5.4. The Fourth Year's Work (2000)

5.4.1. Work in Angola

In the work in Angola, mainly, the field verification of secular changes in the topographic maps and the land-use survey in the target area (1,000 km^2) in Luanda City (see the attached map) were carried out in order to produce the digital land-use maps based on the 1/25,000-scale digital and to compile topographic maps to cover the target area that were produced using the 1/30,000-scale aerial photos taken in the second-year (1998) work in this Study. This Study was implemented by the engineers of the GIS technical group arranged by the counterpart (MINOPU) under the supervision of the Study Team members and the technical transfer was carried out through these actual works.

It was also planned to carry out the aerial color photography of about 30%, the central part of the target area, and other surrounding area with black and white that was not photographed in the work in 1998 for the 1/10,000-scale aerial color photography necessary for the land-use survey of the target area, and the 1/30,000-scale aerial black/white photography of the surrounding area. However, both aerial photography works could not be carried out for the period of September to November 2000 for the reason described above.

(1) Explanation of Progress Report / Meeting

As the third year's work in Angola of this Study could not be carried out, the reports on the second and third years' works and the black and white photos and color photos that had been obtained in the aerial photography so far were brought into Angola at the time of entry into Angola in the later period of September 2000 and delivered to the counterpart (MINOPU). Of these photos, the aerial photos include the 1/30,000-scale black and white photos used in production of new maps for Luanda area and the 1/10,000-scale color photos for the same Luanda area.

The items delivered to the counterpart at that time are as follow:

a. Progress report 2 and Progress report 3 — 20 volumes each
b. Color aerial photo prints with the scale of 1/10,000 (Luanda area) — 3 sets
c. Black and white aerial photo prints with the scale of 1/30,000 — 3 sets
d. ArcView manual — 10 volumes
e. Arc/Info manual (draft) — 10 volumes

f. Land-use classification manual (draft) for land-use maps with the scale of 1/25,000 — 10 volumes

g. Samples of the out-put maps with the scale of 1/1Million, 1/100,000 and 1/25,000 digital topographic map data — 1 set

The sample maps are the color output maps from the digital maps and digital topographic maps that had been created so far.

At the time of delivery of those items, the Study Team made the explanation of the Report on the work for each fiscal year. In particular, the details on the work processes in Japan in the third year's work were not informed to the MINOPU side. Thus, it was a relief to the MINOPU side to know that the secular changes in the 1/100,000 digital topographic maps were made using the "SPOT" images in Japan within the framework of the third year's work.

The explanation of the Reports at that time covered 2 years' work and included many contents so that the MINOPU side seemed to have a difficulty in fully understanding all the contents of these Reports so soon. Then, MINOPU proposed that the technical staff on the Angola side including IGCA would review these Reports before holding the meeting with the Study Team, which accepted this proposal.

At the start point of the work for this fiscal year, the MINOPU side determined the GIS support staff and the GIS technical group within MINOPU for the maintenance work after the completion of this year's work. This was the Study Team had been anxious and questioned about to the MINOPU side. The Study Team was anxious about the fact that there were few engineers within MINOPU for this GIS maintenance work after installation of all the products and computers after completion of this Project. The GIS staff for maintenance that MINOPU organized and informed the Study Team were as follows:

Dr. Manuel António Paulo	Coordinator
Mr. António Montenegro Duarte Ferreira	General Manager
Mr. Domingos Armando	Technical Manager
Mr. Rodolfo Guedes Silva	Technical
Mr. António Joaquim Airosa de Oliveira	Technical
Mr. Domingos Jacinto Ganga	Technical
Mr. José Manuel Januário	Technical
Mr. Benjamine Afonso	Technical
Mr. João Luís Bernardes da silva	Technical
Mr. Francisco Teca	Technical
Ms. Lourdes Vaendela Domingos Liahuca	Administrator
Ms. Elvira Maria Afonso Taveira	Secretary

The above eight (8) engineers including the Technical Manager were the officials of IGCA to whom the Study Team provided the technical transfer in the joint works through the study works in Angola during the study period up to the fourth year in this Study.

The names of these members were informed to Mr. Hirai, Team Leader who arrived in Angola at the end of October 2000, and the technical meeting mainly on the pending Report delivered this time was held in the presence of Mr. Hirai and the technical manager of IGCA.

In this technical meeting, the queries on the details of secular changes in the 1/100,000-scale digital topographic maps were presented and the Study Team explained that the following items were carried out:

① Correction of changes in woodlands
② Correction of changes in cultivated lands
③ Correction and addition of changes in housing lands
④ Addition of newly constructed roads
⑤ Correction of large changes in existing roads (as far as recognized on “SPOT” images)

The Study Team explained that there were limitations in satellite image interpretation about the deletion of villages abandoned by residents in the suburbs of cities and mountainous areas and the Angola side was convinced of it.

What MINOPU strongly requested to the Study Team at this meeting was related to the GIS seminars that were planned to be conducted by the Study Team after installing the computers, GIS software and digital data. They requested to hold 2 types of seminars: the seminar on GIS introduction for the higher governmental officials of Angola and the technical seminar for the related engineers. Therefore, the Study Team decided to hold the prior discussions on the method of these seminars in order to meet the requests from the Angola side as much as possible.

It was after 3 weeks that the Study Team received the response to the letter that the Study Team sent to MINOPU on the permission for aerial photography. The MINOPU's reply informed very simply that no official permission had been issued yet and that MINOPU had a large expectation for this GIS project. The photography supervisor could do nothing than carrying out the supervision and technical transfer on the land-use study during this free period.

(2) Supervision of Land-use Pre-interpretation

The major objective of the Study was to develop basic data to improve the capital city of Luanda in the Republic of Angola. The digital maps were prepared in the area where new topographic maps at a scale of 1:25,000 were prepared.

1) Land use classification

The Study team prepared a draft of the land use classification to be reviewed by the Angola side. The Study team proposed 28 items to be classified to prepare the land use maps and delineated areas for each land use. The classification is not limited to vegetation classification, but it extends to urban land uses which include facility and structure types to enable analyses of urban conditions and functions.

1. Blocks in town; Fireproof buildings	2. Blocks in town; Non fireproof buildings	3. Villages; Fireproof buildings	4. Village; Non fireproof buildings
5. Multi-floor residential building	6. Commercial use and diverse services	7. Industrial use	8. Government and public organization
9. Education and culture	10.Health and welfare	11.Trasportation and storage	12.Other urban services
13.The others	14.Cemetery	15.Park and green zone	16.Sports and recreation
17.Transitional urban area	18.Vegetable and grains	19.Orchard	20.Sugar cane
21.Closed farming exploitation	22.Glass land	23.Glass land with sparse trees	24.Shrub land
25.Forest	26.Uncultivated terrain	27.Wetland	28.Surface water

The number “13 Others” include military facilities. Before being reviewed by the Angola side, the Study Team explained the land use classification manual (draft) and its application in detail.

In the Republic, there was no land use classification system. The classification prepared by the Study Team was discussed several times among agencies of the Urban Planning Department in the Luanda Province and the Land Organization Council in the Ministry of Planning. In this process, the Urban Planning Department in the Provincial Government of Luanda suggested to include tourism classification and others, and to subdivide the vegetation classification. The total classification types suggested were 30 land use types. The discussions included the following topics: There are no tourism areas to be classified; they are only to be used in the future planning. Because permanent cropland or vegetation are only seen in limited areas, if the vegetation classification is subdivided, difficulties in interpretation and delineation are expected.

The discussion was extended to the military facilities, restricted areas, natural conservation and preservation areas; however, those types of land uses were agreed to be included to other categories. The final land use classification agreed with the Angola side has the following 25 categories as in the attached Appendix:

1. Fireproof buildings	2. Non fireproof buildings	3. Multi-floor residential buildings	4. Commercial use and diverse services
5. Industrial use	6. Governmental and public organization	7. Education and culture	7. Health and welfare
8. Transportation and storage	9. Supply and treatment facilities	11.The others	12.Cemetery
13. Park and green zone	14.Sports and recreation	15.Non-use area	16.Vegetation and grains
17.Orchard	18.Plantations	19.Closed farming exploitation	20.Grass land with sparse trees and shrub
21.Forest	22.Inproper terrain	23.Wetland	24.Surface water
25.Special protection zone			

"15 Non-use area" includes sand area. The items and application areas are as specified in the appendix. The Study Team respected the opinions of the Angola side on the range of application. As for the standards on the minimum areas to be classified, there was no positive opinions from the Angola side; therefore, the standard suggested by the Study Team was adopted.

2) Aerial photograph interpretation

Color aerial photographs taken in 1998 at a scale of 1/10,000 were used for the preliminary interpretation. Schools, hospitals, pubic facilities, transportation facilities and others based on the finalized classification were clearly delineated, as the photographs were color and the scale was larger. The GIS technical group that is familiar with the area contributed to the precision of the interpretation. The result of the preliminary interpretation was recorded on working aerial photographs in symbols. Only in the Futungo region, twice-enlarged panchromatic photographs at a scale of 1:30,000 were used, since the flight permit was not given within the study period.

