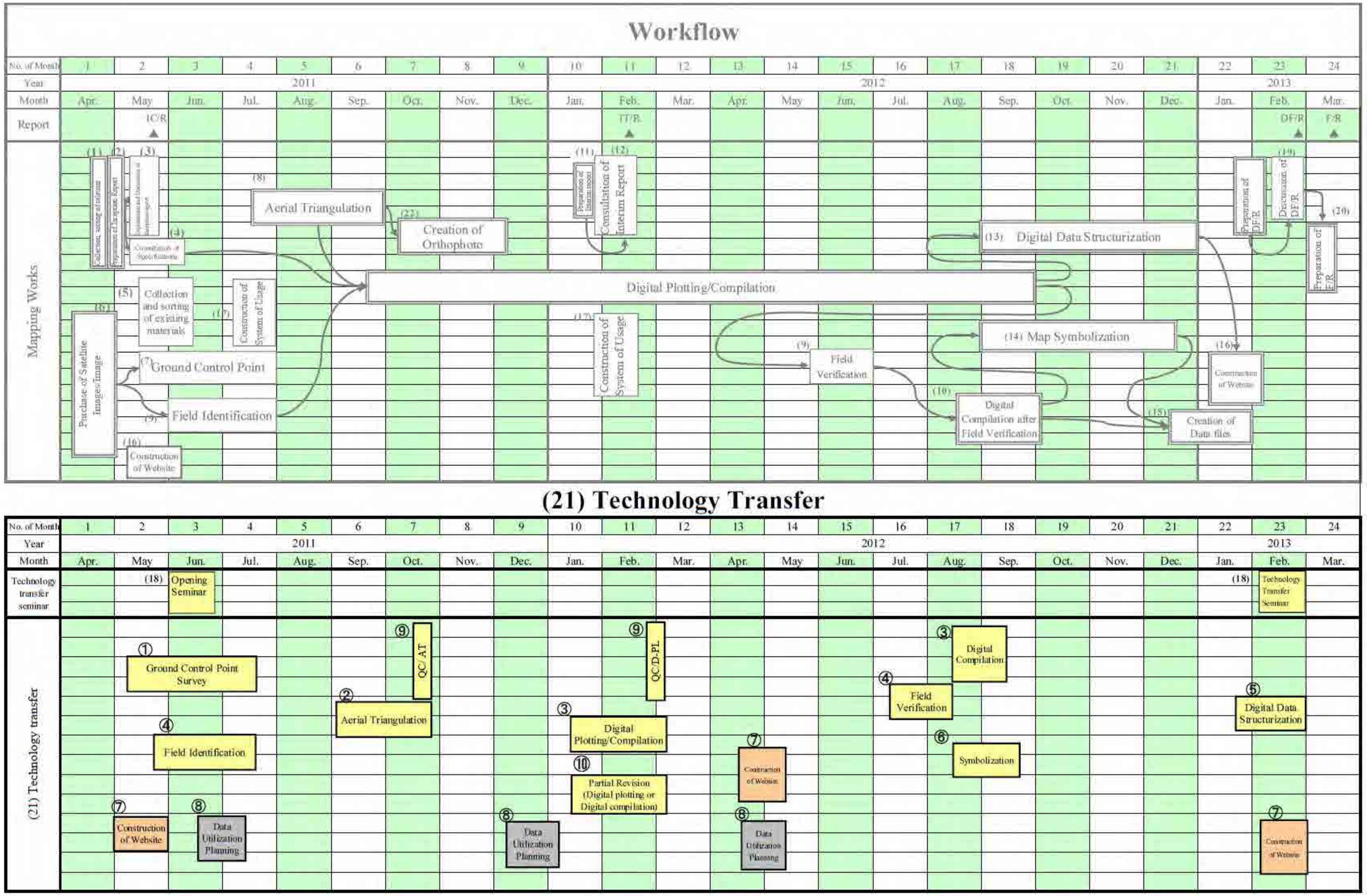
Chapter 3 (21) Technology Transfer

The table below shows the implementation of technology transfer in comparison with the plan. The details are given in the text.

Table 3-1 Technology transfer work



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

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

(1) The technology transfer should enhance the capability of the ANAT of Senegal to create and update of topographic maps independently.

(2) The digital topographic maps and other outputs that have been created are applied as geospatial information, and promote the efficient progress of the national development plan.

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

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

Table 3-2 Description of technology transfer work

No	Technology transfer work	Description	Method of transfer
①	GCP survey	・ Selection of GCPs ・ GNSS survey ・ Pricking ・ Pricking point register ・ Quality (accuracy) control	Each process learned through OJT
②	Aerial triangulation	・ Aerial triangulation of satellite images ・ Aerial triangulation for digital plotting and orthophoto data creation ・ Quality (accuracy) control ・ Creation of work manuals	Each process learned through OJT
③	Digital plotting/digital compilation	・ Reconfirmation of map symbols of small-scale topographic maps ・ Appropriate data classification of acquired data ・ Extraction of unknown and obscure parts ・ Input of collected data (administrative boundaries and names, road classifications, etc.) ・ Quality (accuracy) control ・ Creation of work manuals	Each process learned through OJT
④	Field identification/Field verification	・ Creation of identification key ・ Survey and summary of extracted unknown and obscure parts	Each process learned through OJT
⑤	Digital data structurization	・ Structurization of topographic data ・ Creation of database ・ Quality (accuracy) control ・ Creation of work manuals	Each process learned through OJT
⑥	Map symbolization	・ Operating procedures for symbolization software ・ Creation of data in accordance with the map symbol specifications ・ Layer management ・ Quality (accuracy) control ・ Creation of work manuals	Each process learned through OJT
⑦	Structuring of Website	・ Understanding of system in use ・ Update and upload of partial correction data ・ Map data management method ・ System maintenance method ・ Creation of work manuals	Each process learned through OJT
⑧	Promotion of Data	・ Workshops/seminars for promotion of utilization	Each process

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

3.1 (21) Technology Transfer

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

3.1.1 ① GCP Survey

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

[Selection of GCPs]

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

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

[GNSS Survey Method]

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

Photo 3-1 Teaching how to set up a tripod

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

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

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

[Baseline Analysis Procedure]

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

[Net Adjustment]

In the same way as for the baseline analysis, a lecture was given at ANAT using an operations manual created by Leica Geo Office (LGO), and this helped the ANAT staff actually carry out this process using software installed in the PCs. In addition, the ANAT staff acquired basic knowledge of GNSS and geodetic survey through the net adjustment and the final output report (Appendix 7).

[Pricking of GCPs]

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

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

[Summary of GCP Output]

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

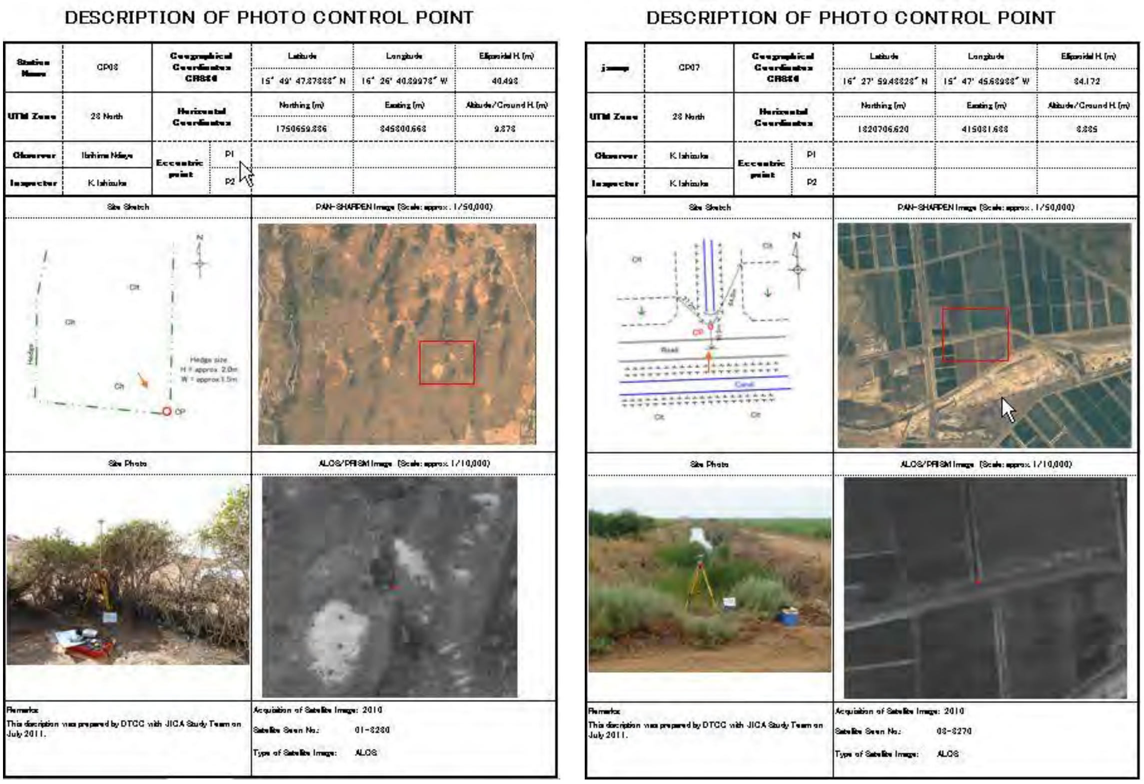


Figure 3-1 Example of explanation of pricking points

Table 3-3 Net adjustment results for GCP coordinates

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

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

3.1.2 ② Aerial Triangulation

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

[Purpose of Work]

