CHAPTER 3. TECHNOLOGY TRANSFER

The technology transfer carried out in this project covered all the mapping processes except Aerial photography. The covered processes were:

1. Premarking of GCP (Setting of Aerial Signal)
2. GPS Survey
3. Leveling and Pricking
4. Field Identification
5. Field Completion
6. Aerial Triangulation
7. Digital Plotting
8. Digital Compilation
9. Data Structurization
10. Map Symbolization

Trainings of the former five processes were conducted in the field. The data acquired through these trainings were employed for the actual mapping in this project. Details of each process are reported in CHAPTER 2.

Trainings of the latter five processes were conducted indoors at DCIG with computer systems.

All the trainees are listed in APPENDIX 2.

Table 3.1 Technology transfer sessions

Subject	Period	Contents	Number of participants (trainees)	Remarks
Premarking of GCP (Setting of Aerial signal)	1~11 May 2007	Explanation of purpose and method (materials, allocation, ground condition) Setting of aerial signals at 22 points	4	2-3 signals per day
GPS Survey	19 June ~2 July 2007	Explanation of purpose and method of GPS observation and leveling. Instruction of manipulation of GPS and leveling devices. Training of manipulation of GPS and leveling devices.	4	At CM01 & AZ001

		Training of GPS observation GPS observation at 23 points		
Leveling and Pricking	3 July ~ 16 Aug. 2007	Training of leveling (adjustment, observation) Leveling for 200km Pricking for 135 points	4	7 km per day
Field Identification	20Aug. ~26 Sept. 2007	Explanation of purpose and method of Field identification Field identification for 1,200km^2	4	
Filed Completion	8 Oct. ~ 17 Nov. 2008	Method of putting the results onto the symbolized map sheets Field completion for 1,200km^2	11	
Aerial Triangulation	30 Oct. ~ 17 Nov. 2008	Creation of camera files and data files of ground control points Inner orientation Observation of pass points and tie points Observation of control points Adjustment computation	2	
Digital Plotting	1 Nov. ~ 3 Dec. 2009	Review of Aerial Triangulation Creation of Library Catalog Various settings for digital plotting	1	
Digital Compilation	1 Nov. ~ 3 Dec. 2009	Training of MicroStation Feature creating Data cleaning Creating topology	2	
Data Structurization	13 Oct. ~ 16 Nov. 2008	Understanding the concept of GIS The operation of GIS software The methodology to prepare GIS data base from the complied plotting data.	2	
	15 Nov. ~ 21 Dec. 2009		5	
Symbolization	1 Nov. ~ 3 Dec. 2009	Training of MicroStation for symbolization	2	

3.1. Premarking of GCP (Setting of Aerial Signal)

This work was performed by technical staff members of DTC under the instruction of the Team. During the work, they learned the purpose of premarking of ground control points (GCPs), proper distribution of GCPs, suitable materials, design and color of aerial signal and use of handy GPS. All the established signals were recognized on the aerial photographs which were taken later. The trainees have attained the target level to perform future practical works.

3.2. GPS Survey

This work was performed by technical staff members of DTC under the supervision of the Team. As they did not have experience in GPS survey, they were briefly trained on operation of GPS equipment before GPS observation. Throughout the observation, they have acquired the skill. All the results of the observation were used for aerial triangulation which was done later in Japan. They have attained the target level to perform future practical works.

3.3. Leveling and Pricking

This work was performed by technical staff members of DTC under the supervision of the Team. Digital leveling method was applied to this project. As they did not have experience in digital leveling, they were trained to learn operation of digital leveling equipment before the work. During the work, they have mastered the skill. All the results of the leveling were also used for aerial triangulation which was done later in Japan. It is evaluated that they have attained the target level to perform future practical works.

3.4. Field Identification

This work was performed by technical staff members of DTC and others under the supervision of the Team. They learned stereoscopic viewing, photo-interpretation, on-site identification of topographic features comparing with aerial photographs, compilation of the results on the photographs. All of the results they made were used for digital plotting which was done later in Japan. It is evaluated that they have attained the target level to perform future practical works.

3.5. Field Completion

This work was performed by technical staff members of DTC and others under the supervision of the Team. They learned on-site checking of topographic features which had been plotted on the map in Japan. They also learned map compilation of the features which they corrected on-site. All the results they made were used for digital compilation and map symbolization which were done later in Japan. It is evaluated that they have attained the target level to perform future practical works.

3.6. Aerial Triangulation

The training on aerial triangulation was conducted at DCIG in November 2008. Two (2) trainees from DCIG participated in this session. The trainees are listed in APPENDIX 2.

The target level to attain is that they can do voluntary training. Before the start of training, the Team investigated their skills and knowledge on the aerial triangulation with a questionnaire in order to meet their needs for the technology transfer. Their responses are attached as APPENDIX 7.

3.6.1. Training session

Training of the aerial triangulation was not given every day but every Monday morning and Wednesday morning, because these trainees also participated in the session of Data Structurization.

The training session was conducted as shown in Table 3.2.

Table 3.2 Training session of the Aerial Triangulation (2008)

Date		Contents
30-Oct	Thu	Explanation about the software
Weekend		
2-Nov	Sun	
3-Nov	Mon	How to operate the software
4-Nov	Tue	
5-Nov	Wed	Aerial Triangulation Step 1 (Create New Block & Add Frame to the List)
6-Nov	Thu	
Weekend		
9-Nov	Sun	
10-Nov	Mon	Aerial Triangulation Step 2 (Interior Orientation & Acquisition of Ground Control Points)
11-Nov	Tue	
12-Nov	Wed	Aerial Triangulation Step 3 (Automatic Tie Points Generation & Block Adjustment)
13-Nov	Thu	
Weekend		
16-Nov	Sun	
17-Nov	Mon	Aerial Triangulation Step 4 (DEM Extraction & Orthorectification / Mosaicking)

3.6.2. Contents

The training was carried out based on Figure 3.1. The software used was LPS (Lieca Photgrammetry Suite) version 9.2.

Interface of this software is user-friendly and it is designed in order to understand easily and execute a sequence of work flow from aerial triangulation work to digital plotting.

Modules of LPS used for training with regard to aerial triangulation are shown below.

①. LPS Core

②. LPS Stereo

③. LPS ATE (Automatic Terrain Extraction)

④. LPS TE (Terrain Editor)

⑤. Mosaic Pro

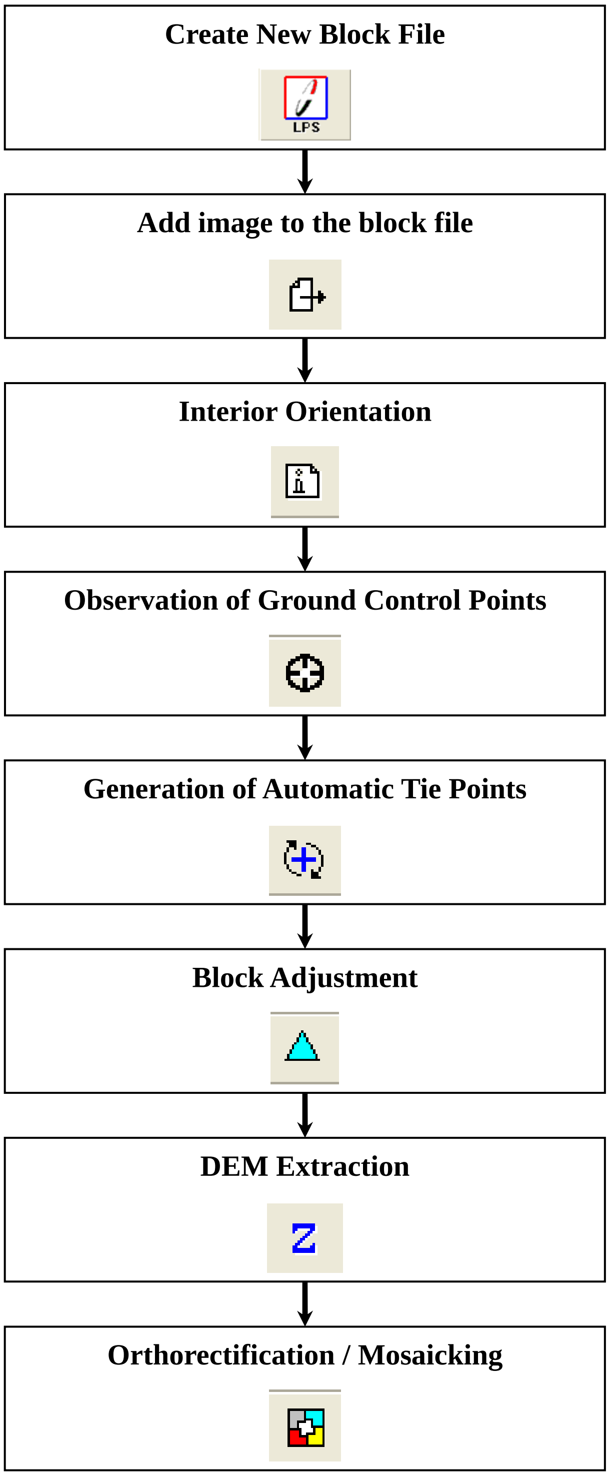


Figure 3.1 Flow of the Aerial Triangulation in LPS

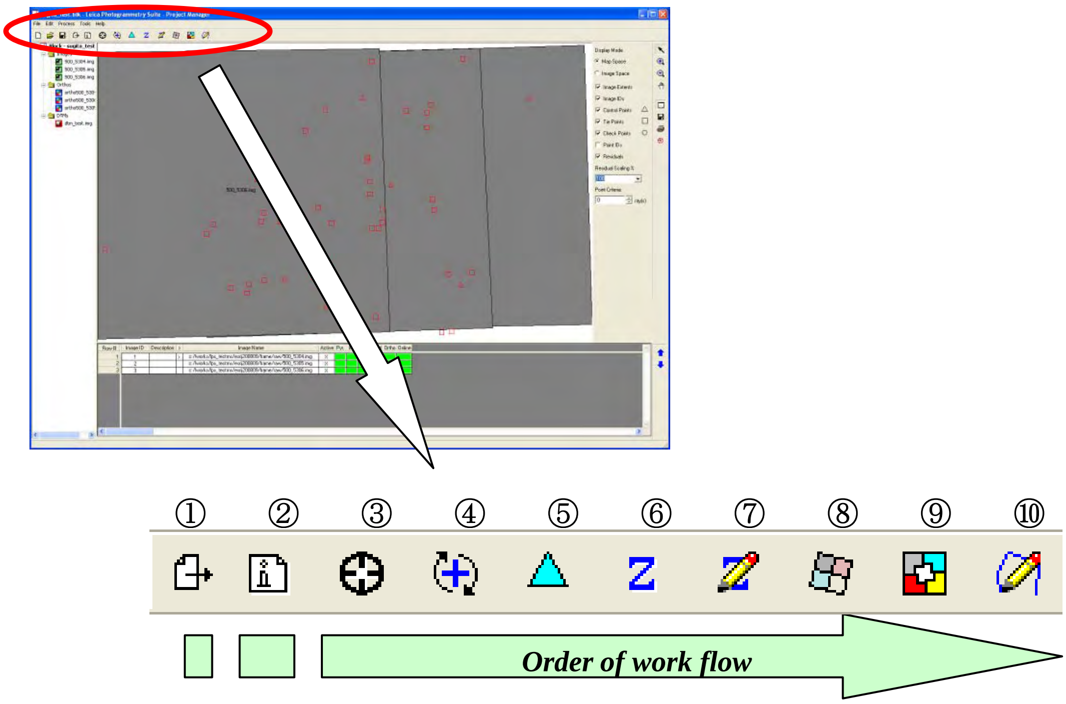


Figure 3.2 Interface of LPS

①. Add Images

②. Frame Editor (Interior Orientation)

③. Point Measurement (Observation of ground control points)

④. Auto Tie (Generation of automatic tie points)

⑤. Triangulation (Block adjustment)

⑥. DEM Extraction

⑦. DEM Editing

⑧. Ortho Resampling

⑨. Ortho Mosaicking

⑩. Feature Collection (This is an item on next year’s technology transfer)

Equipment used for the training

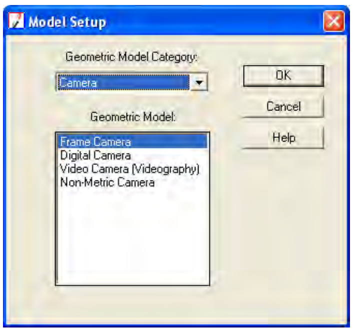
Aspect of training

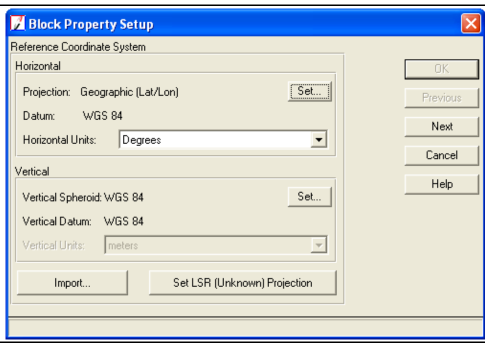
Figure 3.3 Aspect of technology transfer for the aerial triangulation

First, the Team prepared instruction materials for the trainees. The training material such as images was not from the aerial photos taken in this project. The photos used were prepared from other places because the photos taken in this project were unsuitable for trainees to look the ground relief by 3D visualization due to the flat landform of the Study area.

a) <u>Crating a new block file</u>

In this step, a new block file is created for the aerial triangulation. And information such as kind of camera used for photography, coordinate system and so on is set into the block file.



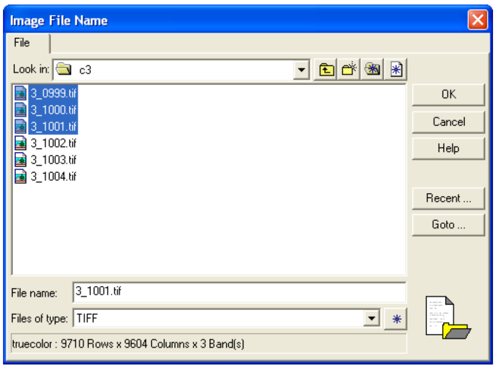


Sample of Setting windows for the block file

Trainees set the information under the instruction of the Team. And they could set without problems.

b) Adding image to the block file

In this step, images to be used for the aerial triangulation are registered into the block file.

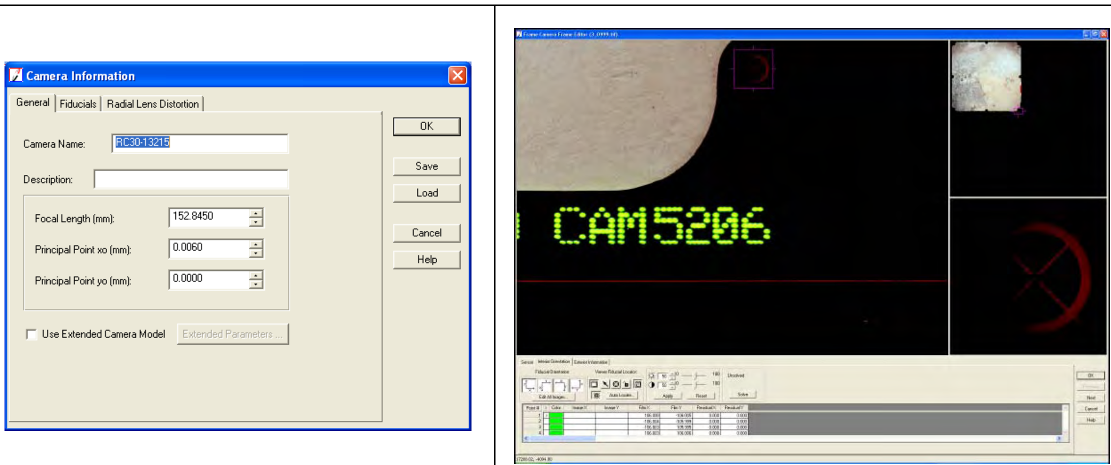


Sample of Setting window

They could conduct this work without problems.

c) Interior Orientation

This is the process of defining the internal geometry of the camera used for photography. Fiducial marks are measured on the image and then compared to the calibrated positions of the camera to derive a solution.

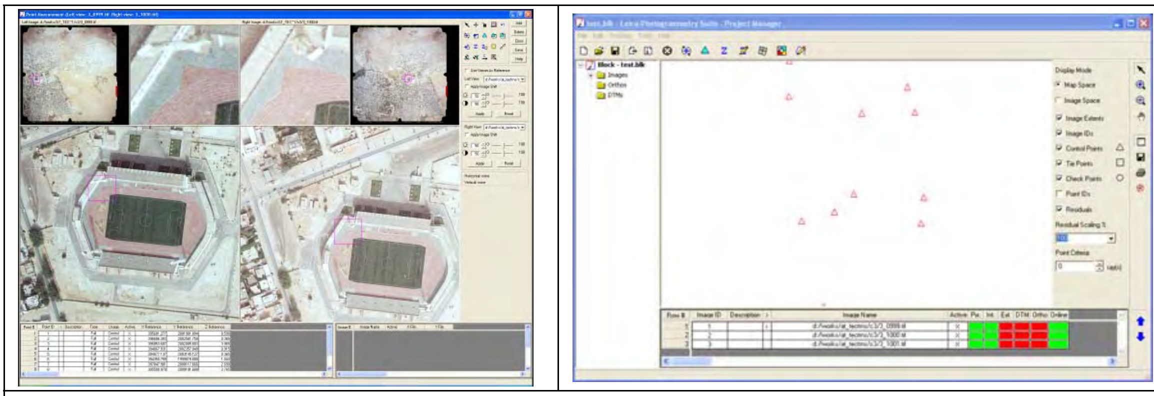


Sample of Setting windows for the interior orientation

Trainees could conduct this process under the instruction of the Team. They, however, must conduct carefully this process which is including inputting camera information and observation of the fiducial marks.

d) Observation of Ground Control Points (GCPs)

In this step, GCPs are observed for the block adjustment (aerial triangulation) by operators. This work is very important for the block adjustment. If this is not conducted correctly, the result of the block adjustment shall be wrong. Therefore, capacity for map reading is required to operator for observing GCPs accurately.