(3) Supervision of Field Verification

For the 1/25,000-scale topographic maps, two types of map data, digital topographic data (digital data) intended for use in the GIS and digital compiled data (raster data) for color printing of digital topographic maps were produced using the 1/30,000-scale aerial photos of the same target areas photographed in 1998.

Of these maps, the compiled topographic maps will be printed within this fiscal year (by the end of March 2001) before the change of schedule.

As the errors in the compiled topographic map data for printing including the topographic features, planimetric features and annotations could not easily be corrected after printing, except for the GIS digital data, the survey of the secular changes in planimetric features and others that had appeared after the aerial photography in 1998 were carried out in parallel with the land-use survey in order to avoid any discrepancies from those planimetric features and other in the land-use maps.

1) Preparation for the field work

The preparatory work for the survey of secular changes in the topographic maps was made using a total of 11 sheets of color output maps (as shown in Figure 4.1) for the compiled topographic maps that were prepared in Japan. The Study Team made meticulous examinations on the work policies, contents and schedules with the cooperation of the officials of the GIS technical group of MINOPU.

The Study Team and the assistant surveyors confirmed that the survey of the secular changes in the topographic maps was intended to correct the digital topographic maps not only for the printed maps but also as the base maps for GIS and also to produce the digital land-use maps. Then, the following preparatory work was carried out for the output maps brought in Angola from Japan:

① Inspection of marginal information on the output maps
② Inspection of annotations such as geographic names, rivers and other names
③ Inspection of map content
④ Extraction of areas with secular changes and items of secular changes
⑤ Check on water pipes, oil pipes and high-tension transmission lines

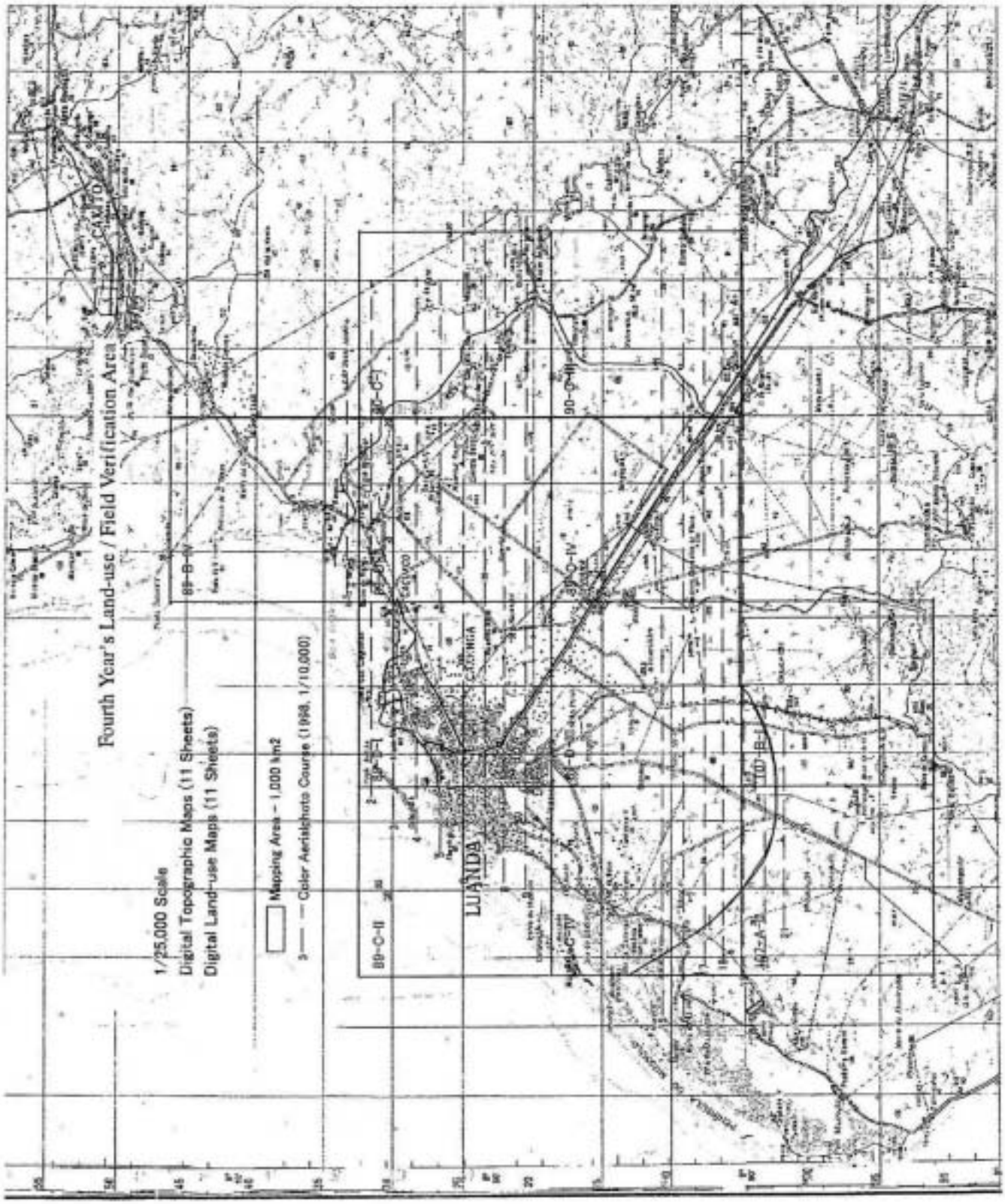
In extraction of areas with secular changes, the GIS technical group pointed out these areas. To the extent that they could verify them, the items of change were extracted. In addition, the doubtful and uncertain matters were noted on the color output maps when the compiled topographic maps were produced. These maps were also brought to Angola from Japan and added to the preparatory and review materials for the field work.

2) Field verification of topographic map

The field verification for correction of secular changes in the topographic maps was carried out by the GIS technical groupe, making use of the results of the preparatory and review work for the field verification. It was taken into account that this field verification was the field completion survey in accordance with the land-use classification newly established.

The secular changes of topographic maps of the study area were obvious because the aerial photos used for production were taken two years ago.

Figure 5.4.1 Fourth Year's Land-use / Field Verification Area



The secular changes due to wide-area building land development were in progress, better than expected; for instance, for the Luanda-Sul development area and the surrounding areas of the Viena industrial district southeast of the city area. These are being developed under the 10-year city plan beginning in 2000 formulated by the Government of Luanda Province in accordance with the resolution in the Parliament of Angola in 1998, including the construction of arterial highways and land development along the arterial highways in the suburbs of the city areas.

Along with the development of factories and housing lots, the construction works of several roads and overhead road bridges at 4 sites are also in progress.

The inflow of population from the inland to the urban areas is still increasing and villages of illegal small houses made of small blocks are formed for a short time in the undeveloped land.
These large changes were beyond the scope of field completion survey and the planimetric features could not be represented accurately without aerial photography.

The Study Team tried again to collect the materials as many as possible in the field survey, but could collect few new materials for the water pipes, transmission lines and public facilities and it took many days to take formalities to acquire those materials.

The Study Team separately acquired the materials such as road construction design diagrams, part of the ortho-photos in large scale produced by the Statistics Office, Ministry of Plan in 1999, and the development planning maps of the Government of Luanda Province and the Empresa de Desenvolvimento Urbano Ltda (EDURB). These materials were used for correction of the roads and other planimetric features.

3) Field verification of land-use
The field verification of land use was conducted to clarify unidentified subjects during the preliminary land use interpretation. The Study Team entrusted prioritization of residential use and mixed use in the central business district to the Angola side. The Study Team, however, suggested that the classification of building use that commercial use needed to be prioritized rather than residential use to show current status of urban functions. In the Futungo region where new color photographs had not been taken included the Luanda-Sul development district and the surrounding areas of the Viana Industrial area developed

within the last two years. The changes were not expressed by photo interpretation alone. On the sites, detailed drawing of those facilities in the newly developed areas was not possible. The expression of such areas was limited, and shown as a clustered residential use. The results of field verification where color photographs were unavailable were expressed on a clear film overlay on panchromatic photographs in ink. The final results of the land-use-field verification with the secular change of the topographic maps were organized on the maps with major topographic features at a scale of 1:25,000 printed on films brought from Japan.

(4) Supervision of Aerial Photography

In the area of 67,000 km^2 in the surrounding area of Luanda, only a total of 2,230 km^2 has been photographed in southern part of the west of Zaire Province, the southwest of Malanje Province and northern part of the east of Cuanza-Sul Province.