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

[Overview of Work]

a) Period

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

- November 8, 2011 to January 26, 2012 (50 days among the period)

b) Trainees

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

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

c) Software Used

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

[Method of Implementation]

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

Photo 3-3 Trainees receive technical training in aerial triangulation

[Description of Implementation, and Results]

- Aerial Triangulation
  - Preparation

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

- Creation of Block Files (Various Settings)

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

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

- Point Measurement Process

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

➢ Tie-point Measurement

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

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

- GCP Measurement

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

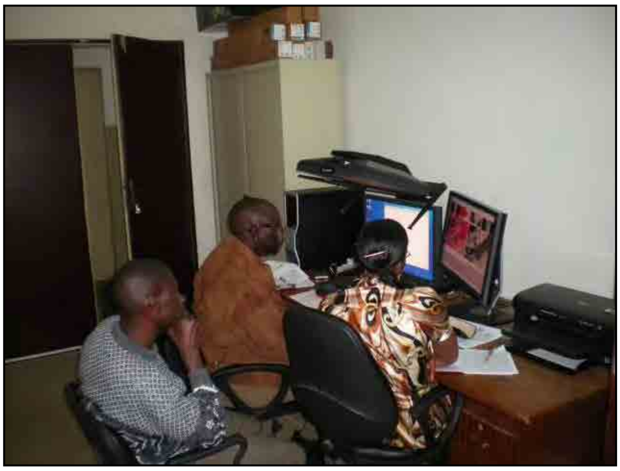
[Calculation Processing and Accuracy Control]

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

[Pan-sharpening]

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

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



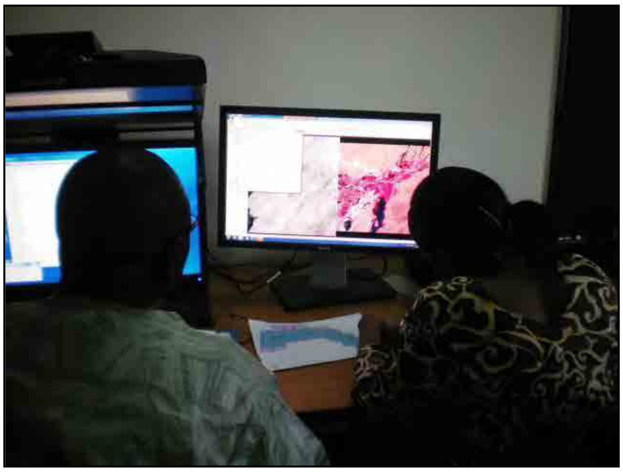


Photo 3-4 Technical training in pan-sharpening

[Implementation of Aerial Triangulation Using Supplied Images]

The purpose of technology transfer in this project is to enable the ANAT to create and update 1/50,000-scale topographic maps of the western area of Senegal on its own. ALOS images of the western area (about 45,000 km^2) were also supplied. Therefore, the Study Team decided to carry out aerial triangulation in the western area in the latter half of the technology transfer, considering that the trainees had more or less mastered the technology for aerial triangulation through the daily practical training. Since no GCP survey had been conducted in the western area, the processes up to the tie-point measurement were implemented in accordance with the processes learned in the first half of the training.

3.1.3 ③ Digital Plotting/Digital Compilation

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

3.1.3.1 Digital Plotting

[Purpose of Work]

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

[Implementation Guidelines]

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

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

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

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

(Questionnaire survey questions)

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

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

Question	c/p-*A*	c/p-*B*	c/p-*C*	c/p-*D*	c/p-*E*	c/p-*F*
Q1	32y	6y	6y	6y	6y	-
Q2	none	none	2y	2y	none	-
Q3	No	3m	3m	Yes	no	-
Q4	-	-	-	GeoView	-	-
Q5	-	-	DEM	-	-	-
Q6	LPS,PRO600	-	LPS,PRO600	Photogrammetry	-	-
Selection status	◎	□	◎	□	◎	□
Selection status: ◎ digital plotting □ digital compilation						

2. Selection of Training Areas

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

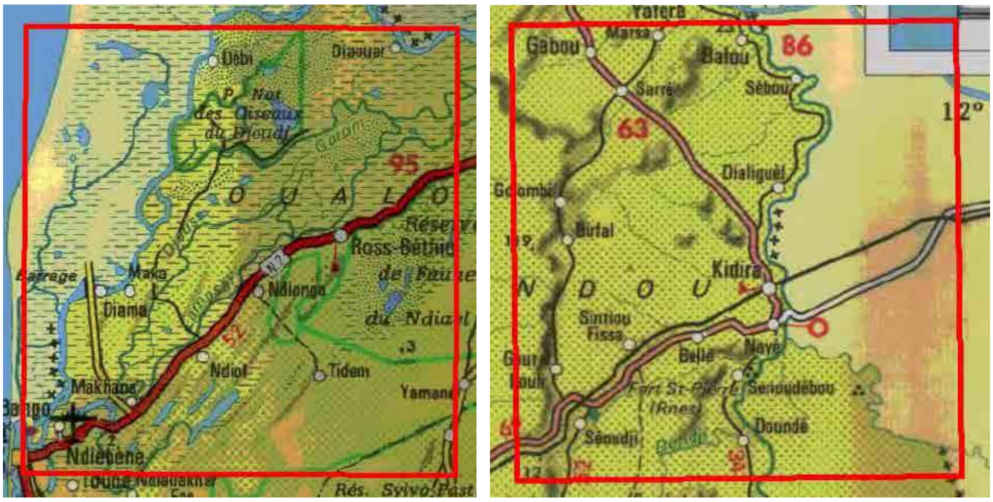


Figure 3-2 Areas near the cities of Saint Louis and Kidira

3. Method of Technology Transfer

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

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

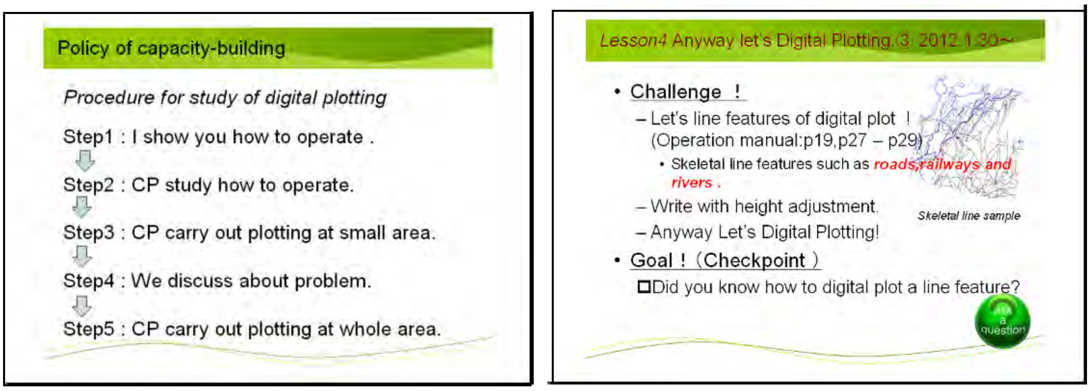


Figure 3-3 Policy for technology transfer and example of individual training material

[Equipment and Main Reference Material Used]

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

<u>1. Equipment Used</u>

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

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

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

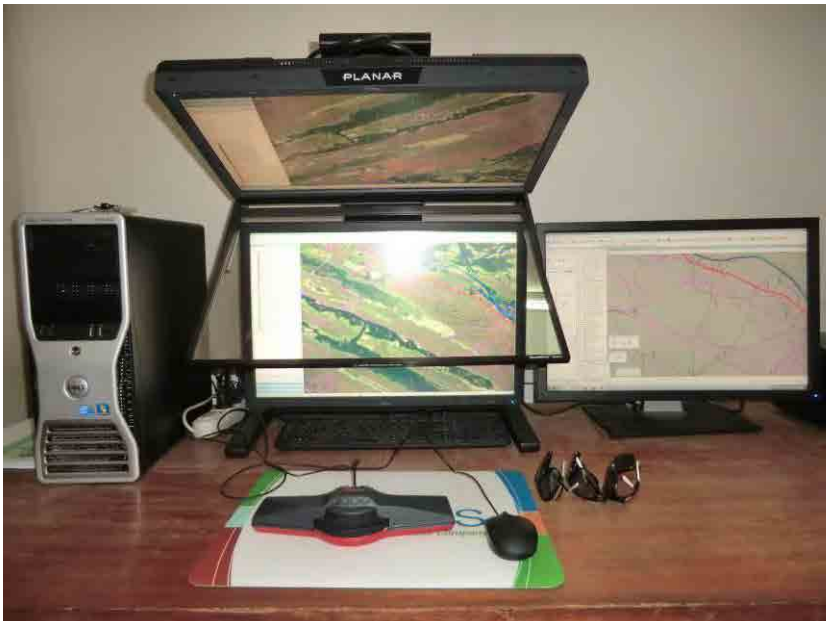


Photo 3-5 Soft-copy plotter used in this work

2. Main Reference Materials Used in This Work

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

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

[Content of Technology Transfer Work]

1. General Explanation of Digital Plotting Work

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

(1) The accuracy of the topographic maps can be ensured by obtaining planimetric features through the placing of a measurement marker (measuring mark) at the appropriate elevation of the feature. Since this requires proficiency, it takes time to obtain measurement values of sufficient accuracy.

(2) The operator needs to obtain topographic features by making predictive decisions in the stereograph interpretation.

(3) The operator needs to have the special skill of being able to pick out planimetric features that match the acquisition criteria while keeping in mind an image of the scale of the map to be created (Long experience is needed as this requires proficiency).