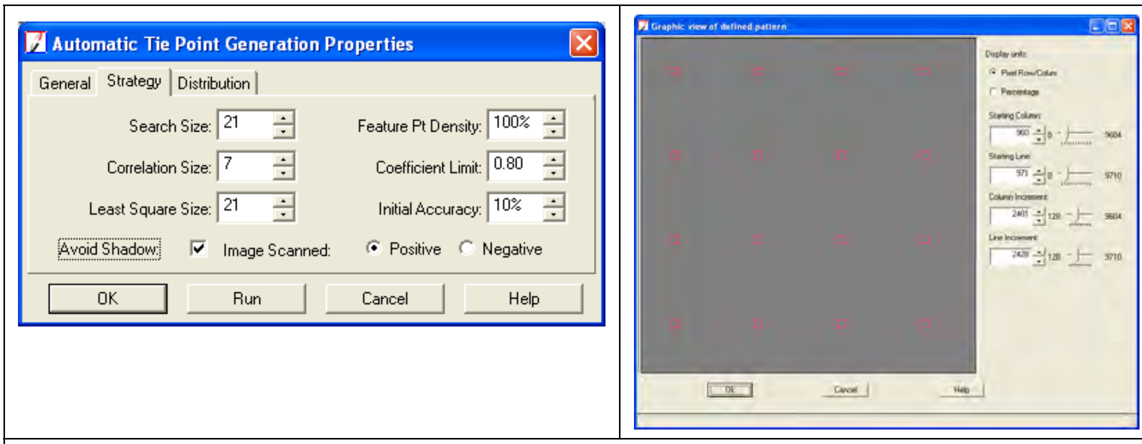


Sample of Setting windows for the interior orientation

Although it took time, trainees could conduct this. They however must skill up the capacity of map reading.

e) Generation of Automatic Tie Points

This is the process of generation of automatic tie points using image matching technology of the software. In this software, both pass points and tie points are called tie points.



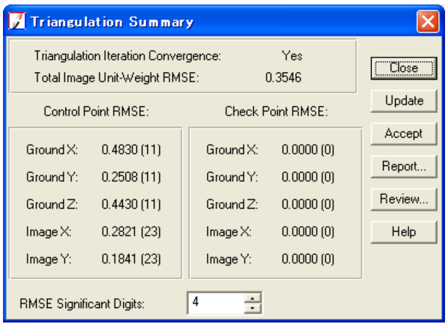
Sample of Setting windows for generation of automatic tie points

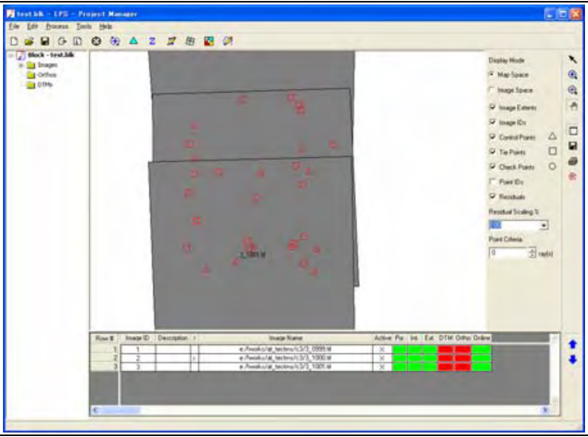
Although the image matching function is very useful for user, the result is not always accurate. Therefore, the result must be checked visually by operator one by one.

The trainees could conduct this process without problems because this step is only to set any parameters. They have tendency to trust the result by software. But, it is necessary to try to check the result by software carefully.

f) <u>Block Adjustment</u>

This is the process of defining the mathematical relationship between the images contained within a block, the camera model that obtained the images, and the ground.



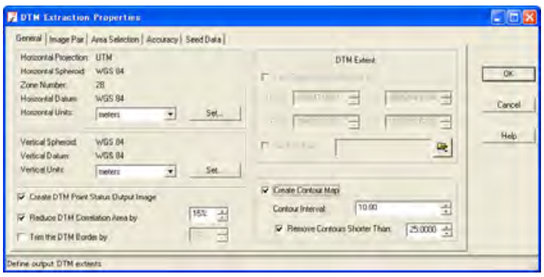


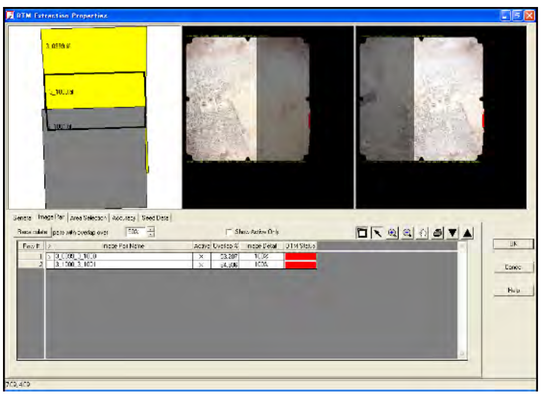
Sample of Setting windows and the result for the block adjustment.

Trainees could conduct this process under the instruction of the Team. They, however, must understand theory of this process and each meaning of various parameters.

g) <u>DEM Extraction</u>

In this step, DEM is extracted automatically from stereo models which are established by the result of the block adjustment.



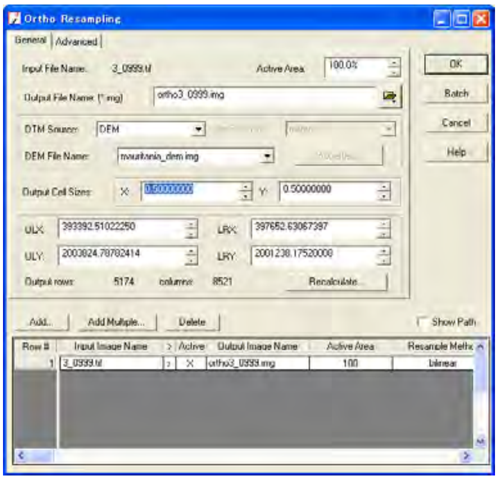


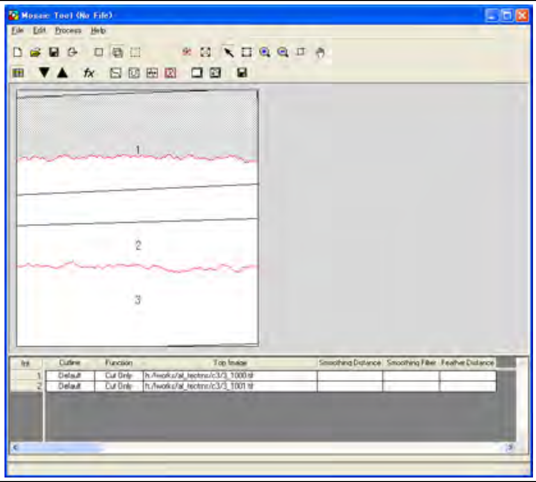
Sample of Setting windows for the DEM extraction.

Trainees could conduct this process under the instruction of the Team. They however must study further meaning of parameters and difference of the result by parameters.

h) Orthorectification / Mosaicking

In this step, the ortho image is generated by using DEM made in above step and the result of aerial triangulation. And the ortho image for large area is generated by mosaicking.





Sample of Setting windows for the Orthorectification / Mosaicking

Trainees could conduct this process under the instruction of the Team. They, however, must study further information about various parameters for the mosaicking. Because there are various options and techniques for color adjustment among neighboring images in the mosaicking process.

3.6.3. Evaluation of trainees and future tasks

a) Evaluation

The team evaluated trainees through the training and as the result of the training.
The evaluation was done from the following aspects.

Table 3.3 The aspects of evaluation for the Aerial Triangulation

	Aspects	Contents
1	Basic Knowledge	Basic knowledge about Photogrammetry, Cartography, Software and this project at start of this training.
2	Motivation	Motivation to understand this training and to apply the result

	Aspects	Contents
		of this training.
3	Understanding	Understanding about the contents of the training
4	Mathematical theory	Understanding about the mathematical theory of aerial triangulation.
5	LPS	Well understanding and manipulation about LPS.
6	Improvement	The improvement of understanding and motivation through this training.
7	Future	The possibility for future application of this training and the data

b) <u>Conclusion and future task</u>

The training was planned in consideration of period, skills and knowledge of trainees. The Team decided that training should be started from software operation not theoretical explanation. The aim of the Team was that trainees studied the theory by themselves after they learned the work steps through the way of software operation.

As current situation, the Team evaluated that the trainees can operate the software. On the other hand, it is expected that the trainees would study and practice more about 3D viewing and measuring by using the material of the training by themselves continuously.

The Team gives the following items for their future task.

- ✧ Practicing using the material of training whenever they have a time.
- ✧ Trying to change the value of parameters in each step and understand their difference.
- ✧ Appreciating the theory of aerial triangulation and its mathematical theory.
- ✧ Having occasions to learn about ground control survey because its knowledge is involved to the aerial triangulation.
- ✧ Improving capacity for map reading.
- ✧ Improving their English skill because language in software is English.

3.7. Digital Plotting

The training on Digital Plotting was conducted at DCIG through November to the beginning of December 2009. One trainee from the Direction of Land Development and Regional Action (DATAR) participated in this session.

The target level to attain is that he can do voluntary training. Before the start of training, the Team investigated his skills and knowledge on digital plotting with a questionnaire in order to meet his needs for the technology transfer. His response is attached as APPENDIX 7.

In practical work, aerial triangulation must have been completed in order to perform the next process of digital plotting. Otherwise, digital plotting is impossible because stereo models established by aerial triangulation are indispensible for data acquisition in 3D visualization. The trainee did not take the session of Aerial Triangulation conducted in 2008. Therefore, a brief training of aerial triangulation was given to him before starting the session of Digital Plotting.

3.7.1. Training Session

The training sessions are shown in Table 3.4.

Table 3.4 Training session of Digital Plotting (2009)

Date		Contents
01-Nov	Sun	Instruction of Technology transfer (Digital plotting, Digital Compilation, Symbolization)
02-Nov	Mon	Explanation of software used
03-Nov	Tue	Review of Aerial Triangulation
04-Nov	Wed	Review of Aerial Triangulation
05-Nov	Thu	Review of Aerial Triangulation
Weekend		
08-Nov	Sun	Review of Aerial Triangulation
09-Nov	Mon	Preparation for Digital Plotting (Creation of Library Catalog)
10-Nov	Tue	Preparation for Digital Plotting (Creation of Library Catalog)
11-Nov	Wed	Preparation for Digital Plotting (Creation of Library Catalog)
12-Nov	Thu	Preparation for Digital Plotting (Creation of Library Catalog)
Weekend		
15-Nov	Sun	Various settings for Digital Plotting
16-Nov	Mon	Various settings for Digital Plotting

Date		Contents
17-Nov	Tue	Various settings for Digital Plotting
18-Nov	Wed	Various settings for Digital Plotting
19-Nov	Thu	Practice
Weekend		
22-Nov	Sun	Practice
23-Nov	Mon	Practice
24-Nov	Tue	Practice
25-Nov	Wed	Practice
26-Nov	Thu	Practice
Weekend		
29-Nov	Sun	Practice
30-Nov	Mon	Evaluation of trainees
1-Dec	Tue	Evaluation of trainees
2-Dec	Wed	Evaluation of trainees
3-Dec	Thu	Generalization

3.7.2. Contents

The training was carried out based on Figure 3.4. The software used was LPS (Leica Photogrammetry Suite) version 9.2 and Bentley MicroStation XM edition (hereinafter MicroStation).

Modules of LPS used for training with regard to plotting are shown below.

①. LPS Core

②. LPS Stereo

③. Pro600 (Pro600 runs on MicroStation platform)

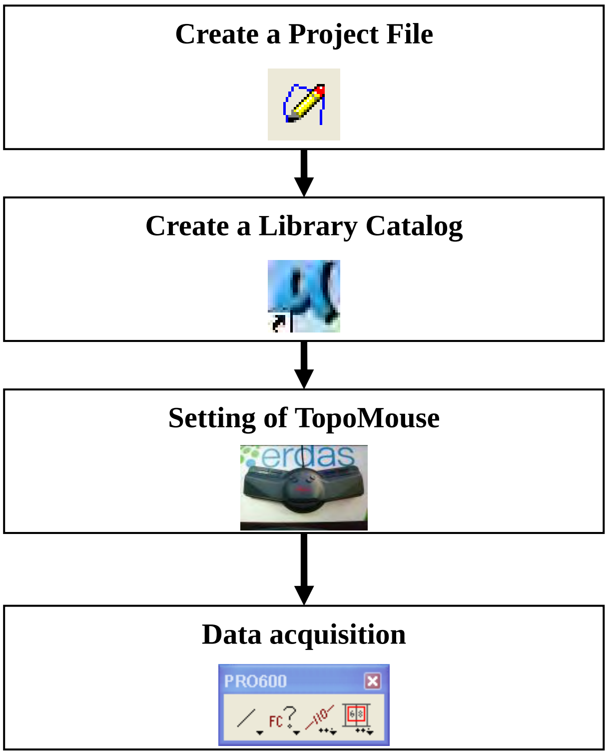


Figure 3.4 Flow of Digital Plotting in LPS

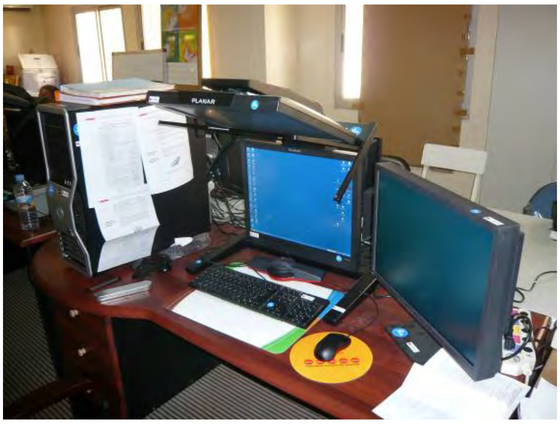
	
Digital photogrammetric system used (LPS and MicroStation are installed)	Instruction

Figure 3.5 Aspect of technology transfer for digital plotting

Aerial triangulation in the project was carried out for about 2,000 km^2 using approximately 450 photos. However, the Team used only 3 photos in the training so that trainees could learn easily the contents of digital plotting and aerial triangulation.

Figure 3.6 shows footprint of photos used in the training. Photos overlap to vertical direction because flight direction in the project was north – south direction. But, a stereo model is displayed right - left.

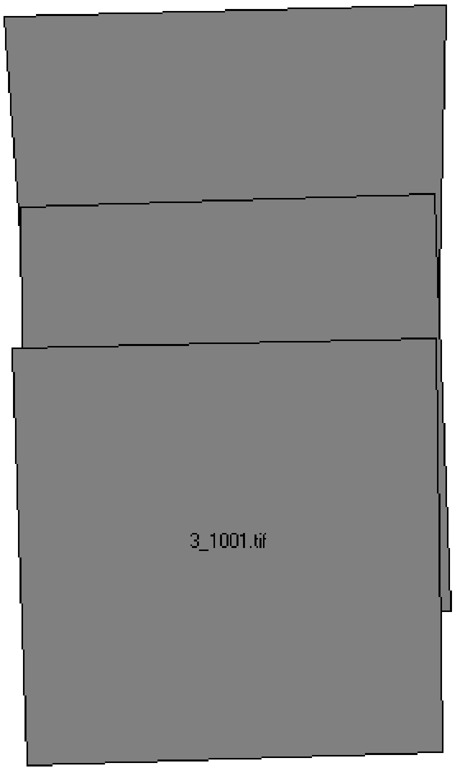
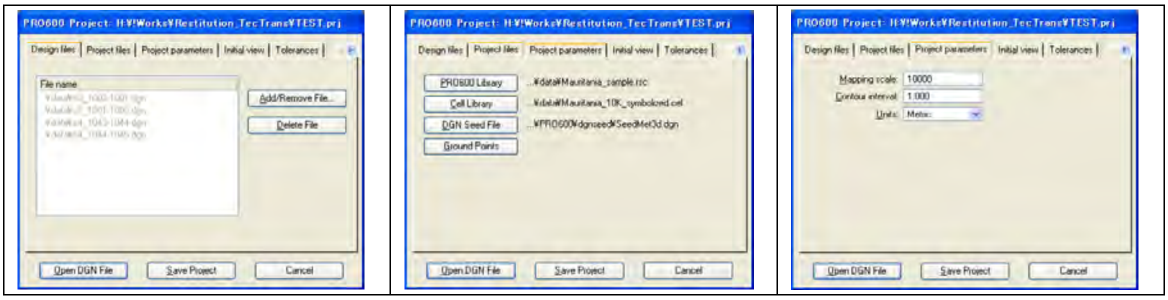


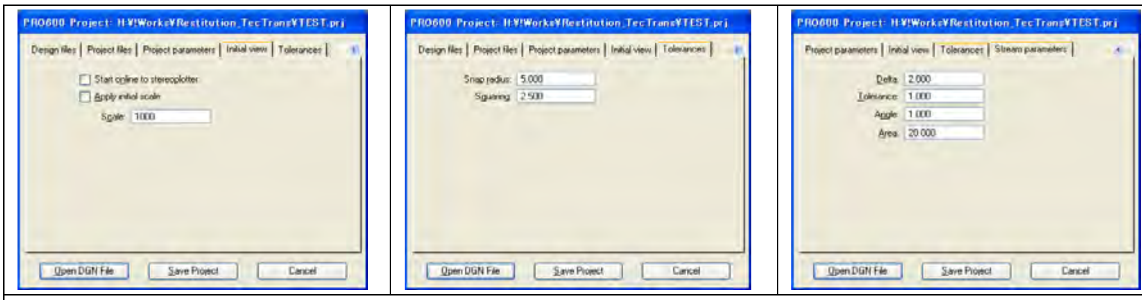
Figure 3.6 Footprint of images

a) <u>Creating a Project File.</u>

To conduct digital plotting using LPS and MicroStation, a Project File must be created in the Pro600 module, and various files and parameters must be set in it. Condition and circumstance of data acquisition are set in the Project File.