Of these, the area of 320 km^2 in Luanda area that has not been photographed in color was the target area of aerial photography in the land-use study for this fiscal year. The area that has not been photographed in color occupies the center part to be covered by the topographic maps newly produced in the land-use study.

Thus, the photography supervisor of the Study Team came into contact with MINOPU and IGCA before his entry in Angola and checked with MINOPU that the permission for aerial photography was issued through the official in charge of aerial photography permission application in IGCA that belongs to Ministry of National Defense of Angola.

Before the supervisor departure from Japan, the supervisor was relieved to receive this information that Ministry of National Defense had issued the permission for photography.

After his entry in Angola, however, the supervisor was informed at the meeting with MINOPU that the permission for aerial photography was rejected by the Office of Precidency. The reason for rejection was that the permission for photography was issued for the former photography, but that this photography was not completed.

The JICA Study Team retorted against this rejection and explained that the former photography was conducted under the adverse conditions such as restriction in weather conditions that are indispensable for photography, the problem of aviation gas shortage, limited dates of flight for photography (especially limited only to flights on Saturdays and Sundays for color aerial photography over Luanda) and repeated airport shutdown due to use of the airport by governmental VIPs.

MINOPU replied only that the photography permit would be applied for based on the

Report that the Study Team presented at that meeting so that this problem would be resolved by the time of arrival of Mr. Hirai, Team Leader. On this matter, the JICA Study Team requested MINOPU for the official replay in writing.

It was after 3 weeks that the Study Team received the response to the letter that the Study Team sent to MINOPU on the permission for aerial photography. The MINOPU's reply informed very simply that no official permission had been issued yet and that MINOPU had a large expectation for this GIS project. The photography supervisor could do nothing than carrying out the supervision and technical transfer on the land-use study during this free period.

5.4.2. Digitizing of Land-use Compiled Data in Japan

The work this year included scanning of the edited originals that are the results of the field verification for land use classification. The features on the originals were classified to 25 categorized, and digitized as the data were organized in layers.

The basic features such as road, rivers, major facilities from the digital topographic maps were used as the background on the computer display to digitize the land use features. In order to keep consistencies with the land use data and the data from the digital topographic maps, the common lines from the digital topographic maps were copied and used to create some parts of land use areas. The software used was the Microstation and generated DXF-format digital data finally. Therefore, the digitized land use maps will have to be revised as the topographic maps will be updated in the following work year.

5.4.3. The Second Work in Angola

(1) Explanation of Progress / Meeting

Reflecting that the aerial photography work could not be conducted within 2000, JICA modified the contents of the study work for this fiscal year at the end of 2000 and decided to put off the pending items of work to the next fiscal year.

After the Study Team arrival in Angola, the Study Team explained MINOPU about the progress of the changed plan of the fourth year's work and reported the progress report on the study work in 2000 for obtaining MINOPU's approval. As to the successive work, the Study Team explained the uncertain elements in the contract between JICA and Pasco Corporation and the tentative work schedule in which the successive work would be included in the Fifth Year's work.

The Study Team also explained that the seminars to be held by the Study Team in Angola

were scheduled for around the end of September 2001 at earliest.

(2) Supervision of aerial photography

The photography supervision was intended for acquisition of the final permission for aerial photography and completion of the successive color photography of the Luanda area.

However, the Study Team received the response that the permission for photography would not be issued on time because the relevant Minister and other Ministers were busy with the negotiation on the budget for the fiscal 2001. MINOPU replied as ever that the procedure for issuing the permission for photography proceeded to be cleared in March 2001.

To prepare for issue of the photography permit, the Study Team had a meeting with the person responsible for photography of the contractor appointed for photography, and prepared necessary documents for application for the following licenses, which were presented to MINOPU:

① Application for aircraft parking at Luanda airport, application for inspection of aircraft body and the specifications of photographing equipment necessary for application for permission for photography, etc.
② Documents for acquisition of pilot license in Angola
③ Documents related to the cameramen and ground crew

As the photography aircraft, it was decided to use a total of 3 aircraft including 2 rear-jet machines, all of which were of jet fuel type to avoid such aviation gas shortage as experienced in the former study work.

For jet fuel, the Study Team negotiated with the Angola Oil Public Corporation so that the company promised to supply the jet fuel at charge to the contractor for photography in order to cause no fuel problem during photographing.

With the above documents, the Study Team discussed with the official in charge of photography permit at the IGCA's airport office.

5.4.4. Progress of Satellite Images Acquisition

The Fourth Year's work of the Study was to end on March 31st 2001 starting on September 7th 2000.

However, due to political unrest in Angola together with the other reason, aerial photographing work, as a part of the Study, was decided not to execute, and then no progress was achieved in the aerial photographing until the March 2001. To deal with this matter, some details of the work plan were changed, and the work period of the Fourth Year was extended to 30 July 2001.

(1) Use of Satellite Image

In the late March 2001, the aerial photographing work was verbally permitted from the Chief Secretary of the Cabinet of Ministry. The aircraft for photographing work were provided by sub-contractor

However, the formal permission of the aerial photography by the Ministry of Defense was not issued another two months until June. In the meantime, the news of such that airplane were crashed by anti governmental force questioned Japanese side whether to continue the aerial photographing work. Especially, the reliability of air control by Angola and its safety were pointed out. Finally Safety Management Department of JICA as well as its Legal Affairs Bureau put a ban on the work due to a difficulty in security in the air of Angola. As alternative to aerial photographing, the use of satellite images was proposed.

(2) Alternative Plan to Remaining Aerial Photographing

The use of satellite images as alternative to aerial photographing is as follows.

1) Aerial photographs in color at the scale of 1:10,000

"IKONOS" satellite images in color with 1m resolution, which recently became available, are to be acquired.

Retrieving and ordering the data including the archives in the last several years were carried out for the work.

2) Aerial photographs in black and white at the scale of 1:30,000

The remaining area for the aerial photographs in black and white widely ranges, thus acquiring "IKONOS" may cost a lot. According to the work plan, aerial photographs only are to be delivered for the usage for the study on resources development and food delivery planning by agencies concerned of Angola.

As an alternative, "SPOT" satellite images are to be acquired. Monochrome images with

10m resolution are fused with images in multicolor spectrum to finally acquire satellite images with 10m resolution in color.

As described in 1) above, retrieving and ordering the data including the archives in the last several years were carried out.

Each image at the subjected area is printed in the format of every 30-minute of longitude and latitude to make easy reference with existing topographic maps at the scale of 1:100,000.

(3) Acquired Satellite Images

Since the period of the Fourth Year work even after extension was limited, only archives images of the area subjected as above were acquired this time.

"IKONOS" satellite images were acquired for Luanda area 115 k m^2.

Regarding "SPOT" satellite images, 22 monochrome image-data (P), as well as the image-data in color (XI) were acquired for the area of Malanje Southwest, Cuanza-Sul then each one set of paper prints was produced.

5.5. The Final Year's Work (2001)

5.5.1. Updating of 1/25,000-scale digital map data

The 1/25,000-scale digital topographic map data was newly plotted in Japan, based on the results of the field survey made using the 1/30,000-scale aerial photos that were taken in August 1998 and those double-enlarged by MINOPU GIS engineer group in the same year. (See Section 5.2.6.)

In the third-year study work in 2000, the basic maps used to make the land-use survey in Luanda area was verified in the field survey referring to the output maps from these updated digital topographic map data. Planimetric features in the study area had had great secular changes for 2 years since the aerial photography was conducted in 1998. In addition, the field survey on secular changes in the topographic maps was carried out, and the results were wrapped up on the output maps. (See Section 5.4.1.)

The work of updating the 1/25,000-scale digital topographic map data for reflecting these secular changes was made on 11 map sheets (1,000 km^2) in Japan based on the results of the third-year (2000) study.

The software Microstation was used to update the map data for reflecting the secular changes, as in the third year's work. This work was to correct the DXF file for the digital topographic map data.

The residential areas around the center of Luanda area were so rapidly enlarged for 2 years since the aerial photography was made, that the ground survey made by MINOPU engineer group in the previous year could not define the accurate boundaries of the residential areas. The scenery of the city was changing even in the year when the updating work was carried out. The main changes included the enlargement of general residential areas, the newly developed sites, improvements in the main roads, and the addition of new structures related to roads.

The image data acquisition by the satellite "IKONOS" on a part (1/3) of the study area, as scheduled in 2001, was delayed, and the digital topographic map data was corrected within the permitted period of work to reflect the main latest changes in planimetric features.
The corrected digital topographic map data was converted again into the Arc/Info format, and the data classified in layers was compiled to create the Arc/Info coverage data.

5.5.2. Compilation of 1/25,000-scale maps for color printing

The compiled 1/25,000-scale digital topographic map data for printing, which was created in 1998 following creation of the digital topographic map data, was recompiled on the drawing software “Illustrator” run on a computer to reflect secular changes in the map data, after the work of updating secular changes as described in the previous section 5.5.1.