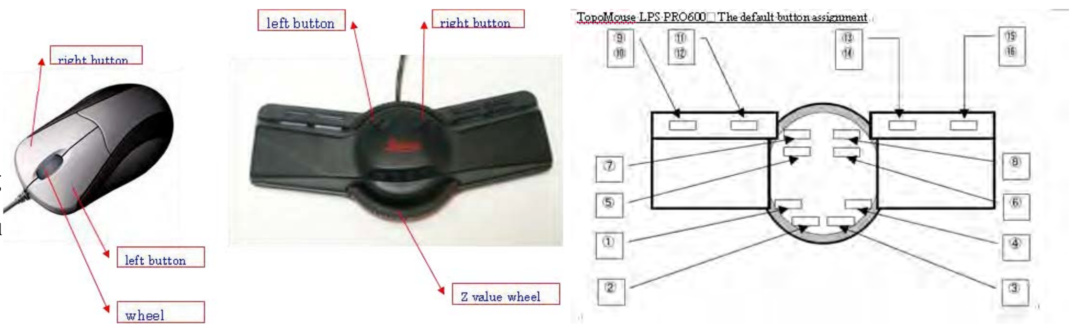
2. Startup and Basic Initial Setup of the PRO600 System

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

3. Explanation of Operation of the TopoMouse System

Using the operating manual and the table of corresponding functions, the Study Team explained how to use the TopoMouse system and the functions of the buttons.

In addition to the functions of an ordinary system mouse, TopoMouse offers individual functions that can be assigned to multiple buttons and used by the operator.



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

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

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

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

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

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

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

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

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

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

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

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

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

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

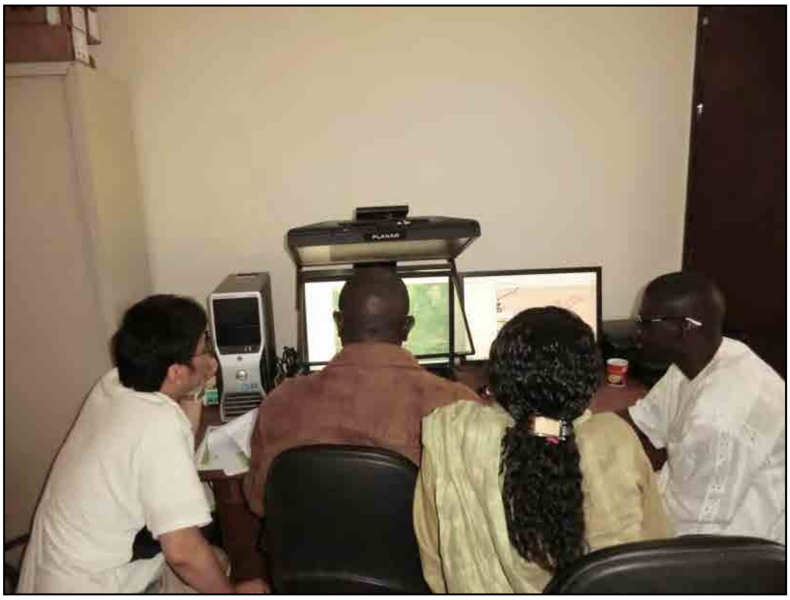


Photo 3-6 Technology transfer in digital plotting

8. Check and Correction of Data Using the PRO600 System

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

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

9. Check and Correction of Plotting Data on Output Maps

The plotting data acquired in the practical training was output on roll paper using a large format plotter (Photo 3-6). Using the output materials, an explanation was given of how to check for omissions in acquisition and misentries, selections and acquisition density balance.

In the practical training, based on the procedure and rules for pointing out problems they were taught how to use leader lines and type symbols according to the content of the problem (Photo 3-7*).

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

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

Photo 3-8 Scene of map inspection by technical trainees

10. Quality Control (Creation of Quality Control Sheet)

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

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

[Map Updating Work]

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

[Content of Technology Transfer Work]

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

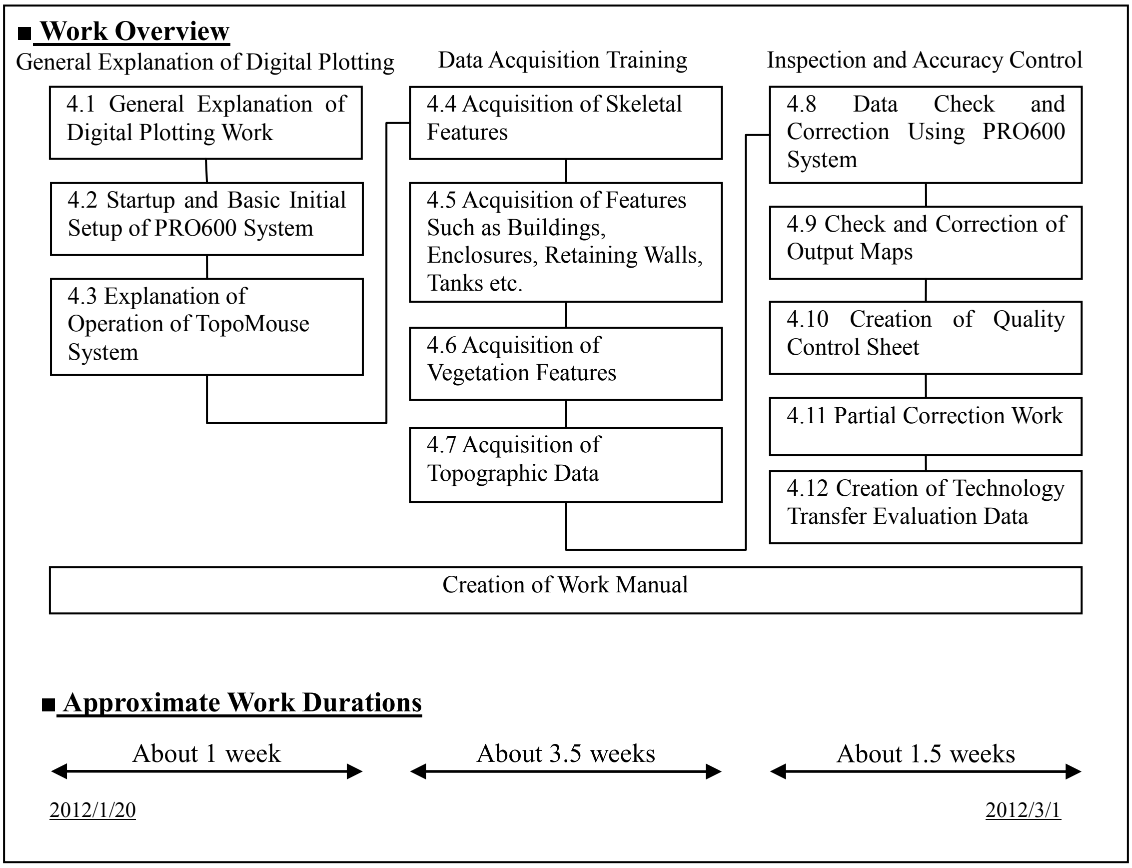


Figure 3-5 Work flow and approximate duration of tasks for technology transfer in digital plotting

3.1.3.2 Digital Compilation

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

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

【Period of technology transfer, and trainees】

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

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

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

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

【Materials used (software)】

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

- MicroStation V8 i
- Bentley MAP V8 i

【Practical content of the technology transfer】

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

<u>a. Understanding of 1:5,000-scale symbol specifications</u>

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

① Any unidentified planimetric feature should be extracted as a survey point of field verification; the worker must not try to interpret the feature, but always verify the feature in the field.

② Close attention must be paid to data type, and any mistakes rectified.

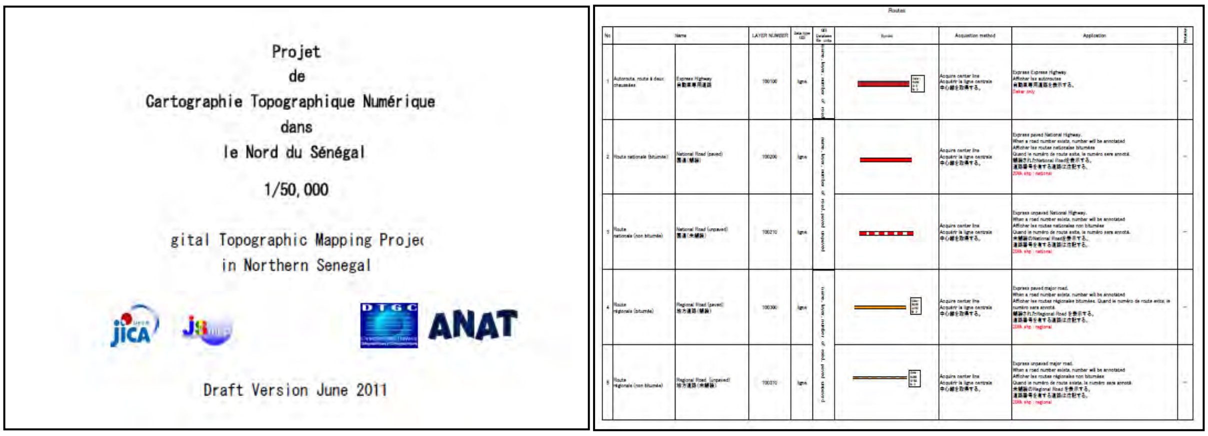


Fig. 3-6 1:50,000-scale symbol specifications (cover) and sample of symbol specifications content

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

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

【Digital compilation configuration technology based on the symbol specifications】