The Team has lectured contents of the Project File and explained meaning of each parameter step by step.





Compendium of the Project File

b) <u>Create a Library Catalog.</u>

The Library Catalog must be created depending on the map specification. Therefore, the contents of maps specification must be understood while the Library Catalog is created.

The contents of Library Catalog created must follow the map specification of the project as shown below. Left side in the following images is default setting. On the other hand, right side is the project setting. The code number of each feature has followed the map specification of the project. Otherwise, any features during data acquisition are not stored in appropriate layers and data quality shall be low.

The Team has lectured how to create Catalog for each feature. To create Catalog for each feature correctly, character of each feature has been considered.

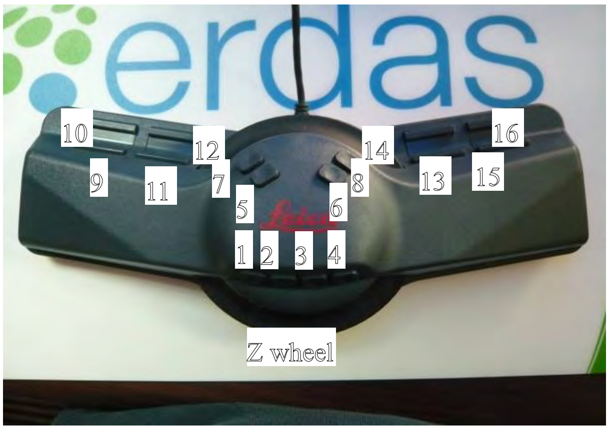
Default Library

Library for the project

c) <u>Setting of TopoMouse</u>

The TopoMouse was installed in the project. In that connection, there are the TopoMouse, the Stealth 3D mouse, the system mouse, the Immersion SoftMouse, the handwheels and footdisk set, and the mouse-trak trackball for data acquisition by 3D visualization, generally.

The TopoMouse has 16 buttons and a wheel as shown below. Moreover, 31 functions exist by combination of buttons. Therefore, it is not easy to learn all functions in short term. A lot of practice shall be necessary to master them.



d) Data acquisition

To acquire the accurate data, operator has to pay the attention to various points such as order of data acquisition, how to interpret features on photos, observation of feature's height and so on. Therefore, it shall take a fair amount of time to master correctly all points for data acquisition and to become independent. It is necessary to practice at short intervals.

In this section, the Team observed trainee's aspect during data acquisition and gave him instruction.

The aspect of stereo model is shown in Figure 3.7. In this report, stereo model is shown on anaglyph mode to show it visually. In practical work, stereo model is displayed on stereo display but anaglyph mode

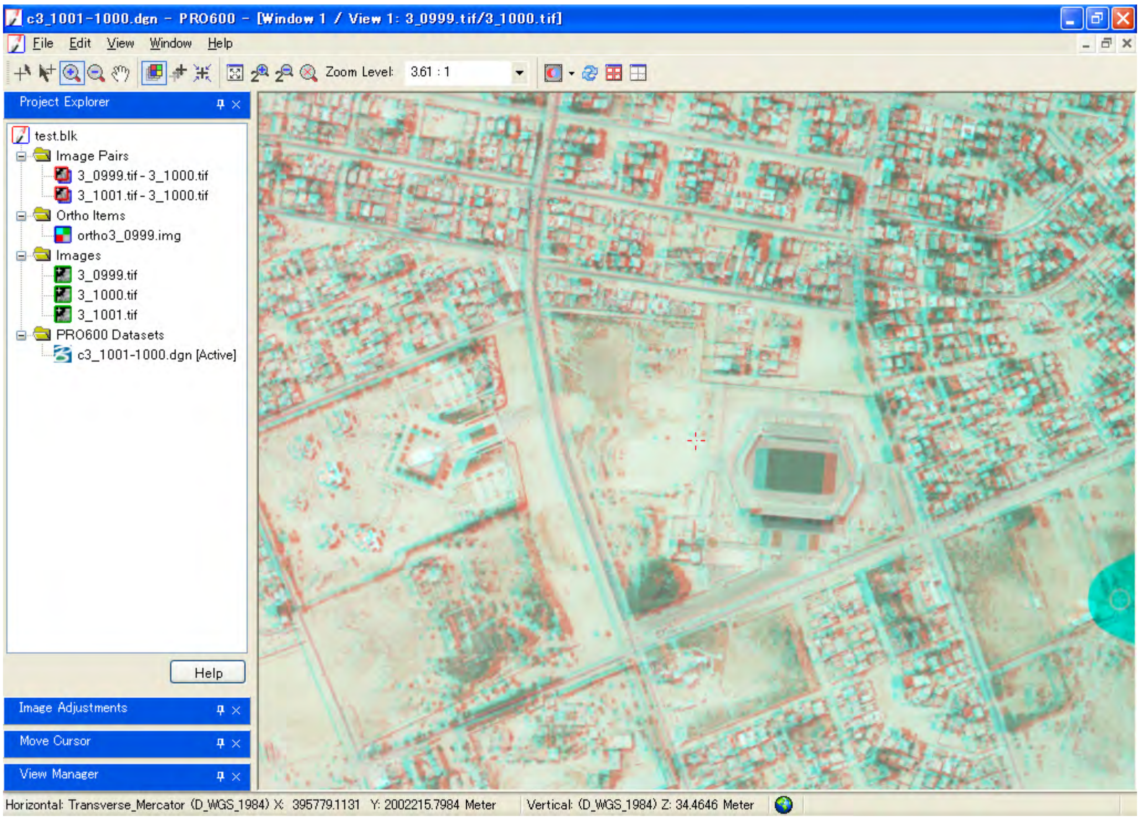
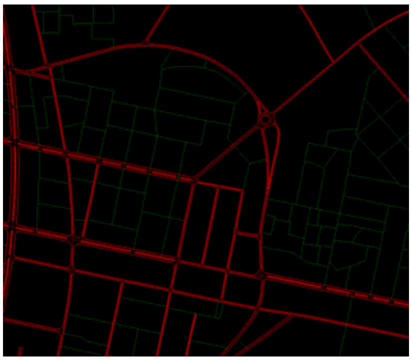
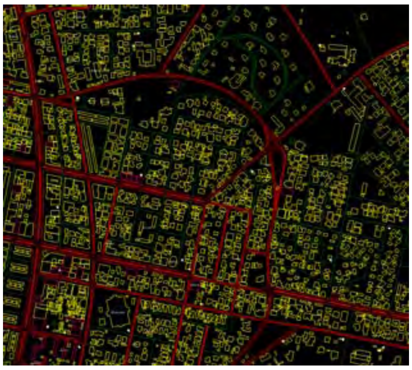
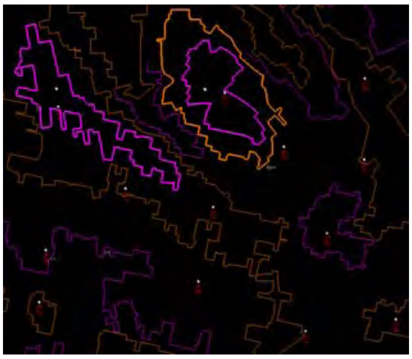


Figure 3.7 Stereo Model in LPS

The following images are sample of order of data acquisition.

1. Line data which shall be bones. (road, railway, river, canal, lake, shore line, power line, pipe line and so on)	
2. Data of buildings, small objects, land marks and plottage. (various buildings, fences, revetments, wells, various tanks, transformer stations, various towers, cemeteries and so on)	
3. Vegetation data (rice field, crop field, orchard, various plantation, forest, bush and so on)	
4. Terrain data (contour, cliff, spot height and so on)	

3.7.3. Evaluation of trainee and future tasks

a) Evaluation

The Team evaluated trainees through the training and as the result of the training. The evaluation was done from the following aspects.

Table 3.5 The aspects of evaluation for the Digital Plotting

	Aspects	Contents
1	Basic Knowledge	Basic knowledge about Photogrammetry, Cartography, Software and this project at start of this training.
2	Motivation	Motivation to understand this training and to apply the result of this training.
3	Understanding	Understanding about the contents of the trainning
4	LPS	Well understanding and manipulation about LPS.
5	Pro600	Well understanding and manipulation about Pro600.
6	MicroStation	Well understanding and manipulation about MicroStation.
7	TopoMouse	Manipulation of TopoMouse
8	Data acquisition	Well understanding and manipulation about Data acquisition.
9	Improvement	The improvement of understanding and motivation through this training.
10	Future	The possibility for future application of this training and the data

b) Conclusion and future task

This trainee had experienced in manipulating ERDAS IMAGINE, which is base software of LPS. Therefore, he could easily understand the manipulation of LPS and could operate it without trouble.

He participated in the training session in a positive manner, precisely taking notes of explanations given by the Team. His level of skill in manipulation of TopoMouse is still low because this manipulation is rather complicated for a beginner. He will be able to make rapid progress in data acquisition of planimetric features if he continues a little more exercise, but, as for terrain features such as contour lines, he is required to do much more and intensive exercise in data acquisition with 3D view.

The Team gives the following items as his future tasks to become independent.

- ✧ Improving knowledge and skills of feature measurement on 3D view.
- ✧ Improving knowledge and skills of photo interpretation.
- ✧ Improving knowledge and skills of geographic features acquisition with 3D photo viewing corresponding map scale.

3.8. Digital Compilation

The training on Digital Compilation was conducted at DCIG through November to the beginning of December 2009. Two (2) trainees from the Société Nationale de l'Eau (SNDE) participated in this training session. They are listed in APPENDIX 2.

The target level to attain is that they can do voluntary training. Before the start of training, the Team investigated their skills and knowledge on digital compilation with a questionnaire in order to meet his needs for the technology transfer. Their response is attached as APPENDIX 7.

On the first day, the Team gave a lecture to the trainees to explain the purpose of Digital Compilation and its relation to Digital Plotting and Symbolization.

Figure 3.8 Explanation about the session

3.8.1. Training session

The training session was conducted as shown in Table 3.6.

Table 3.6 Training sessions of the Digital Compilation (2009)

Date		Contents
01-Nov	Sun	Explanation about technology transfer (Digital plotting, Digital Compilation, Symbolization)
02-Nov	Mon	Basic Training of MicroStation
03-Nov	Tue	Basic Training of MicroStation

Date		Contents
04-Nov	Wed	Basic Training for Creation of Manuals
05-Nov	Thu	Basic Training of MicroStation for symbolization
Weekend		
08-Nov	Sun	Basic Training of MicroStation for symbolization
09-Nov	Mon	Basic Training of MicroStation for symbolization
10-Nov	Tue	Lecture for Data-Type (Point, Line, Polygon) Summary of Digital Compilation (Data Cleaning, Create Topology) Explanation about Feature Catalog
11-Nov	Wed	Lecture for Data Cleaning (Tools for Data Cleaning, The kinds of errors)
12-Nov	Thu	Practice for Data Cleaning (Errors and Tolerance and their effects.)
Weekend		
15-Nov	Sun	Practice for Data Cleaning
16-Nov	Mon	Summarization and documentation of Data Cleaning
17-Nov	Tue	Lecture for Creating Topology (Tools for Creating Topology)
18-Nov	Wed	Practice for Creating Topology
19-Nov	Thu	Summarization and documentation of Data Cleaning
Weekend		
22-Nov	Sun	Practice1, Practice2
23-Nov	Mon	Practice3
24-Nov	Tue	Practice4
25-Nov	Wed	Practice4
26-Nov	Thu	The lecture for Quality Control of Digital Compilation
Weekend		
29-Nov	Sun	Practice5
30-Nov	Mon	Practice5
1-Dec	Tue	Evaluation of trainees
2-Dec	Wed	Evaluation of trainees
3-Dec	Thu	Generalization

a) The basic manipulation of MicroStation

From the response to the Questionnaire (See APPENDIX 7), the situation that all trainees have never touched to any CAD software (MicroStation, AutoCAD, etc) was confirmed, therefore the Team planned the program to start from the basic manipulation of

MicroStation.

In this lecture, the Team lectured and practiced for the basic manipulation of MicroStation and the method of making manuals by themselves.

- STEP1: Drawing

Lecture about tools and basic method for drawing of points, lines, polygons and texts.

- STEP2: Modifying

Lecture about tools and basic method for modifying points, lines, polygons and texts.

- STEP3: View, Raster, Layer, File Control

Lecture about tools and basic method for view, raster, layer, and file control.

b) The objects which need to be modified in digital compilation

The Digital Compilation could be separated into 2 major parts, Data Cleaning and Creating Topology. To learn Data Cleaning and Creating Topology, it is very important to understand the Feature Catalogue which is used in this project is very important.

Trainees learned about the Feature Catalogue and classified each objects.

Table 3.7 The objects and works concerning to Data Cleaning and Creating Topology

Objects	Works in Data Cleaning	Works in Creating Topology
All	Remove Errors (Duplication, Short objects)	
Lines for Network Analysis	Remove Errors (Gaps, Dangles)	
Lines for Creating Polygons	Remove Errors (Gaps, Dangles)	Creating Polygons

Table 3.8 The example of classification of objects in Feature Catalog

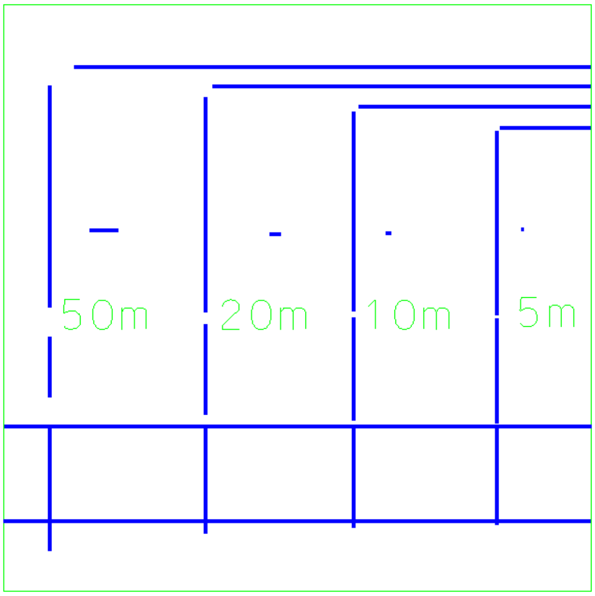
No	Catègorie	Code	Désignation	Data Type	Observations	Classification pour creer de POLYGONE
40	Hydrographie et dé tails particuliers	5101	Lac, Etang, Mare	Polygone	La surfipercifie immergée interprétable sur les photos aériennes dont le côté le plus court est supérieur à 20m sera saisie.	polygone
41		5102	Sebkha	Polygone	La sebkh dont le côté le plus court est supérieur à 100m sera saisi.	polygone
42		5103	Oued	Polygone	La zone immergée au moment de pluie don't le côté le plus court est supérieur à 100m sera saisie.	polygone
43		5104	Zone inondable	Polygone	La zone innondable dont le côté le plus court est supérieur à 100m sera saisie.	polygone
44		5105	Talweg(Lit de oueds)	Ligne	Le lit de oueds dont la longeur est en supérieure à 100m sera saisie.	×
45		5106	Marais salant	Polygone	Le marais salant don't le côté le plus court est supérieur à 50m sera saisi.	polygone
46		5107	Trait de côte(Cordon littoral)	Ligne	Le trait de côte(cordon littoral) au moment de la prise de vue aérienne sera saisi.	○
47		5201	Wharf	Ligne (Polygone)		△
48		5202	Jetée	Ligne (Polygone)		△
49		5203	Brise-lames	Ligne Polygone	Les brise-lames seront encadrées et annotées.	△
50		5204	Revêtement	Ligne	Le revêtement en béton don't le côté le plus court est supérieur à 50m sera saisi.	×
51	Végetation	6001	Limite de la Végétation	Ligne		○
52		6002	Herbes	Polygone	Le terrain herbu dont le côté le plus court est supérieur à 100m sera saisi.	Symbol
53		6003	Buisson	Point Polygone	Le terrain buissonneux dont le côté le plus court est supérieur à 40m sera saisi. Si des buissons sont éparpillés dans d'autres zones de végétation, ils seront représentéés par des points.	Symbol

○:Utilizer comme linéament
△:Utilizer deponds de situation
×:Utilizer jamais
Polygone:Etre deja ″polygone″
Symbol: Pour soulement creation de ″polygone″

c) <u>Data cleaning</u>

- Tools, Errors and Tolerances

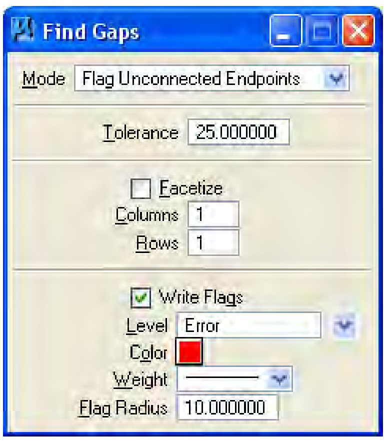
The major tools in Data Cleaning are to find Gaps and find Dongles. To make the trainees understand well about the errors from each tools in Data Cleaning and the setting of tolerance, the Team advanced the training using following sample.