At the same time, the compilation errors that were pointed out and extracted in the inspection of the output maps by MINOPU engineer group were corrected when the land-use survey was made in 1999.

The compiled 1/25,000-scale topographic map data for printing on 11 map sheets was used to create the output maps by means of a color plotter for the final inspection. The products of the study in Japan underwent the type approval test by the official inspection organization, before the printing plates for the maps were produced.

The defects pointed out during the inspection by the Japanese inspection organization were corrected before the produced topographic maps were submitted to the final inspection by MINOPU, and the final map data for printing were created.

5.5.3. Production of satellite images

In and after 1999, it became difficult for several reasons to continue to conduct the aerial photography work as initially scheduled. After having consulted with MINOPU, the Study Team decided to acquire the satellite images of the areas left not shot in August 2001.

In Luanda area, the Study Team decided to acquire the “IKONOS” images for the remaining areas that were not photographed in color, and the “SPOT” images for the other areas.

To do so, the Study Team retrieved and purchased the latest archive image data obtained from the satellites “IKONOS” and “SPOT”. (See Section 5.4.4.)

As for the areas of which any archive image data could not be obtained, the acquisition of their new image data was subcontracted. Thus, the data covering the “IKONOS” areas as well as the southwest of Malange and the west of Cuanza-Sul in the southern region was acquired by December 2001. On Cabinda and Zaire-West covered with clouds over the equatorial zone throughout the year, any complete data has not been obtained, though the satellite shooting continued to be made till the end of February in 2002. Finally these areas were covered by another “SPOT” images and Euro Satelite “ERS” until the end of March in 2002.
The acquired image data is shown in Figs. 5.5.1 to 5.5.3, and Table 5.5.1 to 5.5.3.

Figure 5.5.1 Aerial Photography and “SPOT” Image Acquisiton in Cabinda and Zaire-West Areas

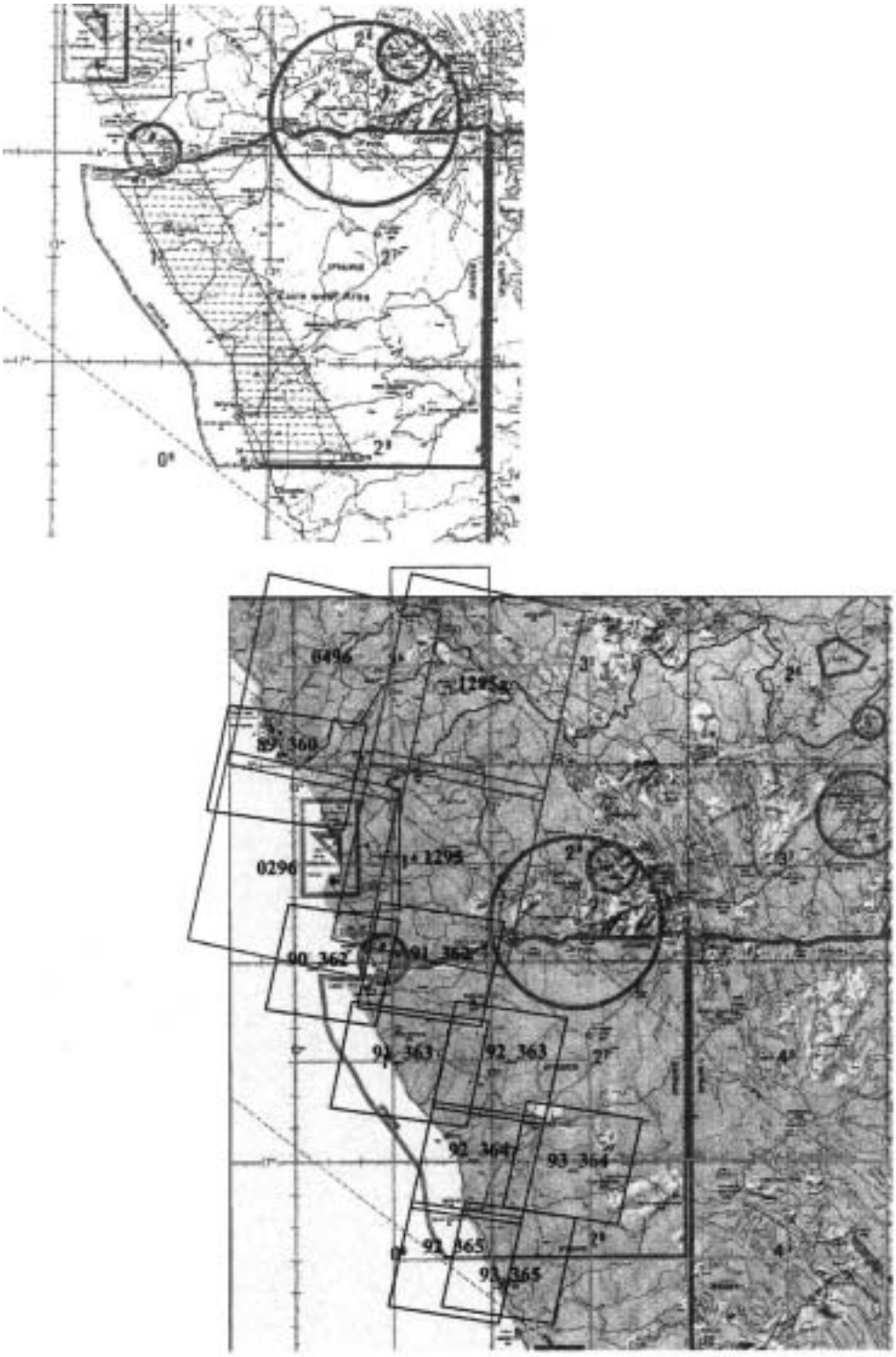
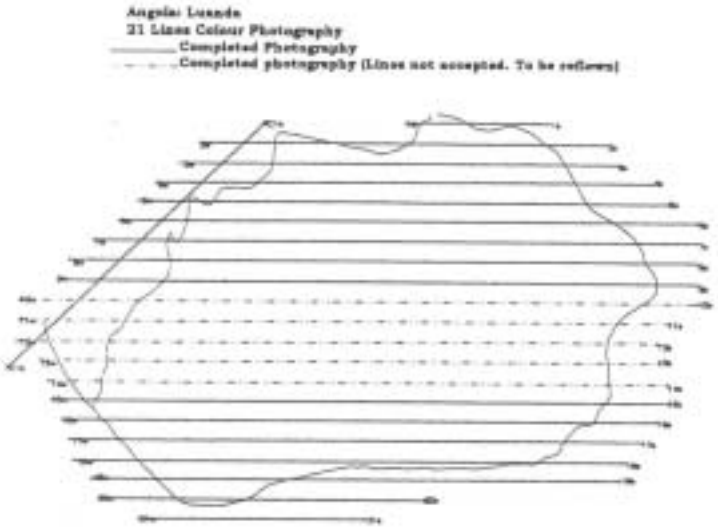


Figure 5.5.2 Aerial Color Photography and Satellite Image Acquisition in Luanda Area



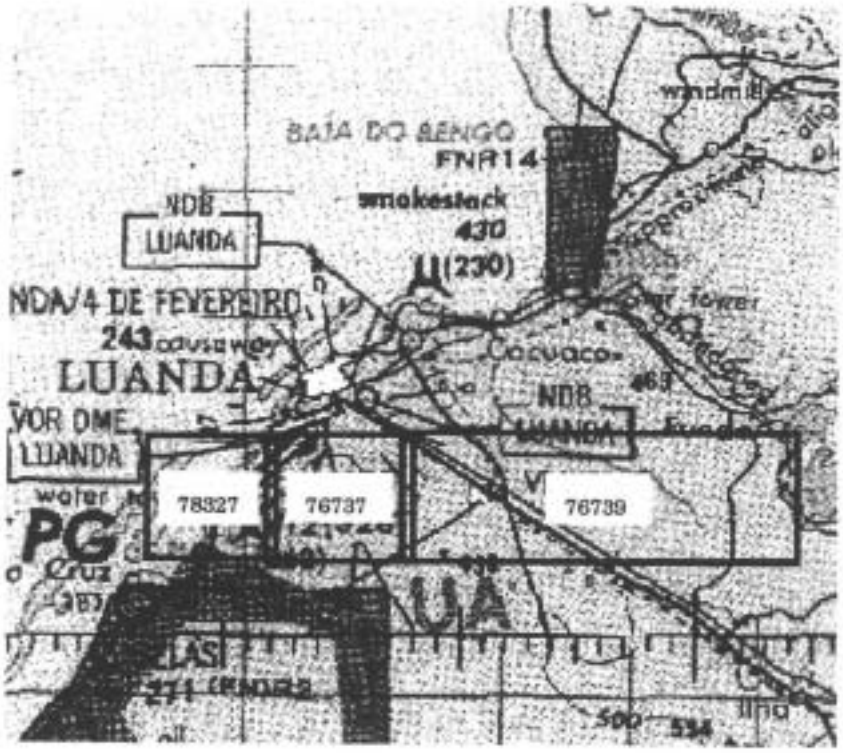


Figure 5.5.3 Aerial Photography and "SPOT" Image Acquisition in Malanje-Southwest and Cuanza-Sul East Area