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

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

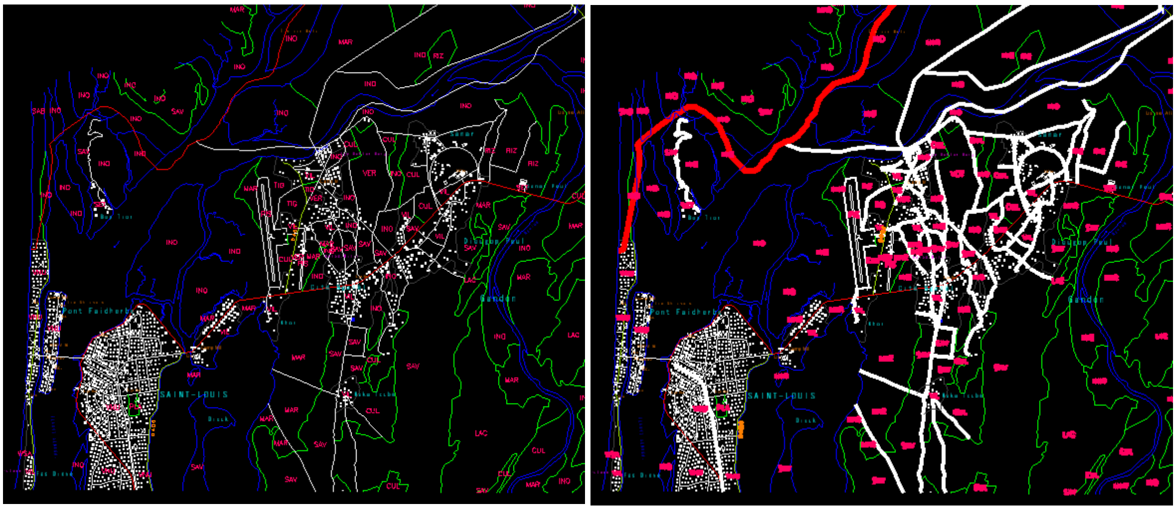


Fig. 3-7 Before and after the setting of line types

【Basic operations needed for digital compilation】

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

- All aspects of tools
- Short-cut function
- Preparation of command files

- Preparation, revision and checking of topology

【Results of technology transfer】

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

- Understanding of the 1:50,000-scale symbol specifications

When faced with an unidentified planimetric feature, the practice has been to deal with it by having the worker make changes to the layer using his own discretion; but with this method there is the danger that it will have an adverse effect on the processes that follow. In cases like this it is necessary to always check with the symbol specifications as the work progresses; the importance of the symbol specifications in cases like this was explained, and the trainees were helped to understand this point.

- Basic skills in operating the digital compilation system software that was introduced

None of the technical trainees had any experience of using V8, but as some time was spent on basic operating skills, there were no problems in the technology transfer of the basic operations. However, it was seen that some trainees were a little bewildered by the arrangement of the tools; the confusion was resolved by using the V8 customization function to change the layout of the user interface to be in keeping with the perceptions of the trainees.

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

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

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

- Basic operations necessary for digital compilation

* All aspects of tools

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

* Short-cut function

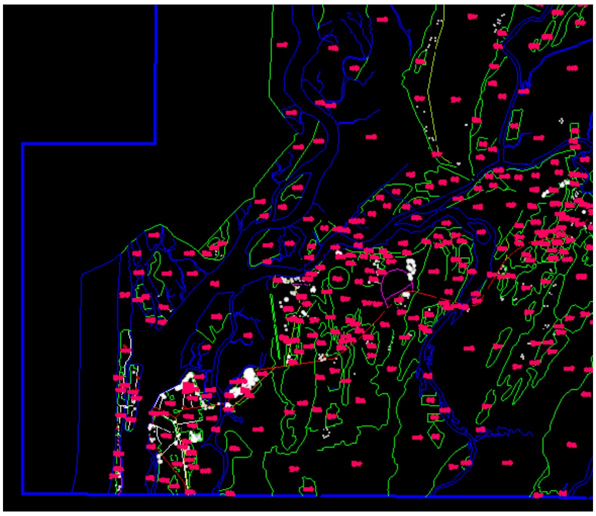
As the ANAT trainees had no experience of using keyboard shortcuts, they were given a demonstration of how to use the mouse and keyboard together and taught through practice how to do this. It is possible to do the work using only the mouse, but combining the mouse with keyboard shortcuts allows for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

* Preparation of command files

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

* Preparation, revision and checking of topology

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



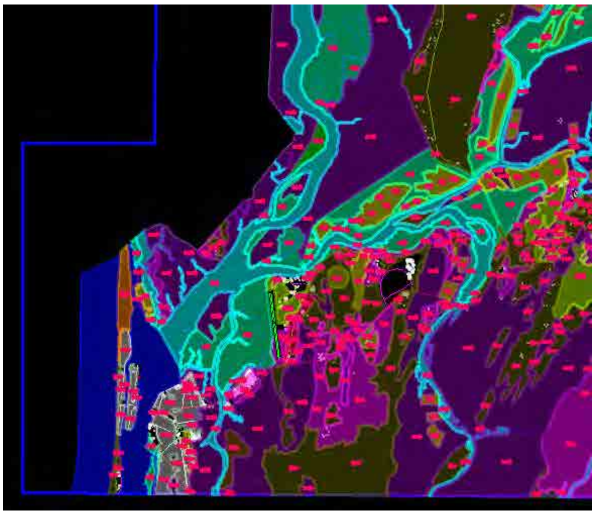


Fig. 3-8 Before preparation of polygons **After preparation of polygons**

Photo 3-9 Trainees carry out practical exercises

3.1.4 ④ Field identification/Field verification

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

【Purpose of the field identification/verification】

1. To confirm in the field any geographical information necessary for subsequent work (digital plotting, digital compilation) that does not show on the photographs (images), and to sort (store) the data.
2. To prepare an instructional interpretation key for deciphering the photographs (images), in order to facilitate the digital plotting.
3. To allow the ANAT trainees to understand and learn the techniques to enable them to update (revise) the data through self-help efforts even after the completion of the original survey.

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

【Instruction given prior to heading out to the field】

① Understanding the difference between satellite images and aerial photographs (color tone, configuration, texture, etc.)

② Confirmation and understanding of selection criteria for applicable map symbol

③ Selection of points to be changed after comparison of existing materials and satellite images, and of illegible points

④ Understanding of how to draw up a work plan conducive to the efficient progress of the work (allocation of the appropriate number of personnel and number of days for the amount of work, troubleshooting, etc.)

【Instruction given in the field】

① Understanding of the importance of confirming the sequence of operations pertaining to implementation of the work

② Understanding of the methods of acquiring data (proper methods of photography using a GPS camera; direction, distance, insertion of map symbol code, etc.)

③ Explanation and understanding of methods of verification in the field of planimetric features etc., that are difficult to interpret

④ Instruction in and understanding of the importance of the interpretation key and how to prepare one

⑤ Instruction in and understanding of how to organize and store the data

【Instruction given after completion of the field identification】

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

【Technology transfer in the field verification】

The ANAT seem to have more or less fully understood the contents of the technology transfer in field verification after a lecture on the basic concepts of field verification and instruction in the field verification work, data storage and data filing in accordance with the specifications provided by the Study Team to the ANAT. It seems that the technology transfer was successfully implemented in general because most of the ANAT staff were engineers with previous experience in field identification. The Study Team used the time before the beginning of the day's field work and during the evaluation meetings held during the time for data filing at the end of the day's work to converse with the ANAT side in order to have as many opportunities as possible for communication with them. The items of technology transfer were as follows:

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

3.1.5 ⑤ Digital Data Structurization

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

[Period of technology transfer, and trainees]

Duration: From 31st January to 15th February 2013

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

[Materials used (software)]

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

[Practical content of the technology transfer]

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

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

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

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

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

2. Structuring of the data

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

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

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

3. Defining projection

The Study Team explained and provided practical training in how to define projection using

ArcCatalog. As the number of feature classes defined in this Project exceeded 200, the team also explained how to carry out batch projection definition.

4. Setting symbols

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

5. Labeling

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

6. Creation of Data for WebGIS

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

As more than 200 Shapefiles were required for the data to be created in this Project, the Study Team also explained how to divide the data in batch using ArcToolbox. Acquisition of a file name using Command Prompt is useful for the creation of a batch. However, the participants had no experience in using Command Prompt. Therefore, the team created a manual on how to use Command Prompt and provided the participants with practical training in using it.