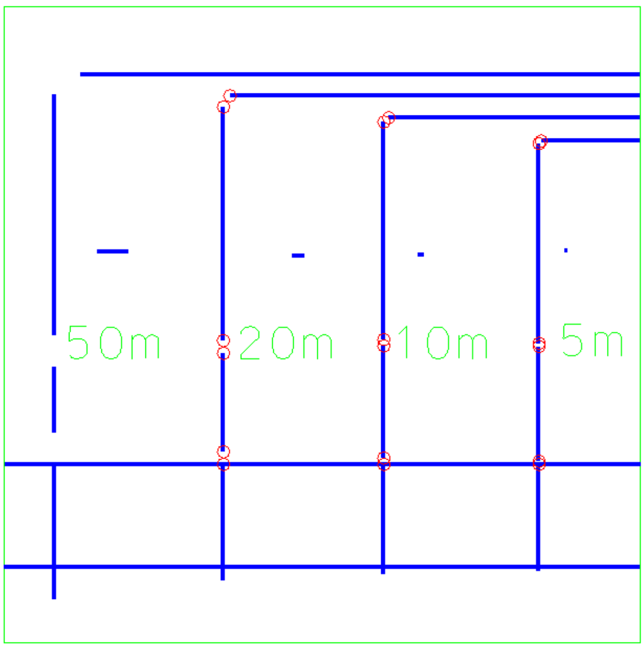
The sample for understanding Errors and Tolerances

d) <u>About tools of finding gaps</u>

In case of following setup of finding gaps, the errors (Red cursors) came as the following figure.



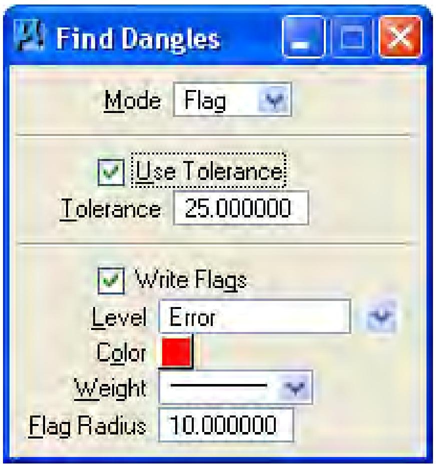
The setting

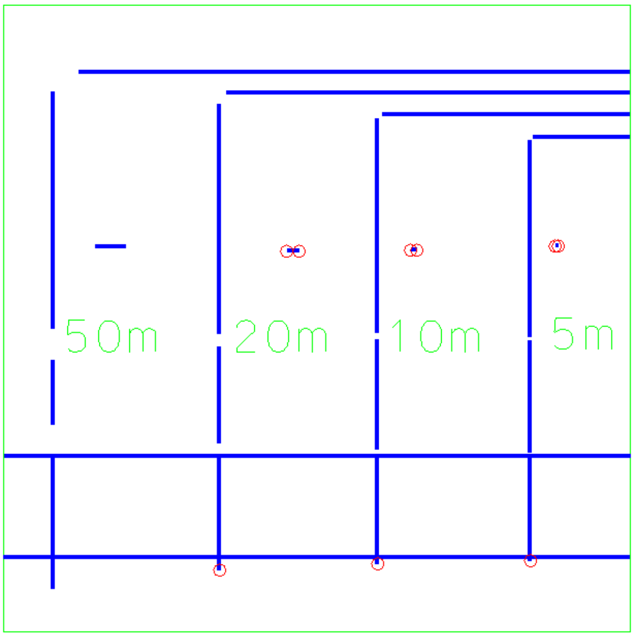


The results of errors from finding gaps

e) <u>About tools of finding dangles</u>

In case of following setup of finding dangles, the errors (Red cursors) came as following figure.





The setting	The results of errors from finding dangles

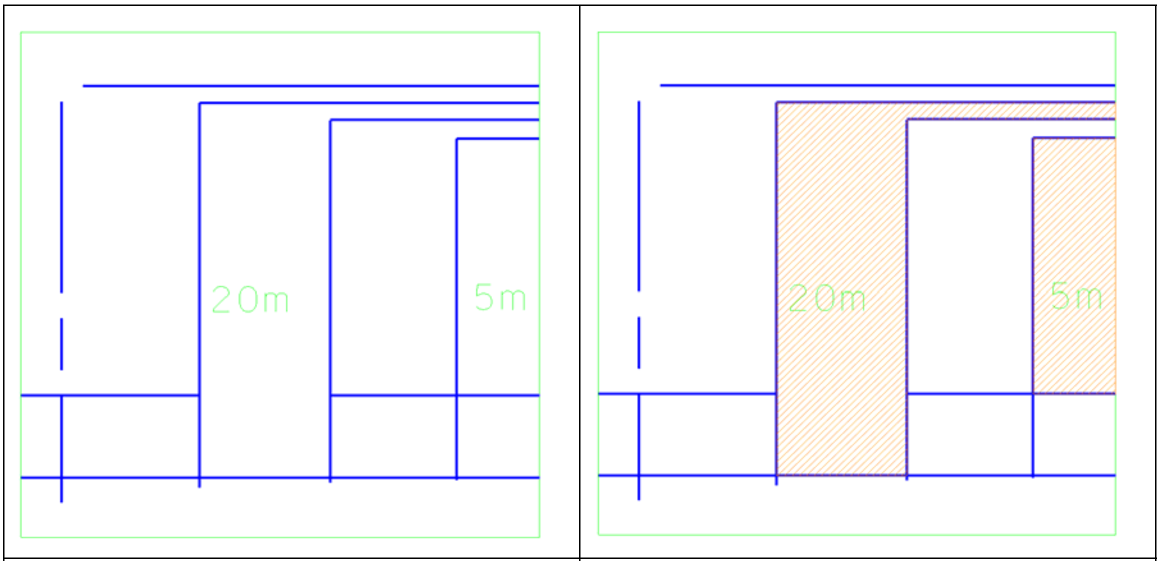
f) <u>Creating Topology</u>

For creating polygons the main tool is Creating Topology. The team explained about the important points in the Creating Topology.

- Before Created topology, all gaps and dangles must be fixed.
- The areas which have symbols in their range could be made polygon.
- The elements should be segmented at every cross points.
- The polygons are created into active layer.

And then the team explained about tools and manipulation for creating topology.

To make the trainees understand well about above points, the Team showed a following example to the trainees.



Before Creating Topology | After Creating Topology

g) <u>Practices</u>

In this practice, Trainees tried 5 type practices.

Table 3.9 The practices for Data Cleaning and Creating Topology

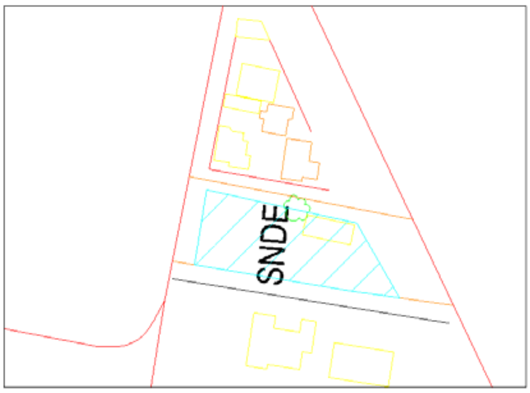
Practice No.	Contents	Target Area (km^2)	Important Points
1	2D Plotting on the orthophoto data for confirmation of Data Cleaning and Creating Topology.	0.03	Review of Data Cleaning and Creating Topology.
2	2D Plotting on the orthophoto data and doing Data Cleaning and Creating Topology.	0.10	Review of Data Cleaning and Creating Topology. To verify the errors which come from the result of Data Cleaning.
3	Practice for Data Cleaning and the result of Data Cleaning.	0.70	To verify the understanding of trainees about the cleaning tools and tolerances.

4	Practice for Data Cleaning and Creating Topology in vegetation area. Quality check for the result of Creating Topology.	2.00	To edit lines concerning the polygons which are being created after the digital compilation.
5	Final practice for Data Cleaning and Creating Topology in urban area.	3.00	To define the lines which are necessary for Data Cleaning and Creating Topology.

- Practice 1

The Team prepared a pilot area as first practice.

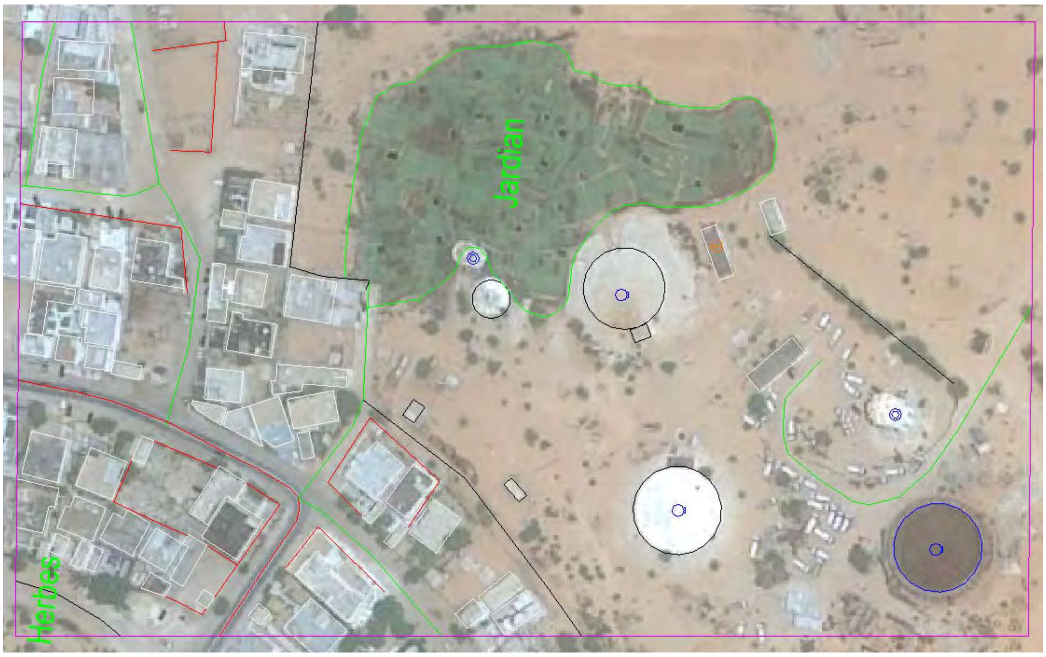
The result of 2D plotting on the image by trainee.



The result of Data cleaning and Creating Topology

- Practice 2

The Team prepared target area bigger than Practice 1



The result of 2D plotting on the image by trainee

Trainees checked and counted the errors from the result of Data Cleaning on the data they plotted. From this confirmation, trainees understood which kind of errors often happen and in which case it will be happened.

Table 3.10 The 2D Plotting errors which detected from Data Cleaning.

Error	Cleaning Tool	Tolerance (m)	Number of errors	Solution
Duplication	Find Duplicate		0	Delete
Gaps	Find Gaps	10	1	Modify
Dangles	Find Dangles	10	6	Delete
Short Objects	Find Dangles	20	2	Delete

	
The 2D plotting errors which are detected by trainees	The result of Data Cleaning and Creating Topology

- Practice 3

The Team prepared a data which has already contains some errors in it. Trainees executed Data Cleaning on the road network to find out these errors.

The data for Practice 3

Table 3.11 The prepared errors by the Team for Practice 3

Error	Number of errors
Duplication	2
Gaps	7
Dangles	3
Short Objects	2

As the result from this Practice, trainees found and understood the difference between errors and each tools and tolerances.

Table 3.12 The errors of road network which detected from Data Cleaning

Errors	Cleaning Tool	Tolerance (m)	Number of errors	Solution	Remarks
Duplication	Find Duplicate		2	Delete	OK
Gaps	Find Gaps	20	9	Modify	There are some small objects which occurred because of being cut by Neatline. However they are not to be modified.
Dangles	Find Dangles	30	5	Delete	There are some overshoots because of the road stops suddenly or connects another kind of road (See Blue Circle). They are not to be modified.
Short Objects	Find Dangles	30	2	Delete	OK

The errors which are detected by trainees

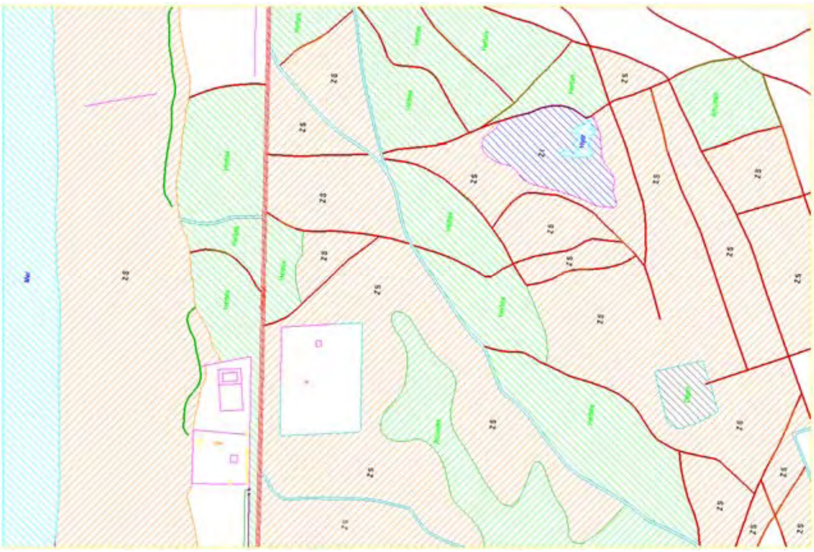
- Practice 4

The team prepared following data as practice. The area covered mainly sea area, sandy area, and vegetation area.

The data for Practice 4

Table 3.13 The classification of layers for Creating Topology

Layer	Object	Use / No Use	Remarks
2002	Voie Goudronnées	Use	
2004	Piste	Use	
2005	Sentier	Use	
2006	Piste aménagée	Use	
2102	La ligne central de Voie Goudronnées	No Use	
3001	Bâtiment	No Use	
3005	Habitat précaire	No Use	
3006	Bâtiment en chantier	No Use	
3007	Bâtiment en ruine	No Use	
4202	Clôture en haie	Use	Use some
4204	Autre limites	Use	
5101	Lac, Etang, Mare	No Use	
5104	Zone inondable	Use	
5107	Ligne côtière	Use	
6001	Limite de la Végetation	Use	
6002	Herbes	Use	Symbol
6004	Arbustes	Use	Symbol
7201	Zone sableuse	Use	Symbol
7204	Escarpement	No Use	
8302	Depôt	Use	Symbol



The result of Data cleaning and Creating Topology of Practice 4

- Practice 5

The Team prepared following data as practice. The area covered mainly urban area. In urban area, there are much more layers than other area and there are a lot of mixed lines complicatedly, which are needed and not needed for Creating Topology.

The points are to find the area should be created polygons and distinguish the necessary layer.

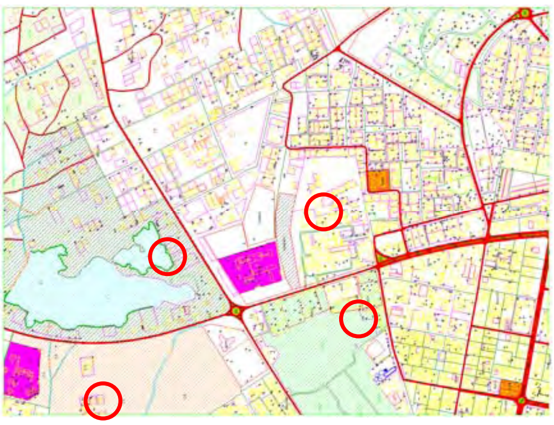
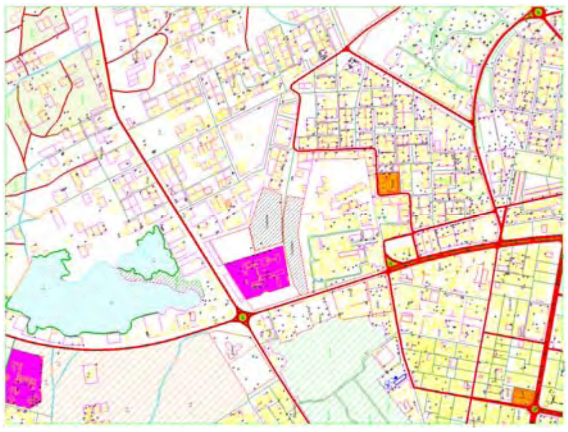
Table 3.14 The polygons which should be created in this Practice

Layer	Polygons	Number of appearance
2002	Voie Goudronnées	1
2010	Terre plein central	26
3103	Ecole	2
3107	Hopital	2
4117	Cimetière	2
5104	Zone inondable	2
6002	Herbes	5
6004	Arbustes	1
6007	Jardins	4
7201	Zone sableuse	5

Notice: Hospital and Schools are not necessary to be polygonized in this project, but there are targets in this practice.