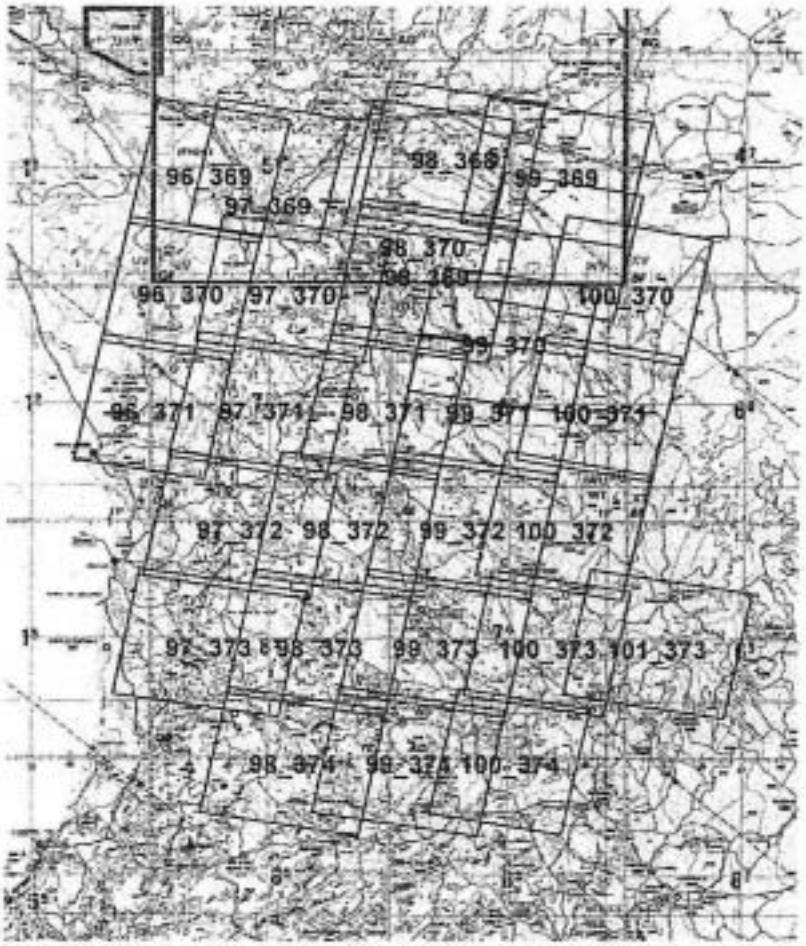


Table 5.5.1 “SPOT” Imagey List (Image level;Pansharpen-1A)

No.	Spot No.	K/J No. K / J	Acquisition. Date	Incidence Angle	Cloud Coverage	Image Quality
1	4	89_360	01/09/25	L30.0		
2	4	90_362	02/0103	R13.1		
3	4	91_362	02/01/19	R24.1		
4	4	91_363	02/01/28	L29.6		
5	4	92_363	01/09/16	R13.1		
6	4	92_364	01/09/16	R13.1		
7	4	92_365	01/09/16	R13.1		
8	4	93_364	01/12/24	R17.2		
9	4	93_365	01/11/22	L15.1		
10	4	96_369	01/09/11	R05.6		
11	4	96_370	01/09/11	R05.6		
12	4	96_371	01/09/11	R05.6		
13	4	97_369	01/11/22	L28.6		
14	4	97_370	00/09/06	L28.6		
15	4	97_371	01/08/27	R25.1		
16	4	97_372	00/09/06	L28.6		
17	4	97_373	01/06/19	L28.6		
18	4	98_368	00/06/15	L25.8		
19	4	98_369	00/06/15	L25.8		
20	4	98_369	01/06/09	L17.9		
21	4	98_370	00/06/15	L25.8		
22	4	98_371	01/08/06	R13.8		
23	4	98_372	00/06/15	L25.1		
24	4	98_373	00/06/15	L25.1		
25	4	98_374	00/06/15	L25.1		
26	4	99_369	00/05/20	L28.6		
27	4	99_369	01/09/22	R16.8		
28	4	99_370	00/07/11	L28.2		
29	4	99_371	00/07/11	L28.2		
30	4	99_372	00/07/11	L28.2		
31	4	99_373	00/07/11	L28.2		
32	4	99_374	00/09/01	L28.2		
33	4	100_370	00/07/02	R22.0		
34	4	100_371	00/07/07	R14.4		
35	4	100_372	00/07/28	R22.0		
36	4	100_373	00/07/27	L17.5		
37	4	100_374	00/09/12	L09.3		
38	4	101_373	00/08/01	L27.9		

Table 5.5.2 “IKONOS” Imagery List

Product Order Number: 76737 Processing Level: Standard Geometrically Corrected Image Type: PAN/MSI Scan Direction: 0 degrees Acquisition Date/Time: 2000-05-17 09:10
Product Order Number: 78327 Processing Level: Standard Geometrically Corrected Image Type: PAN/MSI Scan Azimuth: 0.01 degrees Scan Direction: Forward Acquisition Date/Time: 2001-09-01 09:25
Product Order Number: 76739 Processing Level: Standard Geometrically Corrected Image Type: PAN/MSI
Scan Azimuth: 179.99 degrees Scan Direction: Reverse Acquisition Date/Time: 2001-09-07 09:43 GMT
Scan Azimuth: 180.01 degrees Scan Direction: Reverse Acquisition Date/Time: 2001-10-12 09:19 GMT
Acquisition Date/Time: 2001-10-12 09:20 GMT Scan Azimuth: 0.01 degrees Scan Direction: Forward

Table 5.5.3 “ERS” Imagery List

No. 0296

ID	Orbit/Frame	Date	Satellite	Instrument	Incidence Angle
ERS2/04141/3717/1996-2-4	04141/3717	1996-2-4	ERS2	AMI SAR	23.3193
ERS1/23814/3717/1996-2-3	23814/3717	1996-2-3	ERS1	AMI SAR	23.3193

No. 1295a

ID	Orbit/Frame	Date	Satellite	Instrument	Incidence Angle
ERS2/03368/3699/1995-12-12	03368/3699	1995-12-12	ERS2	AMI SAR	23.3193
ERS1/23041/3699/1995-12-11	23041/3699	1995-12-11	ERS1	AMI SAR	23.3193

No. 0496

ID	Orbit/Frame	Date	Satellite	Instrument	Incidence Angle
ERS2/05143/3699/1996-4-14	05143/3699	1996-4-14	ERS2	AMI SAR	23.3193
ERS1/24816/3699/1996-4-13	24816/3699	1996-4-13	ERS1	AMI SAR	23.3193

No.1295

ID	Orbit/Frame	Date	Satellite	Instrument	Incidence Angle
ERS2/03368/3717/1995-12-12	03368/3717	1995-12-12	ERS2	AMI SAR	23.3193
ERS1/23041/3717/1995-12-11	23041/3717	1995-12-11	ERS1	AMI SAR	23.3193

5.5.4 Map Printing

The compiled digital map data was classified in layers for color separation to represent 6 colors, black, blue, green brown, orange and yellow. The data classified by colors was used to create the output maps, which were then printed on Mylar (transparent) films as the block copies for printing plates.

Color representation was as follows:

Black – Roads, buildings, small objects, general notes, vegetation symbols, and coordinate grids
Cultivated fields (20% masking)

Blue – Lakes and marshes, rivers, water canals, swamps, salt fields, other small objects, river annotations, water depths, depth contours, and small water-related objects
Seas, and lakes and marshes (20% masking)

Green – Vegetation (100% and 20% masking)

Orange – Fireproof residential areas (100% masking), and class-1 and -2 roads (100% masking)

Brown – Contour lines, topographic features and boundarites(50%masking).

Yellow – Non-fireproof residential areas (100% masking), and improved roads (20% masking)

A high resolution was required for the output maps for the block copies used to make printing plates. An image setter that is a high-resolution laser output device was used to create these output maps.

The printing plates were made by printing the block copy output maps on PS plates, and 1,000 copies of each multicolor map sheet were printed on special thick map paper sheets by using a 4-color offset printer.

5.5.5 Installation of GIS Instruments and Data

For building the GIS, it was planned to provide the GIS environment and install the GIS equipment and materials necessary for this Study at the GIS operation room of 75 ㎡ that was prepared by MINOPU on the 4th floor of the joint building in which MINOPU is located.