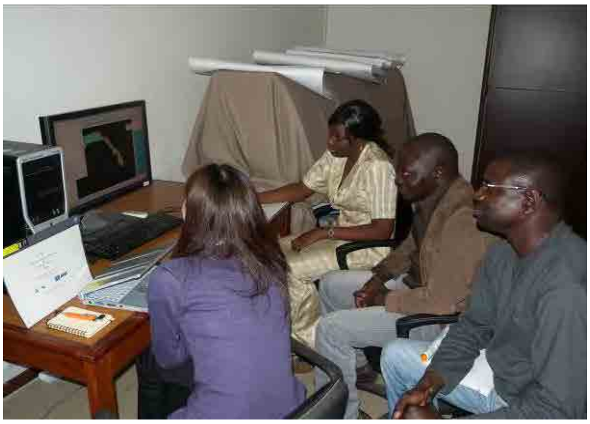



Photo 3-10 Technology transfer on the structuring of digital data

[Results of technology transfer]

The technology transfer achieved the following results:

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

3.1.6 ⑥ Map symbolization

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

【Implementation period and beneficiaries】

The technology transfer in map symbolization was implemented as follows:

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

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

【Equipment (software) used】

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

【Content of the technology transfer】

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

a. Lecture on the printing environment

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

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

b. Basic operation of Adobe Illustrator CS5

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

- How to use the selection tool;
- How to use digital input to draw shapes accurately;
- How to scale up/down, rotate and move shapes;

- How to use the Group, Lock and Hide commands;
- How to paste and draw lines in different ways;
- How to manipulate layers;
- How to create patterns and brushes;
- Etc.

c. Preparation for the map symbolization work

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

- How to register swatch colors (process colors),
- How to create and register vegetation patterns
- How to create and register brush patterns,
- How to create symbol marks,
- How to create a pallet file to be used as a library, and
- How to create a working template file

d. Map symbolization work

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

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

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

Photo 3-11 Technology transfer in map symbolization

【Outputs of the technology transfer】

a. Printing environment configuration

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

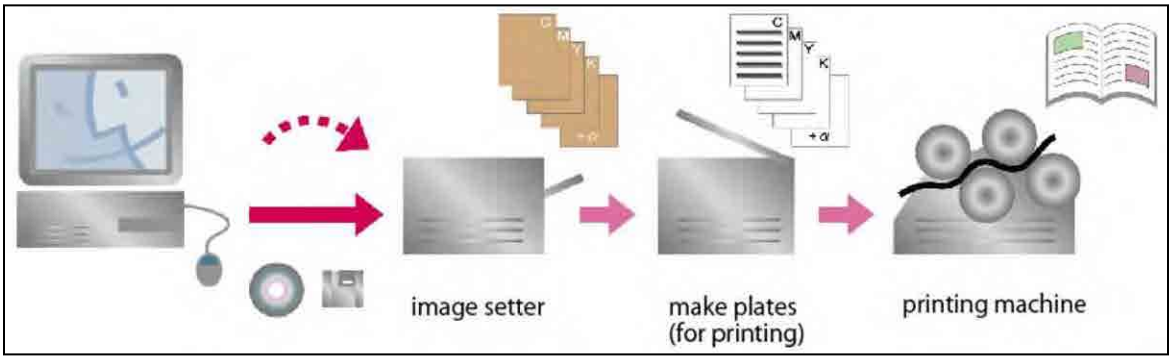


Figure 3-9 Flow of digital data printing

b. Basic Operation of Adobe Illustrator CS5

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

Figure 3-10 DTGC Logo created by a ANAT trainee

<u>c. Preparation for the map symbolization work</u>

* Registration of swatch colors

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

* Creation of a pallet file

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

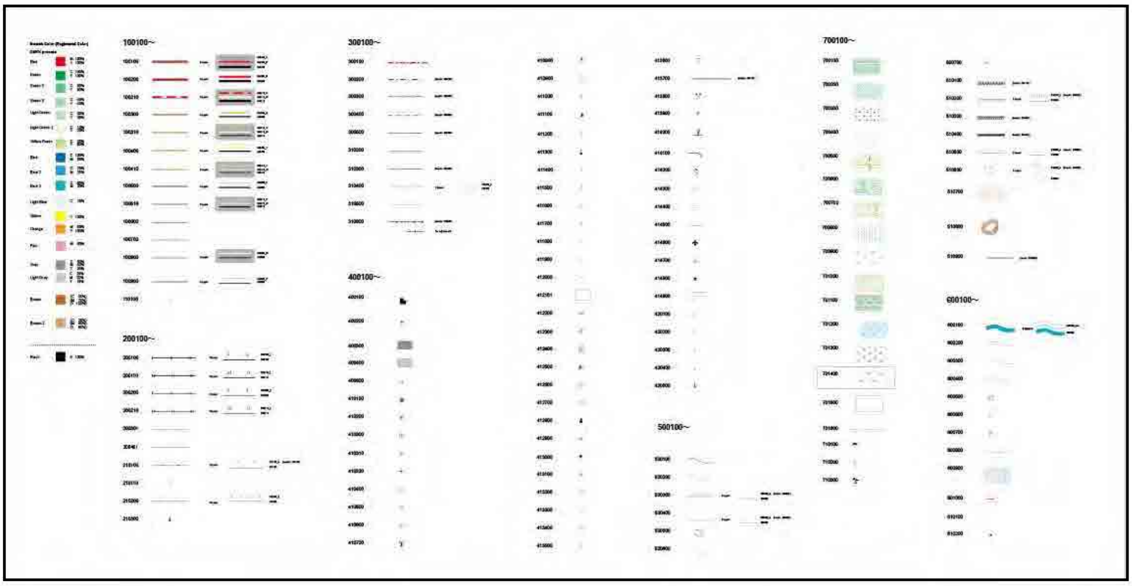


Figure 3-11 (Part of) Pallet file including layer information

* Creation of a template file

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

d. Map symbolization work

* Conversion of the scale of DXF data

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

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

* Arrangement of the vertical order of layers

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

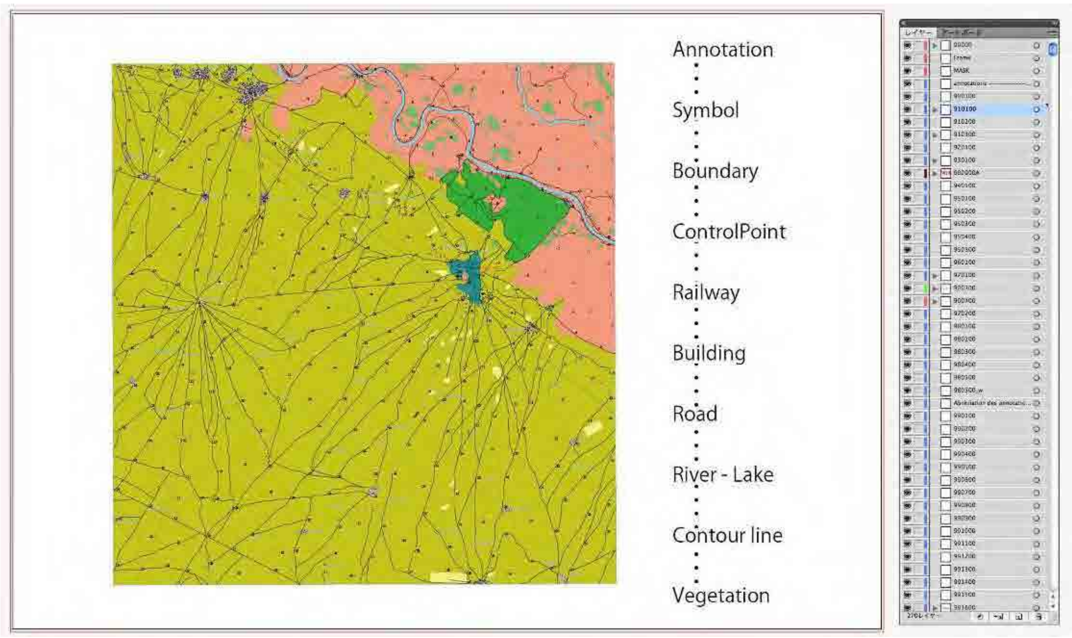


Figure 3-13 DXF file with layers in the appropriate vertical order on the template file

* Conversion of objects in accordance with the symbol specifications

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

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

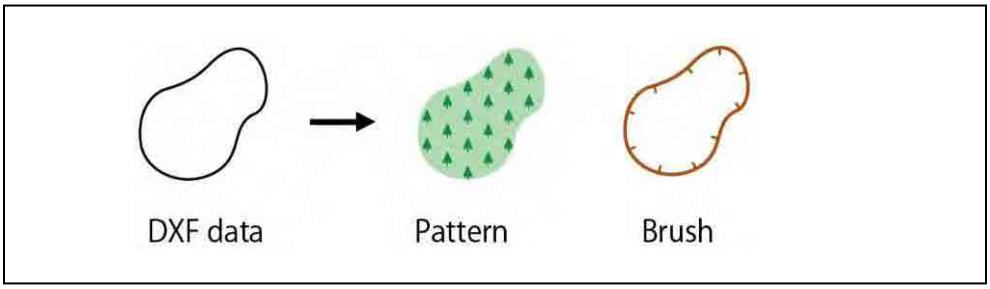


Figure 3-14 Conversion of a DXF data with Pattern and Brush tools

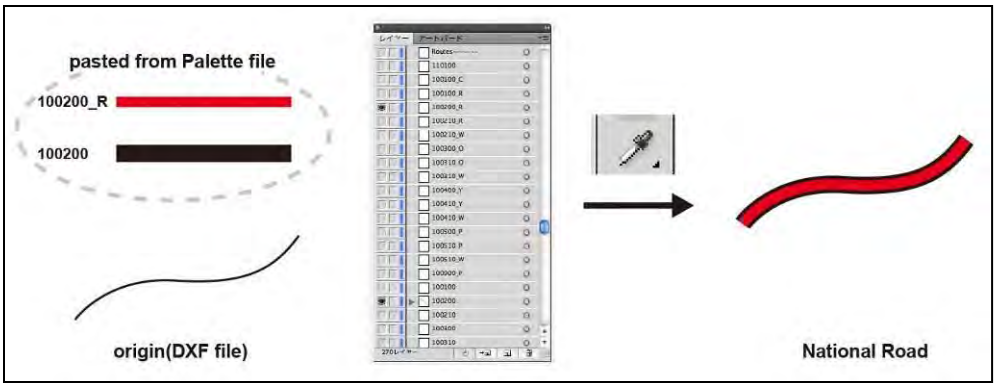


Figure 3-15 An example of a map symbol to be represented on more than one layer (code: 100200)

