 – 11:40 Pause Café

11:40 – 12:40 Démonstration de Photogrammétrique Workstation : LPS

12:40 – 12:50 Discours de clôture par le Chef de projet JSMAP

12:50 - Déjeuner

Photo 2-31Opening session

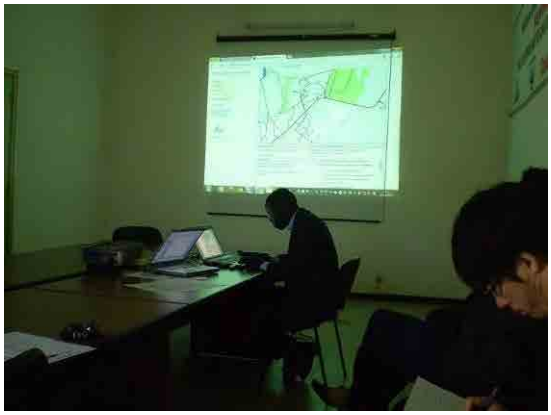


Photo 2-32 Presentation on Web maps

Photo 2-33 Presentation on the Technology Transfer (aerial triangulation)

Photo 2-34 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-sharpen 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.

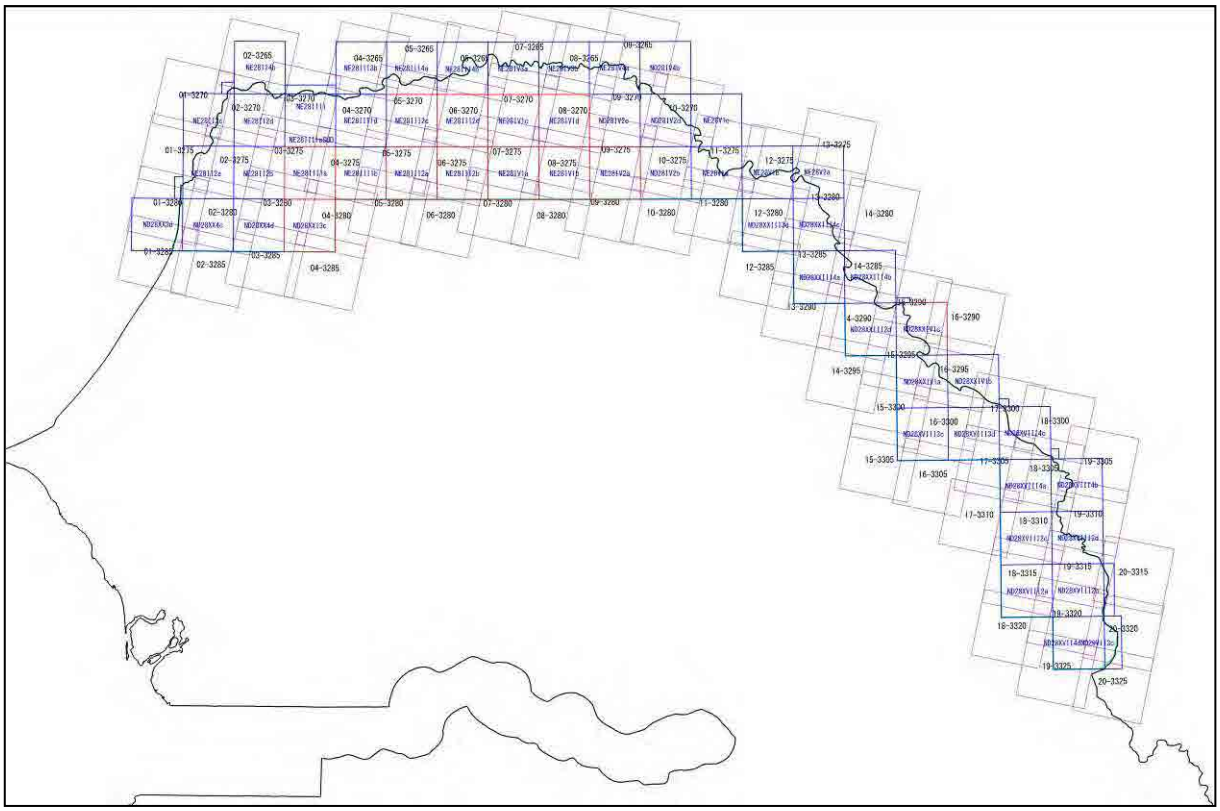


Figure 2-21 Ortho photo grid reference

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