Originally, it was planned that these GIS equipment and materials would be procured and installed around the middle stage of the study implementation period and used for the study works including digitization of land-use study data to be executed in the second half period. However, this plan was very much delayed due to suspension of dispatch of the Study Team to Angola. As a result, the installation of the equipment and materials and installing of the GIS software and study data was implemented in February 2002.

In addition to the GIS operation room, MINOPU set up a support room adjacent to the operation room and a coordination room for managers about 28m distant from the operation room on the same floor. The Study Team planned to use these facilities as MINOPU GIS Center, provide it with appropriate GIS environment and equip it with a free-access floor in the operation room and furniture to store data and documents, but JICA did not approve the budget for these facilities including the free access and furniture.

The GIS facilities provided in 1999 were only one unit of 10kVA generator as an emergency power supply for computer, 2 units of air conditioners for the operation room and the cabling work for these facilities.

In this, the materials and equipment installed in the MINOPU GIS Center are as follows:

(1) Computers

- Desktop Computers; PC-1 to PC-3 8 sets
  Mini-tower Case (Power Supply 230W)
  CPU: Pentium III 933Mhaz
  RAM: 256MB PC600 RDRAM
  GAP: nVidia THT2 PRO 16MB
  HDD: 40GB ATA/66
  CD-ROM: 20/48 x IDE FDD: 3.5” 1.44MB
  LAN: 10/100MB Ethernet
  Mouse: Intelli-Mouse 3-Button
  Monitor: 21” Trinitron
  Pre-Installed Windows 2000 Professional

- Desktop Computers: PC-9 to PC10 2 sets
  Mini-tower Case (Power Supply 230W)
  CPU: Pentium III 933Mhaz
  RAM: 512MB PC600 RDRAM
  GAP: nVidia THT2 PRO 16MB
  HDD: 40GB ATA/66
  CD-RW: 8 x 4 x 32 FDD: 3.5” 1.44MB
  LAN: 10/100MB Ethernet
  Mouse: Intelli-Mouse 3-Button
  Monitor: 21” Trinitron
  Pre-Installed Windows 2000 Professional

- Laptop PC 1 set
  CPU: Pentium III 750Mhz
  RAM: 128MB
  HDD: 10GB
  CD-ROM: 24x FDD: 3.5” 1.44MB
  Display: 14.1” TFT SXGA
  Pre-Installed Windows 2000 Professional

- Ethernet LAN Subsystem 1 set

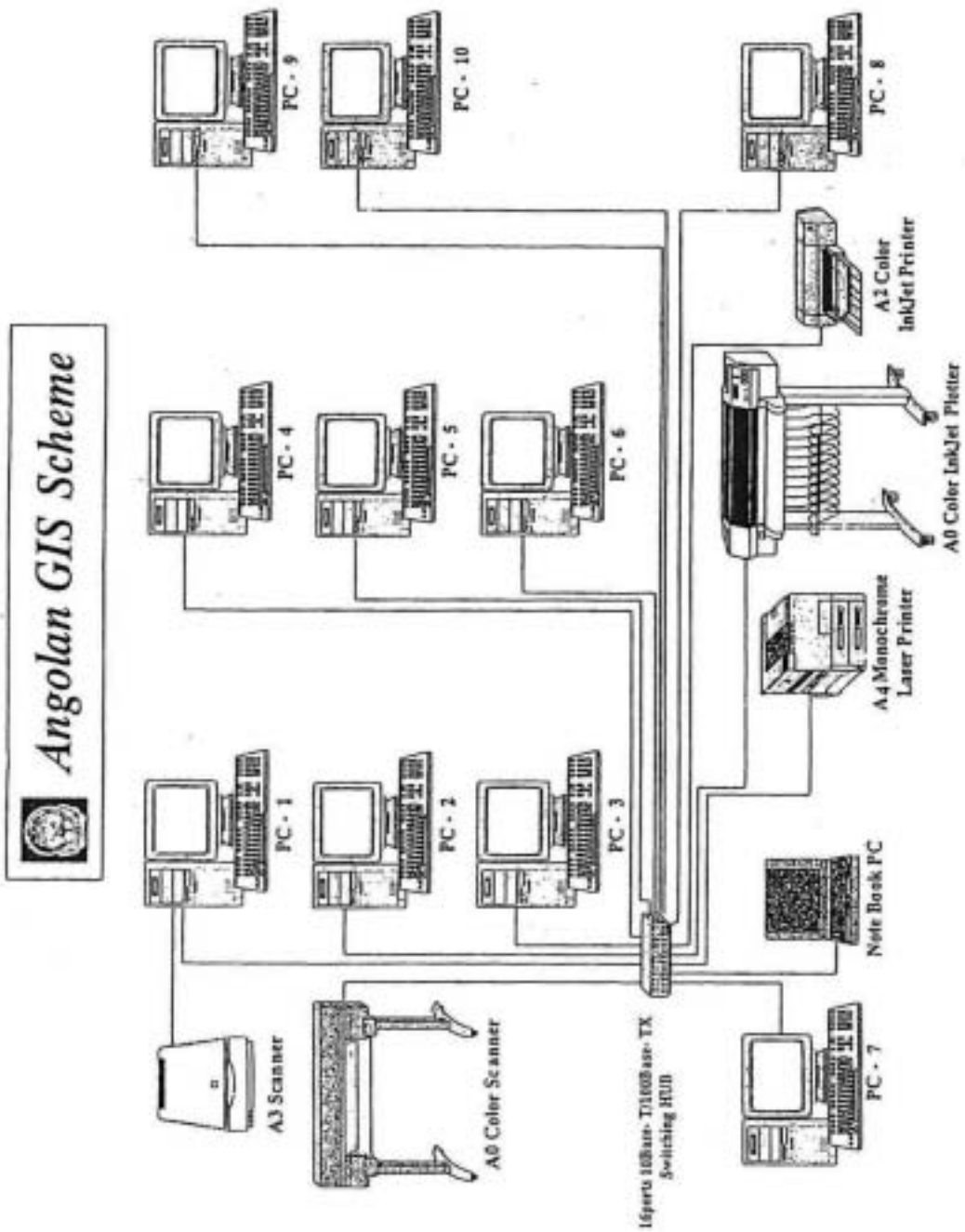
- UPS: APC Smart 100VA 4lec 320 10 sets

(2) Scanners, Plotter and Printers
- Color Scanner: 800dpi (A0 size) 1 set
- Color Scanner: 1600 x 3200dpi (A3/A4 size) 1 set
- Ink-Jet Color Plotter: A0 size 1 set
  Mono: 1200 x 600dpi Color: 600 x 600dpi
- Laser Printer: 1200 x 1200dpi (A4 size) 1 set
- Ink-Jet Color Printer: 1400dpi (A2 size) 1 set
- Ink-sets for each Plotter and Printer

(3) Software
- Arc View v. 3.2 10
- Arc/Info 8.1 1
- ArcEditor GIS v. 8.1 1
- ArcGIS Spatial Analyst v. 8.1 1
- ArcPress for ArcGIS v. 8.1 1
- R2V 2
- Adobe Photoshop v. 6.0 1
- Others

(4) Others
- Paper for Plotter / Printer, Storage Media (CD-R, CD-RW and 3.5” FD)

Figure 5.5.4 GIS System Diagram



5.5.6 Seminar and Technical Transfer

Though the seminars have been originally scheduled two times in Angola at the end of this Survey, it was held one time because the equipments and materials had been imported to MINOPU behind the schedule.

The seminar was held at Hotel Trópico in the morning and afternoon on March 6, 2002, and in the morning, the Study Team made the presentation for the objectives of the Study, prepared survey data and proposed usages of GIS in the future, and in the afternoon, MINOPU had the meeting with the organizations concerned for their interactive usages and operations of the survey results.