* Correction of inconsistencies

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

* Trimming of maps

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

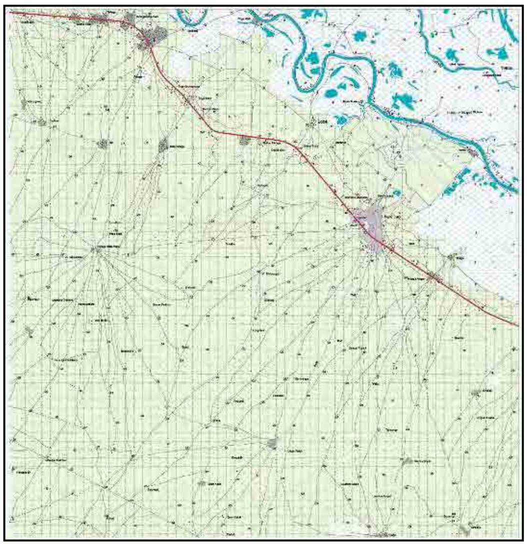


Figure 3-16 Map-symbolized file (NE28IV2c)

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

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

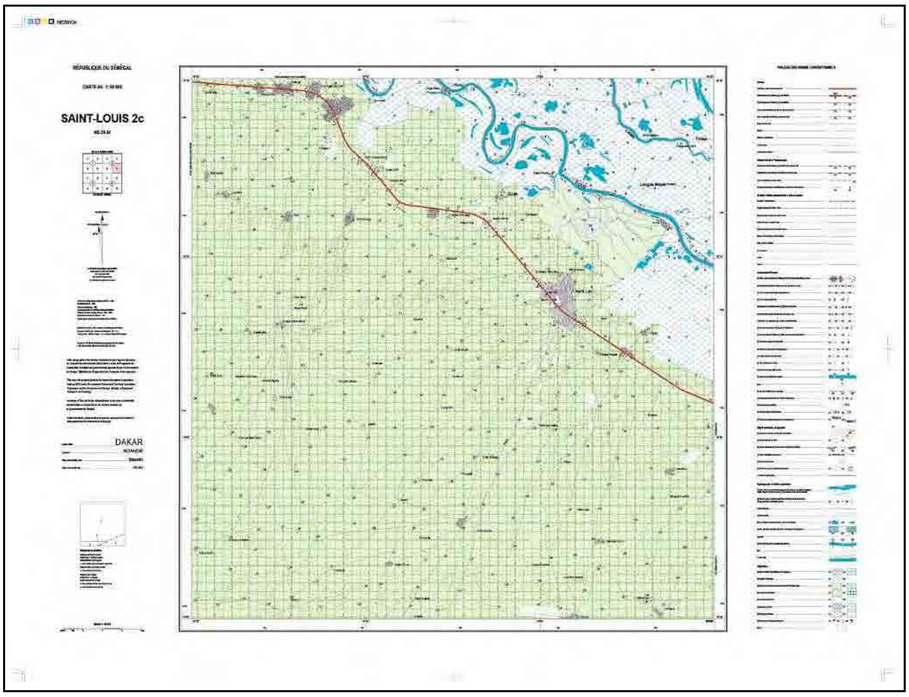


Figure 3-17 Completed topographic map data for printing (NE28IV2c)

3.1.7 ⑦ Structuring of Website

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

[Purpose of the technology transfer]

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

[Focal point in the implementation of the technology transfer]

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

Photo 3-12 Technology transfer for website creation

[Details of the technology transfer]

- Explanation of the technologies used in website creation

  The instructor explained to the participant the functions of each of the open-source programs used on the website. As the person in charge of the creation of the ANAT website, the participant had sufficient skill in the use of the technologies required for the creation of a website, such as how to use Web servers and PHP.

- Registration of the data to be displayed on the Web GIS site

  The instructor explained to the participant how to register structured data with a Web GIS site in order to display them on the site, and how to configure the settings to display map specifications. The instructor first explained the overall workflow. After the participant had understood what processes were required for the registration of new data and the updating of registered data, the instructor explained the details of those processes to him. The participant understood what data files to register, what setup files were required, how each file should be named and how to register data files, and had no problem in configuring the settings.

- Registration of data for downloading

The instructor explained to the participant how to register data and configure the settings to enable the data to be downloaded from the website. The participant had no problem understanding what data files to register, how to register them and how to configure the settings for the registration.

- User registration

The instructor explained to the participant how to register and authenticate users to allow them to download data from the website. The participant had no problem understanding the procedures for user registration and user authentication to be carried out by the website administrator.

- Display of the planimetric features listed on the Web GIS site

The instructor had previously explained the settings required to display registered structured data on the Web GIS site. However, the registration mentioned above is not on its own sufficient to display the data on the Web GIS site. Display of the data requires an additional setting of the date and the addition of information in the list of planimetric features to be displayed. The participant had no problem understanding the procedure required to configure the additional settings.

- Composition of the pages of the website

The instructor explained to the participant the composition of the pages of the website and the procedures required to update the information on those pages. The participant had no problem understanding page composition and how to update information.

- Website relocation

At the time of the technology transfer the website was located on a rental server in Japan. This website is to be integrated with the ANAT website once it has been developed. Therefore, the instructor explained to the participant how to relocate the website, a task that would be necessary for the integration of the two sites. The participant understood the procedure for relocation, although it was explained in theory only using reference materials, because a server to which the website could be relocated was not available.

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

【Plan for the technology transfer】

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

<u>* Goals</u>

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

<u>* Outputs</u>

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

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

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

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

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

【Summary of the obtained outputs】

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

Output 3:

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

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

The Study Team implemented activities relating to output 3 in accordance with the plan. The establishment of a practical system for the promotion of the data utilization including secondary use is required more urgently than the mathematic analyses based on many assumptions. The C/Ps might have failed to comprehend how to perform tasks if they had been given too many tasks. However, they had fully recognized the importance of the topographic maps including their economic significance through the practical activities such as visits to the organizations interested in the digital topographic map data and activities related to accumulation of the cases of the data utilization. These facts have led the Study Team to conclude that the original goal for Activity 3-5 in Table 3-6 has been achieved.

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

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

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

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

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

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

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

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

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

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

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

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

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

3.1.9 ⑨ Quality Control

The technologies for the implementation of accuracy control, which is a part of the quality control, was transferred to the C/Ps so that they could improve their understanding of the correction of errors and inspection in accordance with the work specifications at each stage of the digital mapping process and acquire the capacity to control the quality of the digital topographic map creation work. While ANAT had not created medium-scale topographic maps, they had had experience in creating small- and large-scale maps. Therefore, the Study Team urged them to follow the work specifications in each stage of topographic map creation and in particular to acquire inspection skills through OJT in digital plotting and compilation.
The Study Team transferred to the C/Ps the technologies for the confirmation of conformity with specifications (work specifications, etc.), quantity inspection with quality control sheets and check lists, and visual inspection of the outputs of the process consisting of the digital plotting/compilation and the map symbolization. The reason for the selection of the outputs of the above-mentioned process for the technology transfer in quality control is that virtually all the quality control work is required for the process concerned and, therefore in general, most of the important quality control work is implemented during the digital plotting, digital compilation and map symbolization.

3.1.9.1 Digital plotting

* Data check

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

* Output, visual inspection

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

* Optimization of data management

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

3.1.9.2 Digital compilation/symbolization

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

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

Sample quality control sheet — **Digital plotting,Data compilation/Symbolization** **Quality control sheets** — **Checked Date :** ____________

Project Name	Sheet Name/No.		Mapping Scale	Volume		Executive Organization			Chief Engineer	Checked by	
				Km²							
Item	**Missing**	**Error**	**Item**	**Missing**	**Error**	**Item**	**Missing**	**Error**	**Item**	**Missing**	**Error**
Geodetic points			**Railway institutions**			**Water features**			Water name		
Classification			Over bridge			Classification of symbol items			Place ground name		
Value			Platform			Position of symbol items			**Marginal information**		
Contour Lines			**Administrative Boundaries**			Form of line items			Sheet Name/No.		
Form			Classification			**Traffic**			District name		
Value			Form			Classification			Neat & Grid Line		
Roads			**Public facilities**			Position			Coordinates Value,etc.		
Classification			Classification			**Vegetation**			Scale Bar/Map symbol		
Form			Position			Form of boundary			Sheet index		
Road institutions			**Buildings**			Classification of symbol			Sheet History		
Embankment			Classification			**Natural features**			Planning / Executing Org.		
Underpass			Form			Classification			Others		
Over bridge			**Fences**			Form			Connection between adjacent sheets		
Distance marker			Form			Flow direction					
Bridge			**Building symbols**			**Annotation**					
Foot bridge			Classification			Administration name					
Road divider			Position			Road name					
Railways			**Accessory objects**			Road institution name					
Classification			Classification of symbols			Railway name					
Form			Position of symbols			Railway station name					
			Form of lines			Building name					

Figure 3-18 Quality control sheet form

3.1.10 ⑩ Map Updating work

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

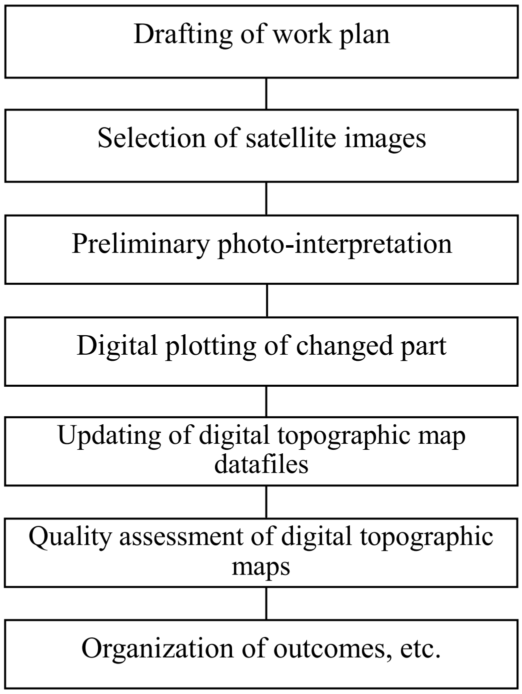


Fig. 3-19 Map updating workflow

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

The map updating work further necessitated the following work.