Table 3.15 The result and evaluation of Practice 5

Layer	Polygons	Number of appearance	Result
2002	Voie Goudronnées	1	Good
2010	Terre plein central	26	Good
3103	Ecole	2	Good
3107	Hopital	2	Good
4117	Cimetière	2	A created area was not proper because the border was not enclosed (Gap)
5104	Zone inondable	2	Good
6002	Herbes	5	Good
6004	Arbustes	1	created area was not proper because the border was not enclosed
6007	Jardins	4	Some lines enclose an area ware not segmented so that an area was not polygoned successfully
7201	Zone sableuse	5	Created area was not proper (an area has duplication) because the border was not enclosed

	
The errors and the result of Practice 5	The result after modification of above errors of Practice 5

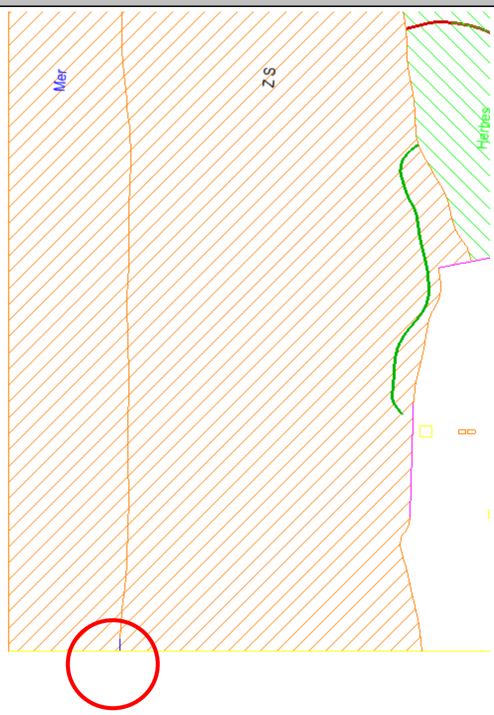
h) <u>Quality Control</u>

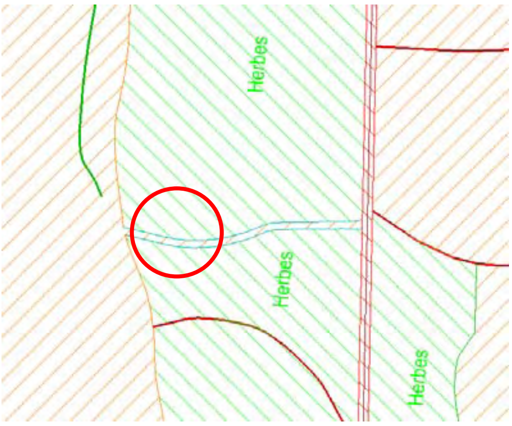
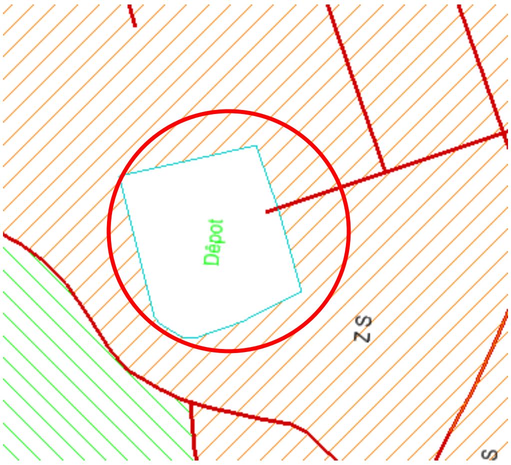
For the check on the result of created polygons (Practice 4), it is necessary to overlay the polygon layers on the original data, and compare the symbols and created polygons.
The following cases are found from this check.

Table 3.16 The type of errors from Creating Topology

Case	State	Cause	Solution
1	There is a polygon in an area which has no symbol.	The area was not enclosed.	Data Cleaning
2	There is an area which has no polygon though there are some symbols in the area.	Creating Topology process was missed	Creating Topology on this area
3	There is no polygon in the area where a polygon should be created.	The miss of putting of symbol inside the area	Put a symbol inside the area.

Table 3.17 Examples of errors as a result from Create Topology

Case	Cause	Example
Case1	The Sea area is covered by “Sableuse”. The line was not connected, the Gap was not detected because the distance was more than “Tolerance” set.	

Case2	The area between "Herbes" (actually road) was covered by "Zone Sableuse". Because the area "Zone Sableuse" was not closed.	
Case3	The "Polygon Creation" has skipped.	

3.8.2. Evaluation of trainees and future tasks

a) Evaluation

The team evaluated trainees through the training and as the result of the training.
The evaluation was done from the following aspects.

Table 3.18 The aspects of evaluation for the Digital Compilation

	Aspects	Contents
1	Basic Knowledge	Basic knowledge about Photogrammetry, Cartography, Software and this project at start of this training.
2	Motivation	Motivation to understand this training and to apply the result of this training.
3	Theory	Well understanding and good motivation for the acquisition toward theory.
4	Manipulation	Well understanding and good motivation for the acquisition toward manipulation of software.
5	MicroStation	Well understanding and manipulation about MicroStation.
6	Data Cleaning	Well understanding and manipulation about Data Cleaning.
7	Creating Topology	Well understanding and manipulation about Creating Topology.
8	Improvement	The improvement of understanding and motivation through this training.
9	Future	The possibility for future application of this training and the data

b) Conclusion and future task

Ms. N'Dourouha had little experience in software except "Microsoft Office" at the start of this training, so that she needed to start from the training of a basic level. However, she tried hard to understand the manipulation of software making her own manuals, and showed remarkable improvement in some practices with slow and steady progress referring her manual.
It is expected that the results (knowledge, technique) of this training and the data of this project would be utilized in some new fields (ex: The planning of water pipes, Land development) by the trainee.

Ms. Yemehelha has already had some experience in AutoCAD, although not so familiar, but her experience was sometimes helpful for understanding the theory and manipulation, and for exercising the software by comparing with the same cases in AutoCAD throughout the training.

It is expected that the results (knowledge, technique) of this training and the data of this project would be utilized in some new fields (ex: The planning of water pipes, Land development) by the trainee.

3.9. Data Structurization

Overall objective of the training on data structurization was to transfer skills for creating GIS data from the compiled plotting data (CAD format) prepared under this project, and further creating some samples of GIS application using the converted data. This training was conducted at DCIG in both the second (2008) and third (2009) phases of the Study. It is expected that this technology transfer would encourage the related organizations for extensive use of data of this project in decision making process.

3.9.1. The Second Phase (2008)

a) Structure and Schedule

Two (2) trainees from the Direction of Cartography and Geographic Information (DCIG) participated in this training. Thus, the number of trainees was good enough to conduct person to person operation support. They are listed in APPENDIX 2.

Before the start of training, the Team investigated their knowledge and experience of data structurization with a questionnaire in order to meet their needs for the technology transfer. Their responses are summarized in Table 3.19.

Table 3.19 Summary of questionnaire response of trainees in the second phase (2008)

SN	Trainee Name	Affiliated Organization	Knowledge about computer	Knowledge of GIS Data	Ever operated GIS Software	Names of operated GIS SoftWare	Understanding of Coordinates	Understanding about Vector data Topology	Ever created GIS data from CAD files
1	Mr. Sow Cheikh	Assistant Director, Cartography service, Direction of Cartography and Geographic Information (DCIG)	Good	Fair	Yes	ArcView (ArcGIS), ArcInfo (ArcGIS), MapInfo, Geoconcept	Yes	Yes	No
2	Mr. Maleck Vall	Chief of Cartography service, Direction of Cartography and Geographic Information (DCIG)	Good	Good	Yes	MapInfo	Yes	yes	yes

The questionnaire survey revealed that, both of the trainees had Good to Fair knowledge of GIS data. They had working experience on MapInfo software and some experience on ArcGIS software, too. However, this was the first training on ArcGIS software for them. Thus, the training was focused mainly on operations of ArcGIS software.

This training was conducted at DCIG from October to November 2008. Altogether 16 sessions (including two review sessions) were conducted. Refer to Table 3.20 below.

Table 3.20 Training session on Data Structurization in the second phase (2008)

Awadh K. SAH, JICA Study Team
October-November, 2008

SN	Date	Day	Time	Topic Description
1	2008/10/13	Monday	10:30-11:30	Lecture: Introduction to GIS
2	2008/10/14	Tuesday	15:00-15:30	Lecture: Introduction to ArcGIS
			15:30-16:00	Practice: Main menu of ArcCatalog
3	2008/10/16	Thursday	10:00-10:30	Demo: Important functions in ArcCatalog
			10:30-12:00	Practice: Iimportant functions in ArcCatalog
4	2008/10/19	Sunday	10:00-10:30	Demo: Menu and important functions in ArcMap
			10:30-12:00	Practice: Main menu and important functions of ArcMap
5	2008/10/21	Tuesday	10:00-10:30	Demo: Menu and important functions in ArcMap *(Continued)*
			10:30-12:00	Practice: Main menu and important functions of ArcMap (Continued)
6	2008/10/23	Thursday	10:00-10:30	Demo: Creating new Dataset (Line, Point)
			10:30-12:00	Practice: Creating new Dataset (Line, Point)
7	2008/10/26	Sunday	10:00-10:30	Demo: Creating new Dataset (Polygon)
			10:30-12:00	Practice: Creating new Dataset (Polygon)
8	2008/10/28	Tuesday	10:00-10:30	Demo: Overviewing the menu and functions for Table
			10:30-12:00	Practice: Overviewing the menu and functions for Table
9	2008/10/30	Thursday	10:00-10:30	Demo: Data query and updating Table data
			10:30-12:00	Practice: querrying and manipulating the tabular data
10	2008/11/2	Sunday	10:00-10:30	Lecture/Demo: Introduction to ArcToolBox
			10:30-12:00	Practice: Main functions of ArcToolBox
11	2008/11/4	Tuesday	10:00-10:30	Lecture/Demo: Some Main functions of ArcToolBox
			10:30-12:00	Practice: Some Main functions of ArcToolBox
12	2008/11/6	Thursday	10:00-10:30	Demo: Logical operator and Map Overlays
			10:30-12:00	Practice: Logical operator and Map Overlays
13	2008/11/9	Sunday	10:00-10:30	Lecture: Map composition
			10:30-12:00	Practice: Map composition
14	2008/11/11	Tuesday	10:00-10:30	Lecture: Overviewing the layers of this Project and schema for GIS database
			10:30-12:00	Practice: Creating schema for GIS database
15	2008/11/13	Thursday	10:00-12:00	Review of previous sessions
16	2008/11/16	Sunday	10:00-12:00	Review of previous sessions

The training was designed to be practical as much as possible. Each session (except the first and review sessions) was divided into two parts: lecture/demonstration, and practice. The practices were designed for immediate practice for the trainees on personal computer.

Figure 3.9 shows the environment of a training session.

Figure 3.9 A session of training in the second phase

b) Content Description

As mentioned above, this training mainly concentrated on operations of ArcGIS software. Sample data covering a part of the Study area was used for the demonstration as well as for practices. The contents are summarized as follows:

- Introduction of Components of ArcGIS software

ArcGIS is an integrated collection of GIS software products for building a complete GIS for an organization. As presented in Figure 3.10, this software has wide range of products and under this project; ArcInfo along with extensions like ArcGIS 3D Analyst, ArcGIS Spatial Analyst, and ArcGIS Network Analyst is being installed.

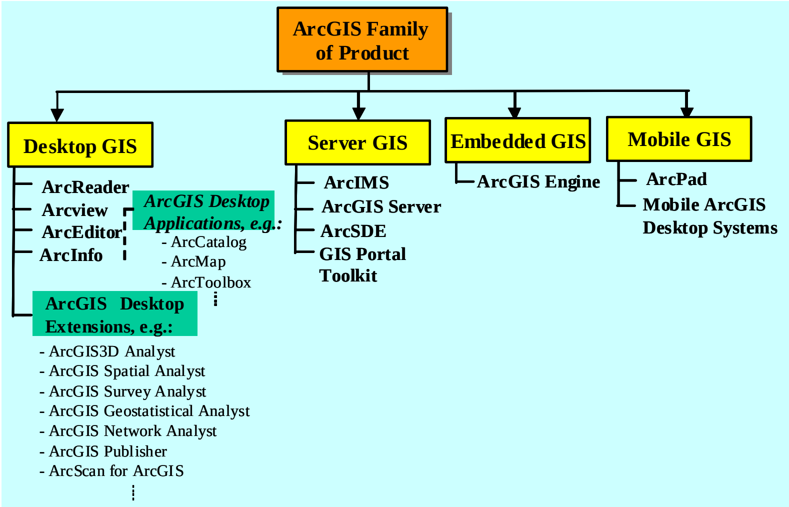


Figure 3.10 ArcGIS Software Family of Products

The components of ArcGIS; ArcCatalog, ArcMap, and ArcToolBox were introduced first by explaining their basic functions. Main points were as follows:

- ArcCatalog:
  - Familiarizing the various Menus (File, Edit, View, Tools, Window, Help).
  - Displaying GIS file and its Table
  - Displaying and Editing of Metadata
  - Creating New Shapefile.
  - Use of "conversion Tools": practice of converting MIF file to Shape file.

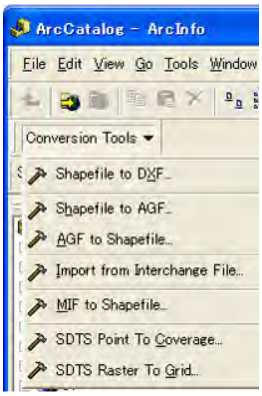


Figure 3.11 Conversion Tools in ArcCatalog of ArcGIS Software

■ ArcMap:

- Familiarizing the Menu including adding a GIS file
- Practicing functions included in the Layer Properties Window.
- Displaying and setting up options in Data Frame Properties.
- Displaying Various Toolbars and familiarizing the included functions.
- Adding the XY data to create point data.

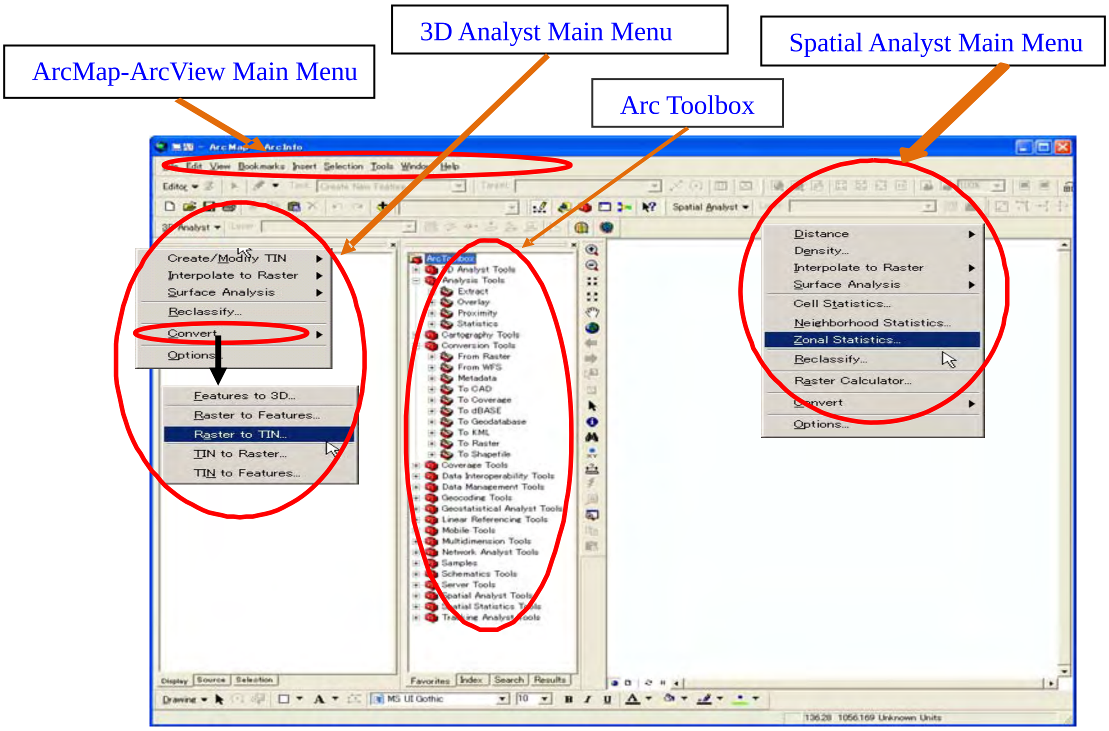


Figure 3.12 ArcMap, ArcToolBox, 3D Analyst, and Spatial Analyst of ArcGIS software

■ ArcToolBox

- Introducing the ToolBoxes, ToolSets, and Tools.
- Practicing with functions under Projection and Transformation, Feature Conversion, Extract, and others.