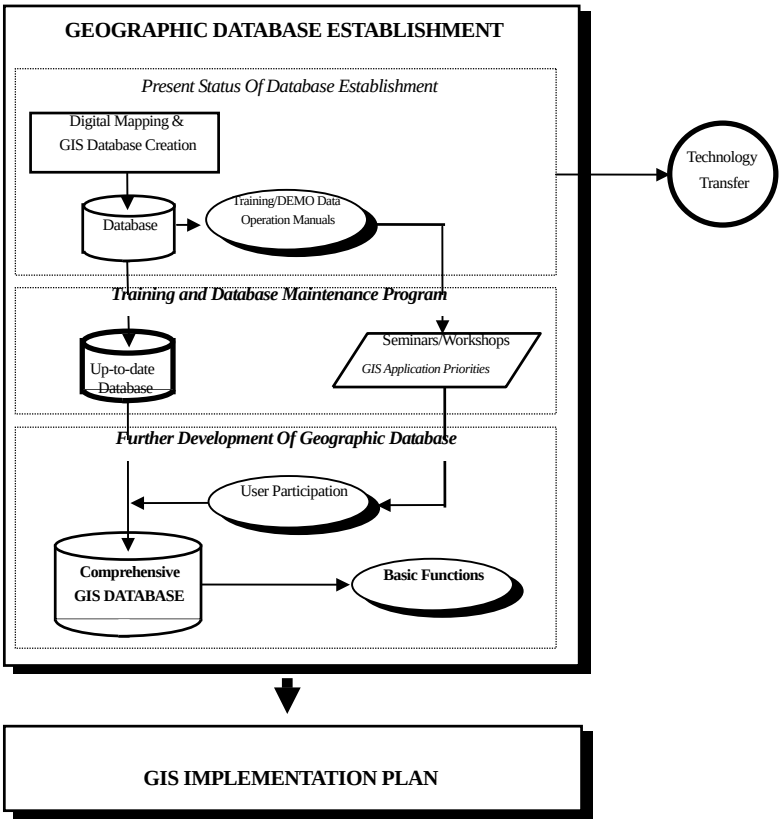
The technical transfer has been conducted to the GIS experts of MINOPU for installations of GIS software, survey data and peripheral computer devices after the introduction of the equipments and materials. Continuous technical transfer was followed for contents and structures of the installed data, data retrieval employed by ArcView, how to output the data by plotters as well how to basically update the data of ArcInfo by following the manuals of the Study.

5.6. Maintaining of Comprehensive GIS Database of Angola

Establishment of Comprehensive Geographic Database in Angola has been carried out within the scope of this Project. It is discussed in this Chapter, how the accomplished database can be maintained, and developed further by MINOPU for the Government of the Republic of Angola.

Three stages in Implementation of GIS, as well as the current stage of GIS Development in Angola have been addressed in the Progress Report 2 of March, 1999; Page 46. The project was properly designed in compliance with the common staging plan for GIS. If all of the proposed project-tasks could be performed smoothly, the first stage of GIS Implementation would be complete. However, due to the unfavorable security conditions for on-site works in Angola, as well as lack of the required attribute data, MINOPU will have to maintain and enhance the accomplished database, without on-site assistance of the Japanese Experts.

However, to facilitate Database Maintenance effort, suggestions are made based on the approach depicted schematically in the Figure below, and discussed more detail in the following chapters.



5.6.1. Present Status of Database Establishment

The Project at the current phase will provide a database and technology transfer materials,

which include a training database for use with the Operation Manuals, and also the data for DEMO purposes on a CD-ROM.

GIS Expert of the Study Team will conduct a presentation to the managerial staff of MINOPU, focusing on "*Database Maintenance Approach Using the Project Documents ?*". It would be useful for MINOPU in preparing a *Database Maintenance Action Plan*.

(1) Database

A database will become available so far, as the data have been acquired in this project at three levels of scale; 1:1,000,000; 1:100,000; and 1:25,000, covering corresponding the Study area defined for each mapping scale.

1/1million Scale data, covering the whole country of Angola are acquired, and a total of nine Arc/Info Coverage (vector data) and one Arc/Info Grid (raster data) are made available, as listed in the table below. These data can be used with Arc/Info Operation Manual, and can be shared by the other Agencies, as well.

Name	Type	Format	Name	Type	Format
ADMIN	Folder	ARC/INFO Coverage	LAKES	Folder	ARC/INFO Coverage
ANIGBP	Folder	ARC/INFO Grid	PROVINCE	Folder	ARC/INFO Coverage
CITIES	Folder	ARC/INFO Coverage	RAILS	Folder	ARC/INFO Coverage
EX-1	Folder	ARC/INFO Workspace	RIVERS	Folder	ARC/INFO Coverage
EX-2	Folder	ARC/INFO Workspace	ROAD_ORG	Folder	ARC/INFO Coverage
EX-3	Folder	ARC/INFO Workspace	ROADS	Folder	ARC/INFO Coverage
EX-4	Folder	ARC/INFO Workspace	VEGETATION	Folder	ARC/INFO Coverage
EX-5	Folder	ARC/INFO Workspace	AGBP.LEG	Text-File	AGBP-Legend
EX-6	Folder	ARC/INFO Workspace	README.DOC	Text-File	Folder Description
INFO	Folder	INFO-Directory			

It is to be noted that the data are acquired from different sources, and those are not complete or outdated. It is advisable to update these data, especially attributes such as, population.

(2) Operation Manuals, Training and DEMO Data

The suggestions in this chapter are discussed with respect to GIS Implementation in Angola, rather than the software usage. In preparing operation manuals, it was attempted to select specific functions of the GIS software, which are useful for the MINOPU staff in maintaining the accomplished database. Any GIS software might be appropriate, so long as the objective discussed here could be met. In that meaning, the operation manuals prepared here are not the "Software User Manual". However, it is advisable for MINOPU staff to work with the user manual, as well.

1) ArcView Training Data Set

ArcView Operation Manual has been prepared in March, 1999. Now, a data set is provided in *Angola*-Folder on the CD-ROM, to facilitate self-study by using that manual. To make feature symbolizing easier, symbol-files are included. An ArcView program (apr-file), a Map-Layout sample, and eps-file for printing are also attached there, to observe the results obtained by the ArcView operations in this manual.

2) Arc/Info Operation Manual

An Arc/Info Operation Manual is prepared comprising of explanatory texts and operation guides for self-study, which will have to use with the *Training Database* described in (1). The Arc/Info functions in this manual are specifically selected to serve database maintenance efforts of MINOPU, including the attribute data editing.

3) DEMO Data

The DEMO data are consisted of digital maps at a scale of 1:1,000,000 covering the whole country area, one map-sheet (No. 89) at a scale of 1:100,000, and one map-sheet (No. 89-c2) at a scale of 1:25,000. All the data layers are in ArcView Shape File format. Sample prints in A4-size are referred throughout the discussions in Chapter 5.6.2, which follows. Reproduction of those samples will be possible using the eps-format print-files in the PRINTS-Folder on the CD-ROM.

5.6.2. Training and Database Maintenance Program

After completion of the current project phase, MINOPU should set highest priority for editing/updating of the accomplished database. Only this up-to-date database will be a sound foundation for further development of GIS in the Republic of Angola. It is advisable to establish a *Database Maintenance Action Plan* which will include Training and Database Development Tasks, by considering suggestions in this chapter.

The *Action Plan* should be designed encouraging the technical staff of MINOUP to learn database updating methods in a productive manner. It means that each of the training module should be completed by a product, as specified in the MINOPU Training Plan. After successful execution of this training plan, MINOPU will be in a position to conduct a series of GIS Workshops and/or GIS Seminars for the other Agencies. The objective should be, to further develop Comprehensive GIS Database of the Republic of Angola, which can be shared by the relating Agencies.

The critical issue might be the selection of trainees. The selected trainees of MINOPU should continuously be trained at all levels of the training program, and should serve the database updating task.

(1) Up-to-date Database

The need for updating database will become evident through the corresponding Progress Report for each level of Mapping Scale. This chapter will focus on the question of "*How To Proceed ?*"

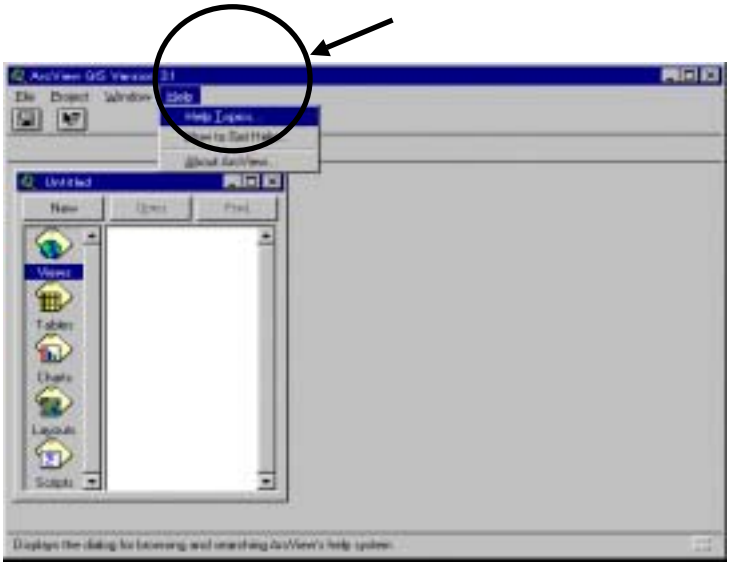
1) Using ArcView Operation Manual

ArcView Operation Manual has been prepared in March, 1999 and now, the Sample Data for this manual is provided on the CD-ROM. The first part of the MINOPU's *Training Plan* is suggested to include "Learning with ArcView Operation Manual".

The students should strongly be encouraged to learn "*Working With Tabular Data*" in On-Line Help of the software, which can be accessed as shown in the figure below.

This learning process will help the technical staff to creatively use the software.