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

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

3.2 Evaluation of the technology transfer

*** Overall Evaluation of the Technology Transfer**

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

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

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

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

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

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

【Overall Evaluation】

- It was expected that when the technology transfer was finished there would be four completed topographical maps created by ANAT, but the slow progress resulted in the completion of less than one map. It is thought that the reason for this is that after the technology transfer not sufficient work was done to enable the engineers to operate the workstation and improve their skills.

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

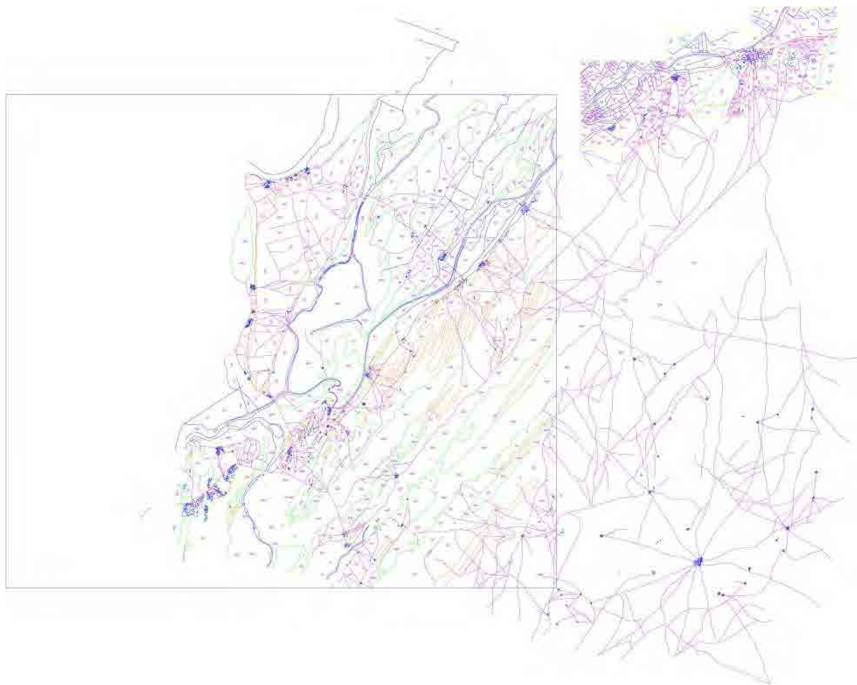


Figure 3-20: Topographic map created by ANAT

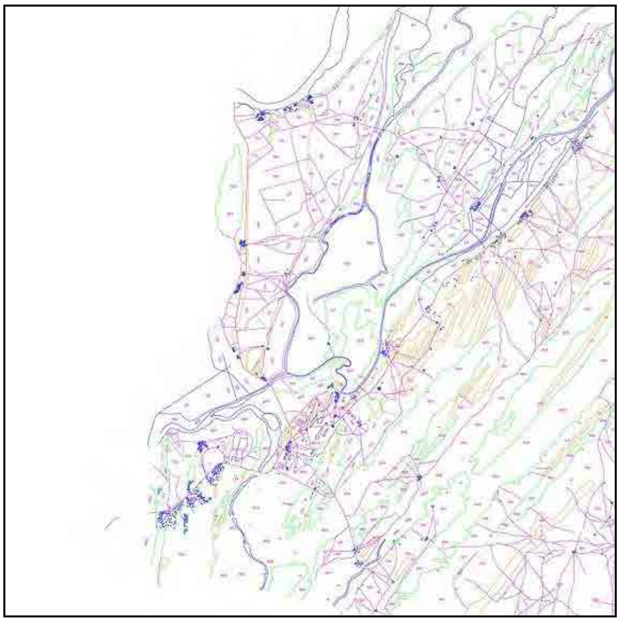


Figure 3-21: Output of the plotting by the ANAT engineers (during the plotting process)

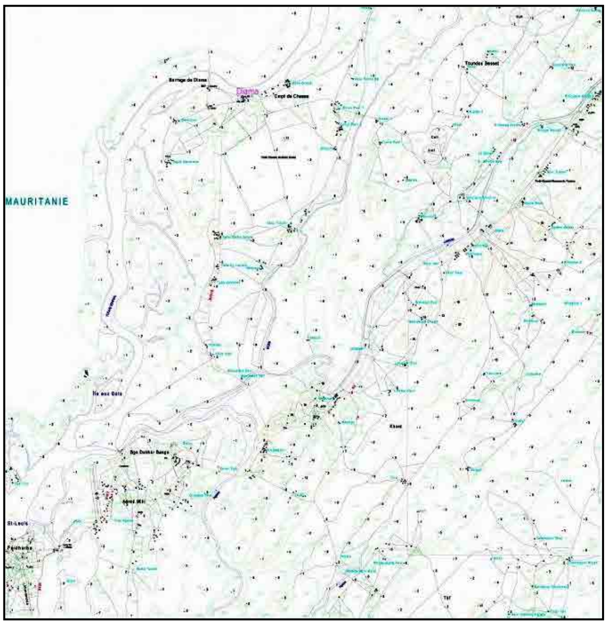


Figure 3-22: Output of the plotting created by the Study Team (at the completion of the plotting and compilation)

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

① **Ground control point survey**

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

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

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

② **Aerial triangulation**

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

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

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

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

<u>* Digital Plotting</u>

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

Table 3-7 Proficiency in digital plotting/compilation

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

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

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

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

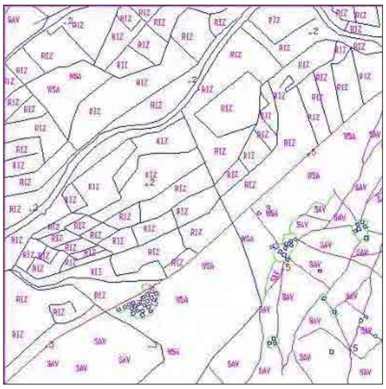
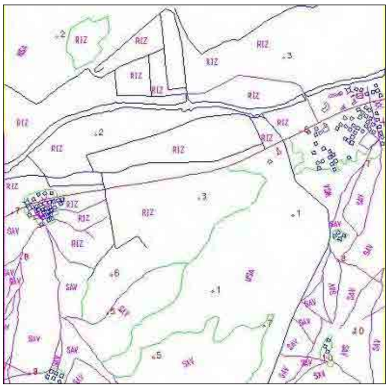
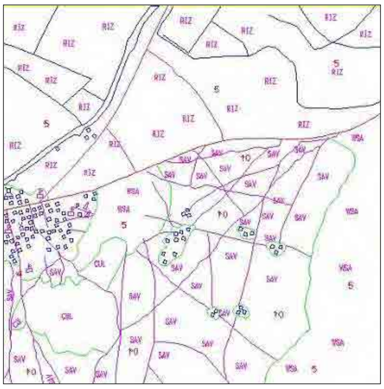


Figure 3-19 Sample created by Trainee A



Sample created by Trainee B



Sample created by Trainee C

The technology transfer in digital plotting had to be implemented intensively in a short period because minor problems with the equipment caused a delay in the commencement of the work. Digital plotting requires not only a basic knowledge of map creation but also an understanding of the symbol specifications and a wide variety of technologies, including how to operate the equipment and how to interpret photographs. Therefore, the two-month period allocated to the technology transfer seems to have been too short. Moreover, as repeated practice is needed to maintain and improve technical capacity, the Study Team recognizes the need after the completion of the technology transfer for special consideration to be given to (*e.g.*) the implementation of follow-up training after a period of self-sustained training.

* Digital Compilation

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

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

④ **Field identification/verification**

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

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

⑤ **GIS Data Structuring**

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

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

The staff members of ANAT had had some experience in using ArcGIS in their work. This being the case, the Study Team transferred the concept of and the method for the effective use of the tools of ArcGIS, and the technology to make the method more efficient.
Following the technology transfer, the participants now have a solid understanding of the structuring of digital data using ArcGIS. However, it was regrettable to note that some of the participants, who are administrators at present or may be in the future, did not seem to have a strong motivation to absorb new technologies.
The participants had to do the same work repeatedly at many stages in the structuring of the GIS data implemented in the Project. However, the Study Team did not observe in the participants the will to improve the efficiency of the work. They seemed to be satisfied with the level of technologies they had, and seemed to have little interest in acquiring advanced technical knowledge. These observations have led the Study Team to consider that measures to enhance motivation of ANAT members will be required if the implementation of technology transfer on ArcGIS and other subjects is to be continued and upgraded, and that because of its importance priority should be given to assistance in raising motivation.

⑥ **Map symbolization**

Despite having no previous experience in using the graphic software, Adobe Illustrator, in this technology transfer the ANAT engineers were able to acquire the ability to perform independently a series of tasks, from the creation of objects to be used in the symbolization and the entry of data digitally compiled after field verification (in DXF format) to the data compilation for symbolization. On the basis of this observation, the Study Team concludes that their understanding and proficiency have almost reached the level at which they will be able to create topographic map data for printing.
The Study Team expects the map symbolization technologies transferred in this study to be used in the creation of 1/50,000-scale map symbolization data and to open up the possibility for the creation of small-scale maps through a scaling-down compilation of the data. The team also expects these technologies to open up possibilities for the creation of thematic maps through modification of the specifications. In order to realize these possibilities, the Study Team expects ANAT to maintain, extend and improve on the technologies acquired in the technology

transfer and to create independently various data for printing.