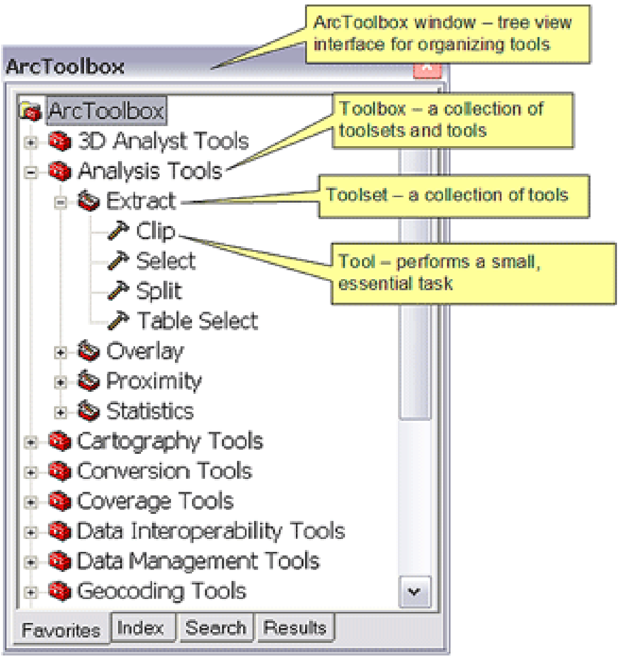


Figure 3.13 Arrangement of ToolBoxes, ToolSets, and Tools in ArcToolBox

- Creation and editing of new spatial dataset

This included creation of new Feature Datasets (Polygon, Line, and Point) using ArcCatalog and then inputting the features using ArcMap. The practices were carried out by assigning small area (about two blocks) within the Nouakchott city to input the features likes building as polygon, road as line, and isolated tree as point.

The inputting features (addition/editing) were carried out in ArcMap using 'Editor' Toolbar, that looks as follows:

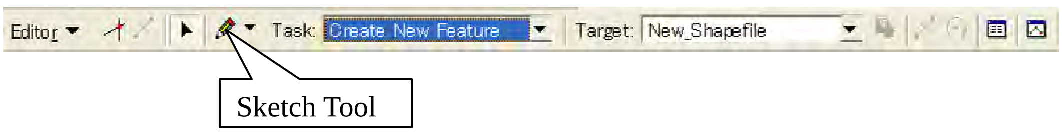


Figure 3.14 Appearance of Editor Tool Bar

- Overview of functions in Table

Along with introducing the menu, various functions in Table Window were practiced, such as how to:

- Select or de-select Rows or Columns (Fields).
- Query data, Add and Delete field, add and edit data in Table, add Length/Area as

separate column.

- Import table created in Excel software.
- Export the selected Rows or whole to a separate file name.

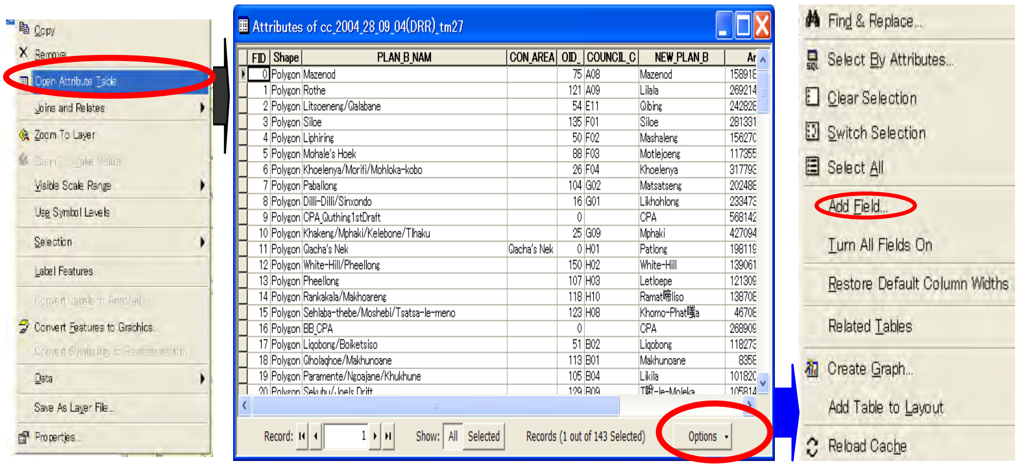


Figure 3.15 Displaying the Table and menu under 'Options' Tab

- Logical operator and spatial analysis

This included building of logics to select set of features based on defined criteria and then exporting these features as a new file. Also, the spatial analysis functions such as Clipping, Buffering the featured with defined criteria, Overlaying features of two files, and Generalizing were explained along with practice. An example of Clipping is presented in Figure 3.16.

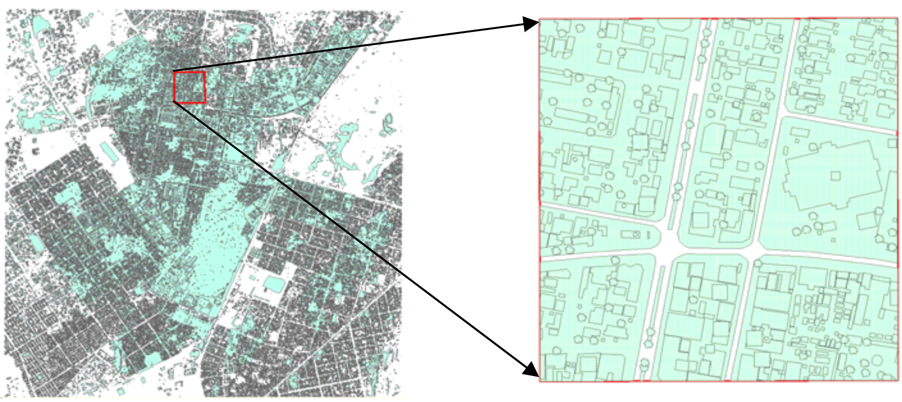


Figure 3.16 An Example of Clipping to extract Data Covering Area of Interest

- Map composition and layout

Steps for preparing layout and composing Map were shown. For this, the features, such as; building, road, and isolated tree, created in sessions “Creating New Dataset” were used as sample data. During this practice, various options for selecting symbols that present in ArcGIS were presented. After inserting items such as Legends, Scale bar, and Text description, function for exporting the map to other formats such as .jpg, .pdf was also carried out. A sample of composed map is presented in Figure 3.17.

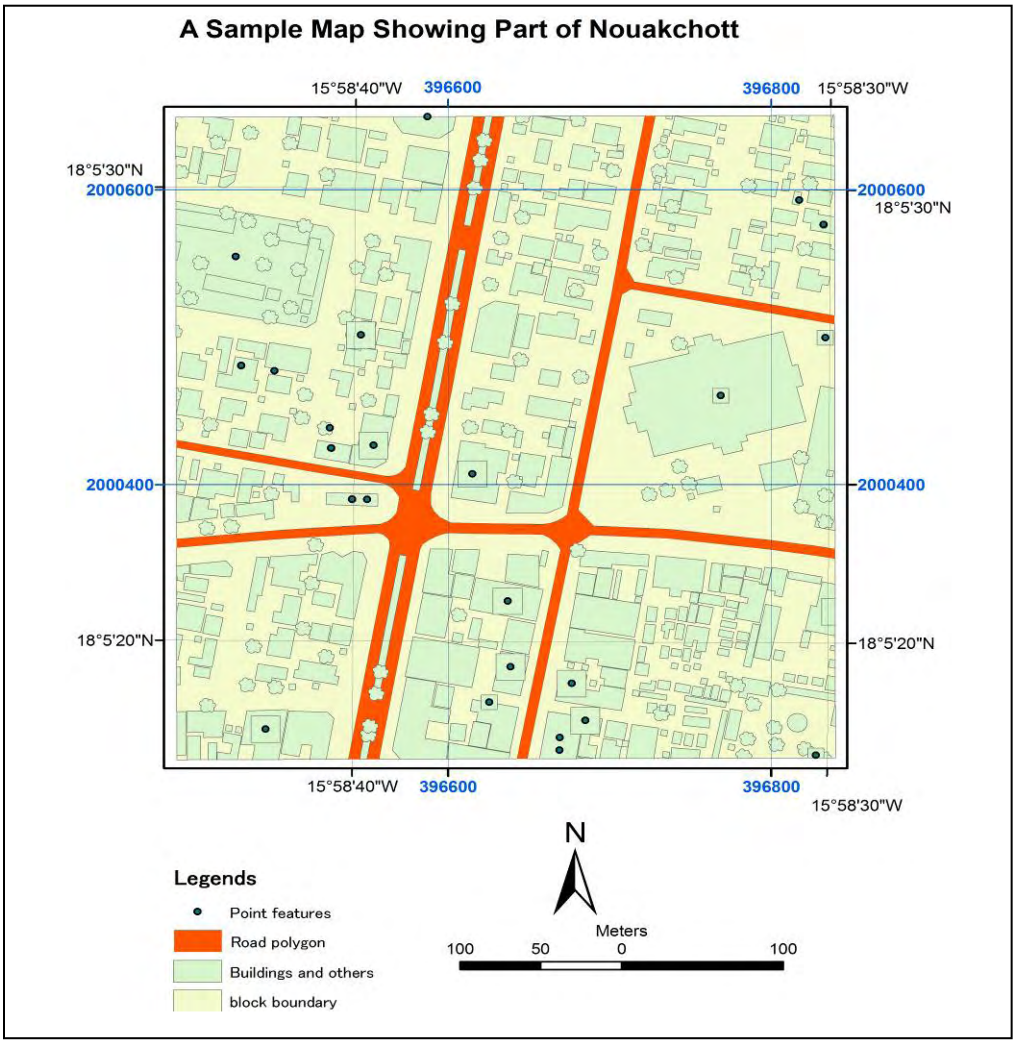


Figure 3.17 A Sample of Composed Map Prepared using ArcGIS

c) <u>Challenges and Resolution</u>

This training being conducted first time for the Trainees, there were some challenges, which were resolved with the optimum efforts. These are listed below:

- Levels of Understanding of English Language:

Challenge: The trainees' level of English understating was not sufficient to quick grasping of operations of ArcGIS software, which is in English.

Resolutions: Communicating through translator; repeating the demonstration; watching their practice activity intensively; promoting them to take note of operations.

Busy schedule:

Challenge: In addition to attend this training course, the attended trainees had also to do their regular task. Thus, despite the willingness, sometimes they remained unable to join some of the training sessions as scheduled.

Resolutions: Re-arranging the schedule, providing time even for individual trainee to make up the missed session.

d) Evaluation of Trainees

The trainees involved in the GIS Data Structurization in this phase were evaluated considering the aspects presented in Table 3.21.

Table 3.21 Aspects for evaluating trainees in the second phase (2008)

	Aspects	Contents
1	Basic Knowledge	Basic knowledge about GIS data and ArcGIS at start of this training.
2	Motivation	Motivation to understand this training and to apply the result of this training.
3	Improvement	Overall improvement of understanding regarding operating ArcGIS, and structurization and analysis of GIS data through this Training.
4	Components of ArcGIS	Improvement of understanding of components of ArcGIS; ArcCatalog, ArcMap, Tables, and ArcToolBox and also about 3D and Spatial Analyst, etc.
5	Input and Edit GIS Data	Improvement of understanding regarding Input and Edit of GIS data.
6	GIS Data Analysis	Improvement of understanding regarding Spatial Analysis of GIS data.
7	Map Composition	Improvement of understanding regarding composing, and printing or exporting map.

	Aspects	Contents
8	Future	The possibility of applying the acquired training knowledge in future.

The level of both trainees, with respect to various aspects mentioned in Table 3.21, was conducted. In conclusion, both trainees showed very good motivation to learn about contents of the training. Despite being busy in other works, they tried their best to attend the sessions. It is expected that they would continue to exercise the operations by themselves.

3.9.2. The Third Phase (2009)

a) Structure and Schedule

Considering that the last training (conducted in the second phase) focused on functions of ArcGIS Software, the training on the third phase emphasized on structurization of GIS data from the compiled plotting data (CAD format) and preparation of sample application using mainly the converted GIS data. However, out of 6 (six) trainees attended this time, 5 (five) had not attended the last training and also a trainee (Mr. Maleck Vall) who attended last time wished to repeat some of lessons carried out last time. Thus, this training composed of three main components with numbers of sessions for each one:

- Introduction of functions of ArcGIS software
- Conversion of the project CAD data to GIS data base.
- Creation of GIS application using mainly converted GIS data

Numbers of sessions were conducted for each of the above components. Refer to Table 3.24.

- Trainees:

This training was attended by six (6) trainees as presented in Table 3.22 below and in APPENDIX 2. They were grouped into three in order to conduct individual training using a restricted number of equipment.

Table 3.22 List of Trainees in the Training of Data Structurization in the third phase (2009)

SN	Trainee Name	Affiliated Organization	Designated Group
1	Mr. Cheikhna Ould Elémine	GIS chief of Service, Mauritanian Geological Research Office (OMRG)	Group 1
2	Mr. Moussa Mamadou Saidou	Chief of Service, Direction of Development of Territory and the Regional Action (DATAR)	Group 2
3	Mr. Maleck Vall	Chief of Cartography service, Direction of Cartography and Geographic Information (DCIG)	Group 3
4	Mr. Sy Abdoul	Chief of Service of Urban Plan, Direction of Urbanism	Group 3
5	Mr. Cheikh Tijani Ould Cheikh Mohamédou	Technical advisor, Urban Community Nouakchott (CUN)	Group 4
6	Ms. Aminetou Mint Mokhtar	GIS Expert, Urban Community Nouakchott (CUN)	Group 4

The trainee Mr. Sow Ceikh, who had attended training in the second phase, could not attend this time as he was transferred to other organization and was busy with his work schedule.

In order to determine an effective means of technology transfer, questionnaire survey was conducted to understand the experiences and knowledge of trainees who attended for the first time in training of this Project. Their response has been summarized in Table 3.23. This revealed that, most of them had Good to Fair knowledge of GIS data and coordinate systems. Some of them had occasional experience of operating GIS software, too.

Figure 3.18 A Session of training in the third phase

Table 3.23 Summary of Questionnaire Response of Trainees in the third phase (2009)

SN	Trainee Name	Knowledge about computer	Knowledge of GIS Data	Ever operated GIS Software	Names of operated GIS SoftWare	Understanding of Coordinates	Understanding about Vector data Topology	Ever created GIS data from CAD files
1	Mr. Cheikhna Ould Elémine	Fair	Fair	Yes	ArcView Ver. 3.X, ArcGIS (ArcView), ArcGIS (ArcInfo), MapInfo, ERDAS, GLOBAL-Mapper9, ENVI4.2	Yes	Yes	Yes
2	Mr. Moussa Mamadou Saidou	Fair	Fair	Yes	ArcGIS (ArcInfo)	Yes	Yes	No
3	Mr. Sy Abdoul	Fair	Negligible	No	-	Yes	No	No
4	Mr. Cheikh Tijani Ould Cheikh Mohamédou	Good	Good	Yes	ArcInfo(ArcGIS), MapInfo	Yes	No	Yes
5	Ms. Aminetou Mint Mokhtar	Good	Fair	Yes	ArcView Ver. 3.X, MapInfo	Yes	No	Yes

This training was conducted at DCIG from November to December 2009 and considering the above questionnaire response, detail components of technology transfer were determined and arranged in 17 sessions (including one for review). Refer to Table 3.24.

The training sessions were designed to be practical as much as possible. For that purpose, sessions were divided into two parts: lectures/demonstrations, and practices. The demonstration was conducted including all trainees as one group while for practices, trainees were divided into 4 groups (with 1 or 2 trainees/ group) to conduct person to person operation support. Refer to Table 3.22. The practices were designed for immediate practice for the trainees on personal computer. Environment in one of a demonstration session is presented in Figure 3.18.

Moreover, Mr. Cheikh Tijani Ould Cheikh Mohamédou and Ms. Aminetou Mint Mokhtar having joined the training from 1st December, additional discussions were arranged for them to cover the items of the previous sessions.