"***Working with tabular data***" can be accessed through this **menu-choice**



After completion of this self-study, the student would be able to produce such display and/or output maps, as shown on the Samples in Appendix 5A-1, 5A-2, and 5A-3.

2) Using Arc/Info Operation Manual

The conceptual background of Arc/Info functions, which are essential to database updating is explained, and the operation guides for self-study are included in this manual. Training-data for use with this operation guides are also provided on the CD-ROM. Special attention should be paid to such topics, as Data Model, Data Management, Topological Errors, Tolerances and the algorithm of Arcedit.

After completion of this self-study, the students will become able to input features (point, line, polygons), correct the topological errors, organize in a common coordinate system, join the attributes to the features, check feature/attribute matching between neighboring sheets, edit feature and/or attribute in necessary cases, and produce an output map. The students will also be able to transfer data from and to Arc/Info.

It is expected that editing/updating attribute data may be the first task of MINOPU's *Database Maintenance Action Plan.* Working with the attribute data can be performed in both ArcView (mentioned in above) and Arc/Info (see Exercise-2 of the Operation Manual).

The students should strongly be encouraged to present critical issues in database development and it's maintenance to the managerial level MINOPU-staff.

The students may have noticed how the data can easily be changed. It may cause redundancy in a multi-user environment. Advisable topics to this concern are; data quality (allowable errors, tolerance), work-load, and Database Management.

(2) GIS Seminars and Workshops

The outcome of the Training using ArcView and Arc/Info is expected to be an Up-to-date Database, and well trained Technical Staff, who would contribute to MINOUP in identifying the requirements for further development of the Comprehensive GIS Database.

Both the up-to-date database and well trained staff are valuable resources for MINOPU to conduct a series of GIS Seminars and Workshops within the scope of the *Database Maintenance Action Plan*. Potential database user Agencies should be the participants.
The objective of the seminars and workshops should be; to clarify the priority for GIS Application.

1) GIS Workshops

Through a series of discussions with the potential GIS-user Agencies, MINOPU should formulate a GIS Seminar and/or Workshop Scenarios. The trained technical staff should serve MINOUP by preparing Workshops Manuals and GIS-maps for presentation. Regarding GIS Workshop, it is suggested to assign trained technical staff of MINOPU as a part of the Training Plan, to prepare Guidebook, which will allow the other Agencies to experience GIS functions by themselves.

The ArcView Operation Manual and DEMO Data could be used for this purpose. The trainees should review and revise that operation manual to better fit the workshop scenarios of MINOUP. The samples in the Appendix 5A-1, 5A-2, 5A-3, or even additional samples can be prepared by using readily available DEMO data. The technical staff, after approval of MINOUP will guide the participants of GIS Workshop. The relating Agencies could have better understanding, how GIS can be useful for them. This understanding is believed to activate *User Participation* in Comprehensive GIS Database Development.

2) GIS Seminars

A series of GIS Seminars should be conducted by MINOPU with the managerial level staff of the other Agencies. The outcome of these seminars should be a proposed "*GIS*

Priority Application". The purpose of this activity is twofold; one is to offer a learning environment for managerial level staff of the participating Agencies, and the other is to obtain active involvement of the concerning Agencies in the development of GIS Database, as well as it's application.

MINOPU technical staff, through the learning process described in above would be able to prepare DEMOs for use in the seminars. GIS Expert of Japanese Study Team during his stay in Angola for the Presentation can provide practical advice to the MINOPU staff. It is suggested that preparation of the seminar documents (DEMOs) should be proceeded in three stages.

a. The first stage :

MINOPU staff should learn to produce display maps, as shown on the samples in Appendix 5A-4, 5A-5, 5A-6, and 5A-7.

b. The second stage :

MINOPU technical staff could prepare seminar documents, which will demonstrate "*How new data can be derived from the GIS Database*".

The following topics may be advisable :

- Land Cover and Land Use

  Land Cover Maps can be produced from the accomplished database in this project. DEMO data are provided. It is recommended in the Seminar to identify whether or not the problems exist and to resolve them, if necessary. The sample maps which can be referred for this purpose are Samples 5A-7, 5A-8, and 5A-9 in the Appendix.

  With respect to GIS Database, one suggested topic to be discussed in the seminars may be the Standard Classification of Land Use and Land Cover. At the current stage of the Project, at least two issues relating to this topic are to be resolved. One is Thematic Mapping for existing land use, and the other is the Layer Specification in Digital Mapping at a Scale of 1:25,000.

  The result of GIS Analysis using the Database is always a new data-set. Following this, the Land Cover data could be produced by overlaying corresponding layers from the database. The layers in the database, however, may have to be specified

properly. The Layer Specification, as suggested on Sample 5A-7 in the Appendix can be considered to this concern.

c. The third stage :

MINOPU technical staff could prepare seminar documents, which will demonstrate "*How information can be queried and analyzed from GIS database*". The suggestions are described in below.

- Public Facility & Ground Control Point Information

  The facility information such as, Photos of buildings or bridges, as well as the scanned Ground Control Point documents can be linked with the corresponding map features. Samples 5A-10, 5A-11, and 5A-12 can be seen in the Appendix. ArcView function used here is termed in the Software User Manual as, *Hot Link*.

- Statistical Information (Population Map of Angola)

  Socio-Economic data can be organized by linking with the digital map data in the GIS Database. An example of *Population Map of Angola* is included in the DEMO data, and printed copy (Sample 5A-13) is attached in the Appendix.

  It should be noted that the population data are not up-to-date. When the database is updated, it can be shared by the other Agencies.

- Network Analysis

  Sample 5A-14 in the Appendix shows the example of *Minimum Path* which is computed by the ArcView-NETWORK Extension software. If Transport Network Analysis should have to be chosen as a GIS Priority Application, then the following considerations may need to be discussed in the seminars.

  - In Appendix 5A-14, the length of line section between two nodes are used to determine the *Minimum Path.* In the Network Studies, however, it is determined by the *economic distance*, which is generally expressed by the travel time on each of the *Link* in the transport network. The travel time may differ, depending on the other factors, such as, traffic congestion. Data acquisition for Network Analysis therefore, may have to be performed by Surveys in a Traffic Study.

  - In Exercise-1 of the Arc/Info Operation Manual, *Node Error* is introduced.
    The acquired Road layer in the database corresponds to the mapping standard. It

may be advisable to prepare specific data-set for specific purpose, for example Network Analysis. The question is, how far the linear road data can be used for the analysis, and how far Digital Mapping works would be feasible in a production environment to fulfill the *Connectivity* condition ?

- The User should be aware of capabilities and limitations, depending on the Network Analysis Software. Even the software chosen in this Project, Arc/Info and ArcView have both Network Extension. Because the maker is the same, methodologies may not differ from each other. But, more functionality are provided in Arc/Info. Due to the *Cost Factor*, software should have to be carefully selected by a clear definition of the objective.

A verity of query functions are possible, when the network analysis is completed. Example in the DEMO data will show a shortest route from Sosso to Dongo.
The results of queries such as, cities passed by this route, the route directions for drivers, and so on. The road sections falling within potential flood danger zones in Appendix 5A-15 could be used for example, supplementary to the minimum path.

5.6.3. Further Development of Geographic Database

The process here is rather straight forward. However, many considerations may have to be made, and it may even be advisable to proceed this task within a GIS Implementation Strategy of the Government of the Republic of Angola.

(1) User Participation and Comprehensive GIS Database

Well trained technical staff, basic and up-to-date database would be available at MINOUP, after successful completion of the tasks in 5.6.1, as well as 5.6.2. Moreover, the other agencies through the seminars and workshops will also be convinced the usefulness of Geographic Database. The application priority chosen by the Agencies will motivate the concerning Agency to actively involve in further development of the accomplished database at MINOUP.

(2) Basic GIS Functions

The updated basic database, which is supplemented by the specific agency-owned data such as, Land-use, Building-use, and so on, might be the best suited data availability condition to verify *Basic GIS Functions.* Which function to be tested may become evident through the

GIS Seminars and Workshops. The critical issue might be funding. It is therefore advisable to conduct this task within the framework of the GIS Implementation Strategy. One considerable approach may be a *Pilot Study Project.*

5.6.4. Summary

A Database and the Technology Transfer materials are prepared and those will be presented within the scope of this Study. The Counterpart MINOPU is expected to update and maintain this database for the Government of the Republic of Angola, by considering the suggestions discussed here. The essential task suggested here is a *Database Maintenance Action Plan*, which is consisted of Training for MINOPU staff, as well as Seminars and/or Workshops for the other Agencies to activate them to be involved in further development of the Database.

The Government of the Republic of Angola is advised to establish a GIS Implementation Plan, which will allow the accomplished resources by this study, to be developed further to a Comprehensive GIS Database, which will work with the GIS Applications. The relevant approach might be a Pilot Study in a selected study area.