⑦ **Structuring of Website**

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

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

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

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

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

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

As mentioned above, new C/Ps were appointed for this study during the third phase of Work in Senegal. The Study Team has not been able to provide sufficient input to them since their appointment. Therefore, the technology transfer has turned into the unilateral provision of information from the Study Team without any reaction from the C/Ps. In order to improve this situation, the Study Team has been urging the C/Ps by e-mail to be active even when the team is not in Senegal. However, the situation has not improved much.

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

Chapter 4　Works related to the Study Reports

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.7 Report to JICA Senegal Office (Work in Senegal)

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

Chapter 5 Other works implemented

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

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

Venue	: ANAT Conference Room	
Date	: May 16th, 2011	
Attendees	: From Senegal (ANAT)	
	Mr. Abdulaye FAYE	Secretary General/ANAT
	Mr. Mansour DIOUF	Agent Comptroller/ANAT
	Mr. Youssou NDONG	Director of DTGC
	Mr. Mamadou THIAM	Chief of Division for Cartography
	Mr. Abdou Kahdre DIATTA	Chief of Communication Marketing
	From Japan (JICA Senegal Office)	
	Mr. Shinji UMEMOTO	Chief of Bureau/JICA
	Mr. Mamadou NDOME	Representative/JICA
	Study Team	
	Mr. Takashi HARADA	Leader
	Mr. Takao IKEDA	Member of Study Team
	Mr. Naoki GOTO	Member of Study Team
	Ms. Naomi HIRAHARA	Coordinator
	Mr. Atsushi ITO	Interpreter

Overview:

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

Photo 5-1 Kick-Off Meeting

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

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

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

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

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

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

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

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

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

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

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

- Director of DTGC (Mr. Ndong)

  Mr. Ndong said that in order to ensure the success of the project the Senegal side would be mobilizing and allocating staff, and also mentioned that the project occupied a special context due to the fact that the Economic Commission for Africa was recommending the preparation of 1:50,000-scale maps. In this sense he hoped that the support of Japan would serve to satisfy the needs of Senegal. The technology transfer was another aspect. It was planned to use high resolution images to prepare the maps; maps covering an area of 30,000km^2 in Northern Senegal would be prepared, and images covering 45,000km^2 of Western Senegal would be provided; the cartographic information would be released via the Website.

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

- Secretary General of ANAT (Mr. Faye)

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

5.2 Holding of Opening Seminar (Work in Senegal)

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

- Date : June 21^{st,} 2011
- Venue : Hotel Meridian President, Dakar, Senegal

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

Photo 5-4 Participants in the seminar

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

Photo 5-6 Explaining data utilization (Study Team)

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

SEMINAR ON THE DIGITAL TOPOGRAPHICAL MAPPING
PROJECT OF THE NORTHERN SENEGAL
(Project of National Map Infrastructure of Senegal)
Hotel Meridian President - Dakar

Tuesday 21 June 2011

Program

Registration of Guests end at : 9h15m

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

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

09h35 – 9h45 : Speech of JICA Resident Representative

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

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

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

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

10h30 – 11h00 : Coffee break

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

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

11h30 – 11h55 : Discussions

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

End presentations: 12h 00

12h 00 – 13h 00 : Lunch

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

Table 5-1 List of guests

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

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

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

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

Photo 5-7 Assembly of the equipment (PLANAR)

Photo 5-8 Assembly of the equipment (Scanner)

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

Table 5-2 Itemized list of equipment

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

23	A3 printer for printing outputs	HP Officejet 7000 Wide Format Printer – Printer – color – ink-jet – A3 Plus – 600 dpi x 600 dpi – up to 33 ppm (mono)/up to 32 ppm (color)– capacity:150 sheets – USB, Ethernet, 32 MB RAM	1
24	*do* Ink cartridge	HP 920XL – Print cartridge – 1 x black	3
25	*do* Ink cartridge	HP 920XL – Print cartridge – 1 x cyan – 700 pages	3
26	*do* Ink cartridge	HP 920XL – Print cartridge – 1 x magenta – 700 pages	3
27	*do* Ink cartridge	HP 920XL – Print cartridge – 1 x yellow – 700 pages	3
28	Large-size scanner	HP Designjet HD Scanner – Roll scanner – Roll(42")– 600 dpi x 600 dpi – 10Base-T/100Base-TX/Hi-speed USB 204 lb, 1 year warranty	1
29	Large-format printer	HP Designjet T7100, 42" large-format printer – color – ink-jet Print Resolution: 2400 dpi x 1200 dpi, Memory: 32GB Virtual Hard Disk: 160GB, Networking: USB, 1000Base-T, Power: AC 120/230V, Weight: 412 lbs	1
30	Paper roll for printer	Water resident and resistance rolled paper	2
31	Paper roll for printer	Coated paper Roll	5
32	Paper roll for printer	HP – Bond paper – Roll(42" x 150ft)– 80g/m2	5
33	Printer head	Printer head (yellow)	6
34	Printer head	Printer head Gray/Dark Gray	6
35	Printer head	Printer head Cyan/Magenta	6
36	Printer head	Printer head Black	6
37	Printer head	Printer head Dark gray	6
38	Ink cartridge	HP – Print cartridge yellow	6
39	Ink cartridge	HP – Print cartridge Cyan	6
40	Ink cartridge	HP – Print cartridge Magenta	6
41	Ink cartridge	HP – Print cartridge Black	6
42	Ink cartridge	HP – Print cartridge Light Gray	6
43	Ink cartridge	HP – Print cartridge Dark gray	6

Chapter 6 Outputs

6.1 Study Reports

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

Table 6-1 Survey Reports

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

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

6.2 Outputs

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

Table 6-2 Outputs

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

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

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

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

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

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

	Senegal				
40	SAED Senegal River Delta and Senegal and Falémé River Valleys Land Development Corporation				1
41	Local Governments	(Affiliated institutions)			
42	Saint Louis Region	Dagana Department	Podor Department	Saint Louis Department	4
43	Louga Region	Louga Department			2
44	Matam Region	Kanel Department	Matam Department	Ranérou Department	4
45	Tambacounda Region	Bakel Department	Kédougou Department		3
46	International Organizations	(Affiliated institutions)			
47	OMVS Senegal River Basin Development Authority				1
48	Universities				6
49	Mass media organizations				10
	Japan	(Affiliated institutions)			
50	Embassy of Japan				1
51	JICA 3	JICA Senegal Office 2			5
	* A copy of the booklet is to be delivered to an organization with no number attached to its name.			Total	100

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

7.1 Use of Digital Topographic Map Data

* Spread of the use

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

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

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

* Problems and tasks

While there is high expectation for the expansion of the use of topographic maps in Senegal, as mentioned above, there are also problems to be solved. Three specific problems are discussed below.

Firstly, there is a need to establish a geodetic reference system and to develop a network of geodetic control points which can be used in the GNSS surveys. This need arises from the fact that effective use of digital topographic maps requires efficient data creation without spending much effort in establishing control points, and data creation with the standards identical to other available geospatial information so that data can be processed in an integrated fashion. A geodetic reference system compatible with GNSS surveying has been in use in Senegal since 2004. A system similar to this was used in this Project, but it was different from the system used in the creation of 1/200,000-scale topographic maps in 2005. Although this difference creates no practical problem, a situation in which use of multiple geodetic reference systems creates confusion should be avoided. The control points based on the previous geodetic reference system will have to be transformed to those based on the new system and triangulation points and benchmarks shall be established with a density required for the creation of topographic maps without major difficulties in the development of the network of geodetic control points.

The second problem is the shortage of basic data. While 1/50,000-scale digital topographic vector maps of a 30,000 km^2 area in Northern Senegal were created in this project, such maps of the other areas of the country are not available. Therefore, many organizations have to rely on wasteful methods, such as digitization of the existing 1/50,000-scale topographic map sheets, when they require digital topographic vector maps of the area outside the project area in their work. Since these maps were created many years ago and are based on the old coordinate system, they do not represent the current field conditions correctly or cannot be overlaid on other maps. For these reasons, it is not possible to use them as basic maps. Therefore, it is urgently required to create digital topographic vector maps based on the established geodetic reference system of the other areas of Senegal, and Western Senegal around Dakar City where a high concentration of people and business activities is found, in particular.

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

7.2 Recommendations Derived from the Implementation of the Project

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

1. Recommendations for the Project Management

* Strengthening of organizational capacity

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

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

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

* Project Implementation in accordance with Implementation Schedule

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

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

* Improvement of the organizational structure

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

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

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

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

- Improvement of publicity activities

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

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

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

2. Technical Recommendations

<u>* Development of the National Spatial Data Infrastructure (NSDI)</u>

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

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

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

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

<u>* Promotion of technical cooperation within the Western Africa Region</u>

If a measure is found for the transfer of the technologies acquired by the C/Ps in this project from them to their counterparts in the neighboring countries, such a measure is expected to contribute to the upgrading of the level of the technologies in the Western Africa Region in a cost-efficient way. The most obvious advantage of this measure is elimination of the "language barrier" and the ease of communication realized by the adoption of this measure is expected to have beneficial effects on both trainers and trainees. The Study Team requests the Japanese authorities to begin a study for the formulation of a project based on this approach promptly.

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

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

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

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

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