Table 3.24 Training sessions on Data Structurization in 3rd Phase (2009)

SN	Date	Day	Time	Topic Covered in the Session
1	2009/11/15	Sunday	10:30-11:30	Lecture: Orientation about OJT-2; Introduction about GIS and ArcGIS
2	2009/11/16	Monday	9:30-10:45	Demo: Menu and Functions in ArcCatalog
			11:00-12:00	Practice: Menu and Functions in ArcCatalog (Group 1)
			12:00-13:00	Practice: Menu and Functions in ArcCatalog (Group 2)
			15:00-17:00	Practice: Menu and Functions in ArcCatalog (Group 3)
3	2009/11/17	Tuesday	9:30-10:45	Demo: Menu and important functions in ArcMap
			11:00-12:00	Practice: Menu and Functions in ArcMap (Group 1)
			12:00-13:00	Practice: Menu and Functions in ArcMap (Group 2)
			15:00-17:00	Practice: Menu and Functions in ArcMap (Group3)
4	2009/11/19	Thursday	9:30-10:45	Demo: Creating New Dataset (Line, Point, and Polygon)
			11:00-12:00	Practice: Creating New Dataset (Line, Point, and Polygon) (Group 1)
			12:00-13:00	Practice: Creating New Dataset (Line, Point, and Polygon) (Group 2)
			15:00-17:00	Practice: Creating New Dataset (Line, Point, and Polygon) (Group 3)
5	2009/11/22	Sunday	9:30-10:45	Demo: Menu and functions for Table
			11:00-12:00	Practice: Menu and functions for Table (Group 1)
			12:00-13:00	Practice: Menu and functions for Table (Group 2)
			15:00-17:00	Practice: Menu and functions for Table (Group 3)
6	2009/11/24	Tuesday	9:30-10:45	Demo: Menu and important functions in ArcToolBox
			11:00-12:00	Practice: Menu and Functions in ArcToolBox (Group 1)
			12:00-13:00	Practice: Menu and Functions in ArcToolBox (Group 2)
			15:00-17:00	Practice: Menu and Functions in ArcToolBox (Group3)
7	2009/11/26	Thursday	9:30-10:45	Demo: Map composition
			11:00-12:00	Practice: Map composition (Group 1)
			12:00-13:00	Practice: Map composition (Group 2)
			15:00-17:00	Practice: Map composition (Group 3)
8	2009/11/30	Monday	9:30-10:45	Demo: Overviewing the layers of this Project and creation schema for GIS Database
			11:00-12:00	Practice: Overviewing layers of this Project and creation schema for GIS Database (Group 1)
			12:00-13:00	Practice: Overviewing layers of this Project and creation schema for GIS Database (Group 2)
			15:00-17:00	Practice: Overviewing layers of this Project and creation schema for GIS Database (Group 3)
9	2009/12/1	Tuesday	9:30-10:45	Demo: Converting CAD data to Shape file
			11:00-12:00	Practice: Converting CAD data to Shape file (Group 1)
			12:00-13:00	Practice: Converting CAD data to Shape file (Group 2)
			15:00-17:00	Practice: Converting CAD data to Shape file (Group 3)
	2009/12/2	Wednesday	11:00-13:00	Practice: Converting CAD data to Shape file (Group 4)
10	2009/12/3	Thursday	9:30-10:45	Discussion: Converting CAD data to Shape file (*continued*)
			11:00-12:00	Practice: Converting CAD data to Shape file (continued) (Group 1)
			12:00-13:00	Practice: Converting CAD data to Shape file (continued) (Group 2)
			15:00-17:00	Practice: Converting CAD data to Shape file (continued) (Group 3 and Group 4)
11	2009/12/6	Sunday	9:30-10:45	Demo: Checking and Processing the Converted Sheetwise data
			11:00-12:00	Practice: Checking and Processing the Converted Sheetwise data (Group 1)
			12:00-13:00	Practice: Checking and Processing the Converted Sheetwise data (Group 2)
			15:00-17:00	Practice: Checking and Processing the Converted Sheetwise data (Group 3)
	2009/12/7	Monday	11:00-13:00	Practice: Checking and Processing the Converted Sheetwise data (Group 4)
12	2009/12/8	Tuesday	9:30-10:45	Demo: Logical operator and Map Overlays
			10:00-11:00	Practice: Logical operator and Map Overlays (Group 1)
			11:00-12:00	Practice: Logical operator and Map Overlays (Group 2)
			15:00-17:00	Practice: Logical operator and Map Overlays (Group 3)
	2009/12/9	Wednesday	11:00-13:00	Practice: Logical operator and Map Overlays (Group 4)
13	2009/12/10	Thursday	9:30-10:45	Demo: A sample of GIS Model
			11:00-12:00	Practice: A sample GIS Model (Group 1)
			12:00-13:00	Practice: A sample GIS Model (Group 2)
			15:00-17:00	Practice: A sample GIS Model (Group 3 and Group 4)
14	2009/12/13	Sunday	9:30-10:45	Discussion: Regarding Formulation of a GIS Model
			11:00-12:00	Practice: Formulation of a GIS Model (Group 1)
			12:00-13:00	Practice: Formulation of a GIS Model (Group 2)
			15:00-17:00	Practice: Formulation of a GIS Model (Group 3 and Group 4)
15	2009/12/15	Tuesday	9:30-10:45	Discussion: Regarding Preparation of a GIS Model
			11:00-12:00	Practice: Preparation of a GIS Model (Group 1)
			12:00-13:00	Practice: Preparation of a GIS Model (Group 2)
			15:00-17:00	Practice: Preparation of a GIS Model (Group 3 and Group 4)
16	2009/12/20	Sunday	9:30-10:45	Discussion: Regarding Progress of the GIS Model
			11:00-12:00	Practice: Finalization of the GIS Model (Group 1)
			12:00-13:00	Practice: Finalization of the GIS Model (Group 2)
			15:00-17:00	Practice: Finalization of the GIS Model (Group 3 and Group 4)
17	2009/12/21	Monday	9:30-11:00	Overview of Previous Sessions

b) Content Description

- Introduction of functions in ArcGIS software

This component being repetition of what was conducted in 2nd Phase, its contents were same as presented under sub-heading “(2) Content Description” of “i) Training in 2nd Phase”.

- Conversion of the Project CAD data to GIS data base

➢ Over viewing the GIS Layers included in the Plotting data of this project.

There are about 120 types of layers used to compile the topographic maps of this project. So, first these layers were gone through to determine about the way for their grouping and further to create the schema for GIS database. In general, there is not rigid rule for how many layers or which layers need to be included in a group (put in one Shapefile). However, grouping is done considering the similarity among layers, that is, a polygon layer can be grouped with polygon, and so on. Furthermore, the layers of similar categories would be better grouped together. For instance, polygon layer of vegetation category better be grouped with the polygon layers of same category. Contour layers having elevation information better be treated separately. Considering these points, Table 3.25 and Table 3.26 presents a possible way for grouping these 120 layers into 21 Shapefiles.

Table 3.25 A Way to Organize Layers for GIS

No	Catègorie / Category	File Name	Geometry	Code	Désignation / Designation
1	Limites communales ou administratives / Community or administrative boundary	admin_lin	Line	1002	Wilaya / Region
2			Line	1003	Moughataa / Department
3	Routes / Roads	road_lin	Line	2102	Axe de la Voie goudronnèe / Center line of Paved Motorway
4			Line	2103	Axe de la Voie non-goudronnèe / Center line of un-paved Motorway
5			Line	2004	Piste / Cart track
6			Line	2005	Sentier / Foot path
7			Line	2006	Piste amènagèe / Garden road
8			Line	2010	Terre plein central / Median strip
9	Bâtiment / Building	bldg_pol	Polygon	3001	Bâtiment de moins de 3 niveaux / Building having less than 3 storey
10			Polygon	3002	Immeuble de plus de 3 niveaux / Building having 3 or more storey
11			Polygon	3003	Hangar / Hanger
13			Polygon	3006	Bâtiment en chantier / Building under construction
14			Polygon	3007	Bâtiment en ruine / Ruined (deserted) building
12		bldg_pnt	Point	3005	Habitat précaire / Small building
22	Infrastructure et Equipement / Infrastructure and equipment	infra_pol	Polygon	4106	Rèservoir / Reservoir
37			Polygon	4117	Cimetière / Cemetery
38			Polygon	4118	Piscine / Swimming pool
40			Polygon	4220	Piste d'envol et piste de guidage dans l'aéroport / Runway and guidance lane in the airport
19			Polygon	4305	Cuve plus de 10 mètres / Curve more than 10m
23			Polygon	4307	Silo plus de 10 mètres / Silo more than 10m
30			Polygon	4312	Pylône plus de 5 mètres / Pylon more than 5m
33		infra_lin	Line	4113	Ligne à haute tension (Ligne èlectrique) / High tension electric line
34			Line	4114	Conduite d'eau / Water pipeline
35			Line	4115	Pipeline / Pipe line
39			Line	4119	Conduite souterraine / Underground pipeline
15		infra_pnt	Point	4101	Château d'eau / Water tower
16			Point	4102	Potence / Water station (for tank lorry)
17			Point	4103	Borne fontaine / Water station (for cart)
18			Point	4104	Bassin d'eau / Watering place
21			Point	4105	Cuve / Tank
25			Point	4107	Silo / Silo
26			Point	4108	Antenne de relais (Télévision, Radio, Télécommunication) / Antenna (Television, Radio, Telecommunication)
27			Point	4109	Phare / Light house
28			Point	4110	Grue / Crane
29			Point	4111	Monument / Monument
32			Point	4112	Pylône / Pylon
36			Point	4116	Station de marégraphe / Tide guage station
41	Clôture / Fence	fence_lin	Line	4201	Clôture en mur / Wall fence
42			Line	4202	Clôture en fil de fer / Iron fence
43			Line	4203	Clôture en haie / Hedge fence
44			Line	4204	Autres limites de parcelle ou de concession / Other borders of plot or concession
45	Hydrographie et détails particuliers / Hydrography and its structures	hydro_pol	Polygon	5101	Lac, Etang, Mare / Lake, Pond, Pool
46			Polygon	5102	Sebkha / Sebkha (Salt pan)
47			Polygon	5103	Oued / Wadi (Valley)
48			Polygon	5104	Zone inondable / Zone prone to flooding
50			Polygon	5106	Marais salant / Salty marsh
52			Polygon	5108	Mer / Sea
49		hydro_lin	Line	5105	Thalweg (Lit de oueds) / Valley line
51			Line	5107	Ligne côtière / Coastline
53			Line	5201	Wharf / Wharf
54			Line	5202	Jetée / Pier
55			Line	5203	Brise-lames / Break-water
56			Line	5204	Revêtement / Revetment
58			Line	5206	Tétrapode / Tetrapod
57		hydro_pnt	Point	5205	Port d'eau Profonde / Harbor of deep water

Table 3.26 A Way to Organize Layers for GIS *(Continued)*

No	Catègorie / Category	File Name	Geometry	Code	Désignation / Designation
60	Végétation / Vegetation	vegt_pol	Polygon	6002	Herbes / Steppe (grassy) vegetation
61			Polygon	6003	Buisson / Shrub/bush
62			Polygon	6004	Arbustes / Scrub
63			Polygon	6005	Espace vert / Green space
64			Polygon	6006	Ceinture verte /Fixation des dunes / Green belt
65			Polygon	6007	Jardins / Gardens
66			Polygon	6008	Cultures / Farmland
67			Polygon	6009	Plantation / Tree Plantation
68			Polygon	6010	Palmier (Oasis) / Coconut tree
71			Polygon	6013	Arbres / Trees
59		vegt_lin	Line	6001	Limite de la Végétation / Vegetation boundary
70			Line	6012	Rangèe d'arbres / Roadside trees
69		vegt_pnt	Point	6011	Arbre isolé / Isolated tree
72	Morphologie, Relief / Topography, Relief	cont_lin	Line	7101	Courbe maîtresse / Index contour line (10m interval)
73			Line	7102	Courbes normale / Regular contour line (2m interval)
74			Line	7103	Courbe intermédiaire / Supplementary contour line (1m interval)
75			Line	7104	Courbe de dépression / Depression contour. (Index 10m interval)
76			Line	7105	Courbe de dépression / Depression contour. (Regular 2m interval)
77			Line	7106	Courbe de dépression / Depression contour. (Supplementary 1m interval)
79		cont_oth_pnt	Line	7203	Remblai / Artificial slope
80			Line	7204	Escarpements / Escarpment
81		cont_oth_pnt	Point	7205	Brèche / Pause of beach bank
82	Point de contrôle / Control points	contl_pnt	Point	7301	Points GPS existants / Existing GPS point
83			Point	7302	Bornes de Nivellement existantes / Existing level point
84			Point	7303	Points de repère de Nivellement / Leveling bench mark
85			Point	7304	Points cotés / Stereoplotter measurement point
86			Point	7305	Points de contrôle nouveaux / Signpost fixed point
87	Edifice public / Public buildings	pbldg_pnt	Point	3101	Mosquèe / Mosque
88			Point	3102	Eglise / Church
89			Point	3103	Ecole fondamentale / Elementary school
90			Point	3104	Collège / Junior high school
91			Point	3105	Lycée / High school
92			Point	3106	Université / University
93			Point	3107	Hôpital/Centre de santé / Hospital / Health Center
94			Point	3109	Commissariat de Police / Police station
95			Point	3110	Bureau de poste(PTT) / Post office
96			Point	3111	Sapeur-Pompier / Fire station
97			Point	3112	Administration / Administrations (Town halls, Services)
98			Point	3113	Ambassade et Institution internationale / Embassy and international organization
99			Point	3114	Marché / Market
100			Point	3115	Usine / Factory
101			Point	3116	Stade / Stadium
102			Point	3117	Centrale électrique / Power station
103			Point	3118	Poste transformateur / Sub-station
104			Point	3119	Etat Major / Military centers
105			Point	3120	Aéroport / Airport
106			Point	3121	Centre de traitement des eaux potables / Water treatment plant
107			Point	3122	Musée / Museum
108			Point	3123	Station de mètèorologie / Meteorological observatory
109			Point	3124	Banque / Bank
110			Point	3125	Hôtel / Hotel
111			Point	3126	Station de service / Gas station
112			Point	3127	Centre de traitement des eaux usées / Water Treatment Center
113			Point	3128	Terrain de sport (Complexe Sportif) / Sports ground (Sports complex)
114			Point	3129	Dépôt d'ordures / Dumping site
115			Point	3130	Carrière / Sand quarry site
119	Autres / Others	other_pol	Polygon	9100	Zone non spécifique / Non specific zone
120		other_pnt	Point	9000	Point d'indication / Indication point

➢ A Possible Way of Converting CAD to GIS Data

For the conversion, each assigned group was provided with CAD data of one sheet from 4 map sheets; XV-1A-11, XV-1A-12, XV-1A-16, and XV-1A-17. Two ways of conversion were demonstrated and included in practice, the 2nd way being some modification of 1st with respect to steps. Followings are the steps included in the 1st Procedure:

1). Over viewing of the 120 GIS layer of this project

2). Formulation of Files and their structure considering following points:

- Arrangement of layers into shape files (for instance, as in Table 3.25 and Table 3.26)
- Naming of shape files (for instance, as in Table 3.25 and Table 3.26)
- Creation of Folder/ File Structure, for instance as presented in Figure 3.19.

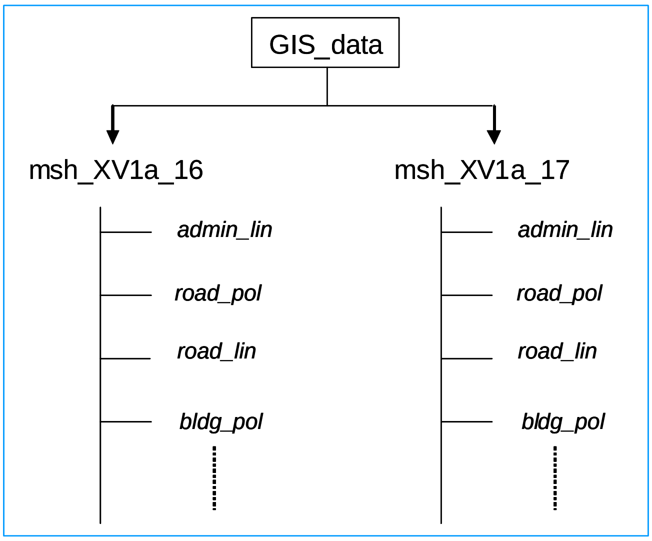


Figure 3.19 An Example of Folder/File Structure for Arranging GIS data

3). Creating Shape files with following schema:

For example:

i) Shape file - *road_pol.shp*

Name	Alias	Type	Length	Precision	Scale	Number Format
FID	FID	Object ID	4	0	0	
Shape	Shape	Polygon				
layer_code	layer_code	Long	5	5	0	Numeric
perimeter	perimeter	Double	10	9	2	Numeric
area	area	Double	12	11	2	Numeric
remarks	remarks	Text	100	0	0	

ii) iFor shape file - *road_lin.shp*

Name	Alias	Type	Length	Precision	Scale	Number Format
☑ FID	FID	Object ID	4	0	0	
☑ Shape	Shape	Line				
☑ layer_code	layer_code	Long	5	5	0	Numeric ...
☑ length	length	Double	10	9	2	Numeric ...
☑ remarks	remarks	Text	100	0	0	

iii)For Shape file - *bldg_pnt.shp*

Name	Alias	Type	Length	Precision	Scale	Number Format
☑ FID	FID	Object ID	4	0	0	
☑ Shape	Shape	Point				
☑ layer_code	layer_code	Long	5	5	0	Numeric ...
☑ remarks	remarks	Text	100	0	0	

iv)For Shape file - *cont_lin.shp*

Name	Alias	Type	Length	Precision	Scale	Number Format
☑ FID	FID	Object ID	4	0	0	
☑ Shape	Shape	Line				
☑ layer_code	layer_code	Long	5	5	0	Numeric ...
☑ elevation	elevation	Long	8	8	0	Numeric ...
☑ length	length	Double	10	9	2	Numeric ...
☑ remarks	remarks	Text	100	0	0	

v) For Shape file - *contl_pnt.shp*

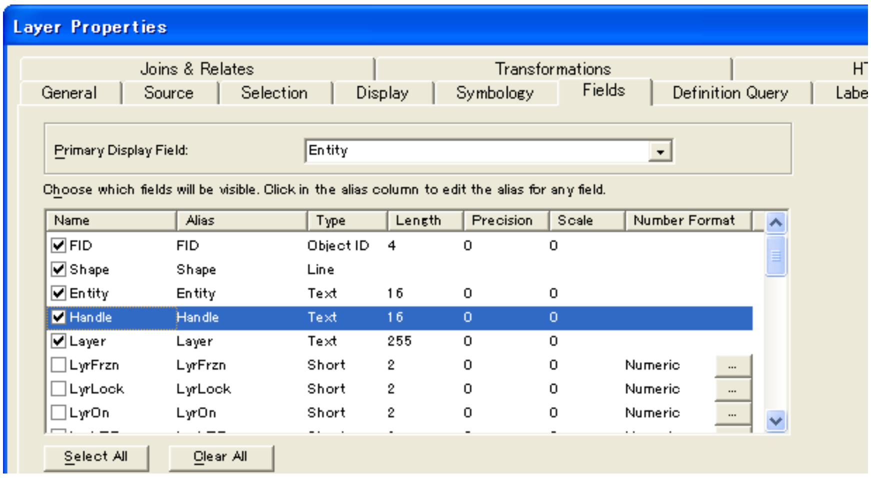
Name	Alias	Type	Length	Precision	Scale	Number Format
☑ FID	FID	Object ID	4	0	0	
☑ Shape	Shape	Point				
☑ layer_code	layer_code	Long	5	5	0	Numeric ...
☑ elevation	elevation	Float	7	6	2	Numeric ...
☑ remarks	remarks	Text	100	0	0	

- Create above five (5) shape files with columns other than FID and Shape similar to as mentioned.
- Define Projection as designated for this project.
- Then copy the file to similar one and rename it as desired.
- Thus, create whole set of shape files for one map sheet.
- Copy the whole set of shape files to another map sheet.

4). Displaying CAD file and preparing it for conversion.

- Display CAD file.

- Check the layers off by displaying "Layer Properties" window and then clicking "Fields" menu.



Note: for contour or control points data, check on also to "elevation" field.

- Save the above file to a temporary **shape file** (for working purpose) by selecting "Data" and then "Data Export" in the "Data Frame Window".
- Define projection of this Shape file.
- Display this new shape file. Add the required columns as in schema of point 3) in the same sequence.
- Transfer / calculate the attribute data in the created column.

5). Transferring data to required shape files:

- Display the required empty shape file.
- Select the required layers in the temporary created shape file.
- Start Editor and first copy the layers from temporary shape file. Then paste to empty file.
- "Save edits" and then "Stop editing". Thus required shape file will have data.
- In the same way repeat this procedure to save other required layers to other Shapefile.

It may be noted that as the 2nd way (procedure), the creation of empty shape files as mentioned in step 3) can be ignored. If so, the temporary (intermediate) Shapefile with all the required columns is created, and then the desired layers can be selected using 'Definition Query', which can be 'Exported' as new dataset with file naming as decided in step 2.

- Checking and Processing the Converted Data

The converted GIS Data was displayed with orthophotos as background to look at the distribution of various layers. The function such as ‘Append’ was used to combine the GIS data of 4 separate map sheets into one file. Also, followings operations were included in the practice:

  - Creating Logical Expression
  - Overlaying (such as ‘Union’)
  - Converting Polygon file to Line and Line file to Polygon

- Creation of GIS application using mainly converted GIS data

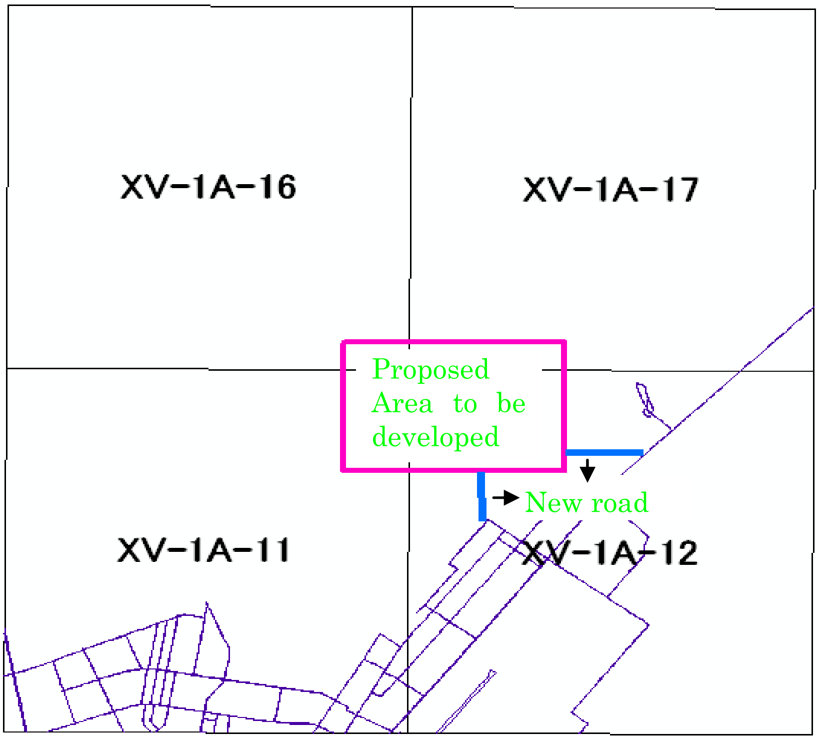
- A Sample of GIS model

To demonstrate the application use of GIS data of this project, a sample model based on the converted 4 map sheet GIS was included in the training using. The detail of this sample application is presented in Figure 3.20.

A Sample GIS Model

Title:

To find out the existing buildings (large and small) to be affected with the proposed development of Industrial and Market complexes in the area and Road improvement as mentioned below:



Note: The width of road to be considered as 30m

Data to used:

- Project data:
  - Large Building as Polygon (*bldg_pol.shp*)
  - Small building as Point (*bldg_pnt.shp* and *pbldg_pnt.shp*)
  - Road Network
  - Road Polygon (*road_pol.shp*)
- Boundary of proposed Area to be developed.
- Others

Methodology Outline:

- Clipping, adding and Buffering road, statistics.

Result: No. of Buildings to be affected (large and small) in development of area and upgrading of Road.

Figure 3.20 A Sample GIS Model

- **Creation of GIS Model by Trainees**

After practice of the above sample GIS model, each trainee was asked to formulate and prepare a GIS model basically using the converted GIS data of this project. Five (5) trainees participated in formulating and preparing a GIS model. Mr. Cheikhna Ould Elémine did understand about GIS models, but he could not participate in this practice due to his busy time. Necessary one to one discussions were held during formulation step and supervision was carried out during the preparation state. Thus, this not only provided them opportunity to put their idea into practice, but also got first hand practice for application use of this project GIS data. Also, this provided to express their understanding about whatever they have learnt in this training. The Title of GIS model created by trainees is listed in Table 3.27.

Table 3.27 Title of GIS Model created by Trainees

SN	Trainee's name	Designated group	Title of GIS model
1	Moussa Mamadou Saidou	Group 2	Suitable site for building the Central Bus Station in Nouakchott
2	Maleck Vall	Group 3	Creation of a GIS model to identify inundated zones in a districts of Nouakchott
3	Sy Abdoul	Group 3	The plan of restructuring of the precarious districts of Dar Naim Commune
4	Cheikh Tijani Ould Cheikh Mohamédou	Group 4	Plan of installation of an esplanade
5	Aminetou Mint Mokhtar	Group 4	Identificaiton of suitable areas for building a new school

The result of a GIS Model created by a trainee is presented in Figure 3.21.

Quartier precaire restructure dans la Moughataa de DAR NAIM

(Suitable Site for Building a Central Train Station in Nouakchott)

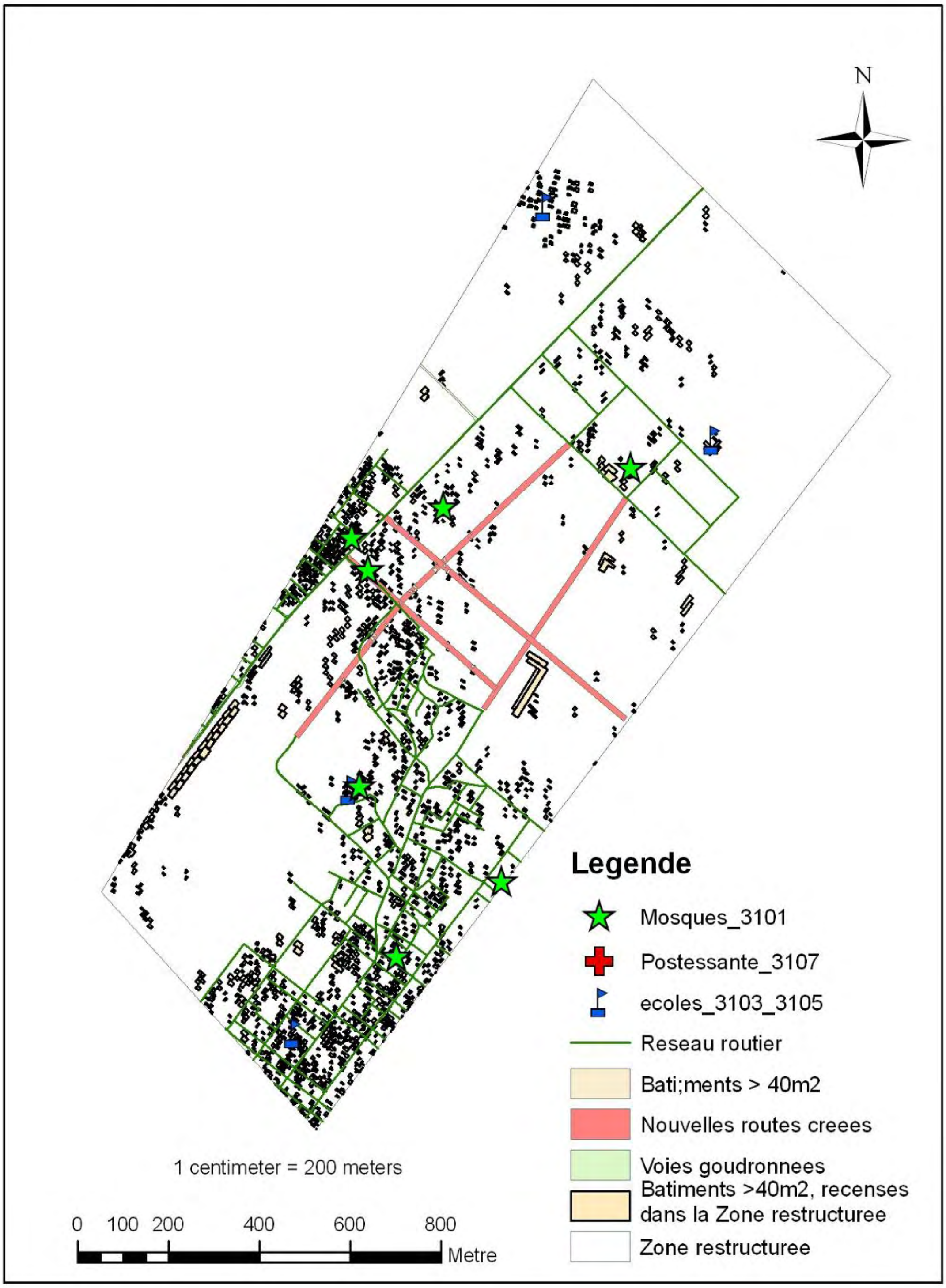


Figure 3.21 A GIS Model Created by a Trainee

c) Challenges and Resolution

During this training also, there were some challenges, which were resolved with the optimum efforts. As in 2nd phase, the trainees attended in this phase had busy schedule, and different levels of understanding of English language. These two problems were resolved in same way as mentioned in sub-heading "Challenges and Resolution" of "Training on Data Structurization in 2nd Phase"; that is, by re-arranging their schedule and communicating through translator, respectively. Besides these, the 3rd one is listed below:

- Different Fields and Levels of Understanding:

Challenge: As mentioned in Table 3.22, six trainees were from four different organizations. Also their level of understanding regarding GIS was different.

Resolutions: During demonstration, encouraging them to ask questions immediately if not understood, checking their understanding regarding particular covered point. During practices, encouraging one to one discussion and repeating wherever needed.

d) Evaluation of Trainees and Future Tasks

The trainees involved in the GIS Data Structurization were evaluated considering the aspects presented in Table 3.28.

Table 3.28 Aspects for Evaluating Trainees on Data Structurization in 3rd Phase

	Aspects	Contents
1	Basic Knowledge	Basic knowledge about GIS data and ArcGIS at start of this training.
2	Motivation	Motivation to understand this training and to apply the result of this training.
3	Improvement	Overall improvement of understanding regarding operating ArcGIS, and structurization and analysis of GIS data through this Training.
4	Components of ArcGIS	Improvement of understanding of components of ArcGIS; ArcCatalog, ArcMap, Tables, and ArcToolBox and also about 3D and Spatial Analyst, etc.

	Aspects	Contents
5	Input and Edit GIS Data	Improvement of understanding regarding Input and Edit of GIS data.
6	GIS Data Analysis	Improvement of understanding regarding Spatial Analysis of GIS data.
7	Map Composition	Improvement of understanding regarding composing, and printing or exporting map.
8	Converting CAD to Shape	Improvement of understanding regarding converting CAD data to GIS Data.
9	Creating GIS Model	Improvement of understanding for using this Project data in creating GIS application Model and extracting information to be used by decision maker.
10	Future	The possibility of applying the acquired training knowledge in future.

The same criteria used in evaluating trainees on Data Structurization in 2nd phase were used in this phase.

In conclusion, all the trainees showed very good motivation to learn about contents of the training. Despite being busy in own works, they tried their best to attend the sessions. In case of missing some sessions, they tried to cover during the next sessions. With their level of improvement achieved through this training, it is strongly hoped that they will be able to increase it further with practice in future.

3.10. Map Symbolization

The training on Symbolization was conducted at DCIG through November to the beginning of December 2009. Two (2) technical staffs from the Société Nationale de l'Eau (SNDE) participated in this session. They are listed in APPENDIX 2.

The target level to attain is that they can do voluntary training. Before the start of training, the Team investigated on their knowledge and experience in map symbolization with a questionnaire in order to meet their needs for the technology transfer. Their responses are shown in APPENDIX 7.

Then, the Team explained the purpose of Symbolization and the relation to Digital Plotting and Digital Compilation to the trainees.

Figure 3.22 Session of map symbolization

3.10.1. Training Session

The training sessions were conducted as shown in Table 3.29.

Table 3.29 Training sessions on Symbolization (2009)

Date		Contents
01- Nov	Sun	Instruction of the technology transfer (Digital plotting, Digital Compilation, Symbolization)
02-Nov	Mon	Basic Training of MicroStation
03-Nov	Tue	Basic Training of MicroStation
04-Nov	Wed	Basic Training for Creation of Manuals

Date		Contents
05-Nov	Thu	Basic Training of MicroStation for symbolization
Weekend		
08-Nov	Sun	Basic Training of MicroStation for symbolization
09-Nov	Mon	Basic Training of MicroStation for symbolization
10-Nov	Tue	Lecture for Data-Type (Point, Line, Polygon) Summary of symbolization (Cell, Line style and Topology)
11-Nov	Wed	Lecture and practice for Cells
12-Nov	Thu	Lecture and practice for Text Style
Weekend		
15-Nov	Sun	Lecture and practice for Line Style
16-Nov	Mon	Lecture and practice for Topology Creation
17-Nov	Tue	Lecture and practice for Patterns
18-Nov	Wed	Lecture and practice for Text and Manipulate
19-Nov	Thu	Lecture and practice for Map preparation
Weekend		
22-Nov	Sun	Lecture and practice for Creating Table (for Printing)
23-Nov	Mon	Practice
24-Nov	Tue	Practice
25-Nov	Wed	Practice for making feature catalog of the Waterworks Bureau
26-Nov	Thu	Practice for making feature catalog of the Waterworks Bureau
Weekend		
29-Nov	Sun	Practice for making feature catalog of the Waterworks Bureau
30-Nov	Mon	Practice for making feature catalog of the Waterworks Bureau
1-Dec	Tue	Evaluation of trainees
2-Dec	Wed	Evaluation of trainees
3-Dec	Thu	Generalization

3.10.2. Contents

The software used for the symbolization was MicroStation. Although the MicroStation is CAD software, it is possible to use for the symbolization in case of large scale map. In the case of small scale map, other software is normally used for the symbolization.

Therefore, the contents of training were how to use MicroStation and lecture about symbolization and practice by them.

a) Cells

The symbol which is called in MicroStation as cell should be created in order to express and realize its attribute on the topographic map.

The team explained about tools and manipulation of MicroStation for Cell Library and Cells.

- Creating Cell Library
- Creating Cell
- Placing Active Cell
- Replacing Cells

Figure 3.23 shows samples of before placing Cell and after placing Cell.

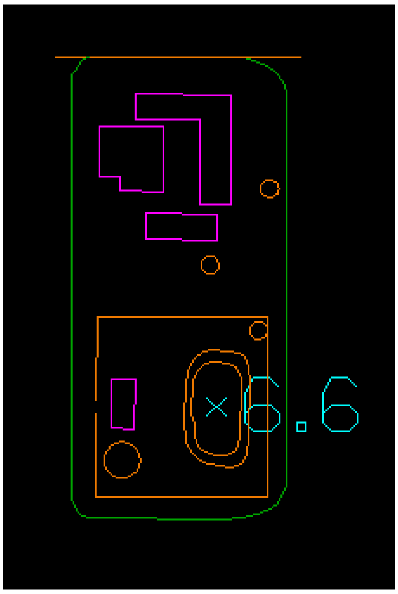
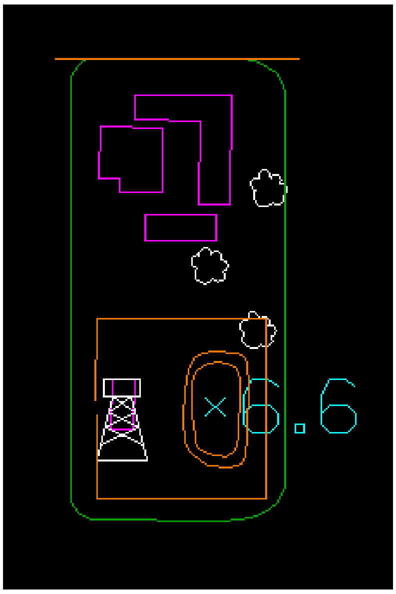
	
Before	After

Figure 3.23 A sample of placing Cell

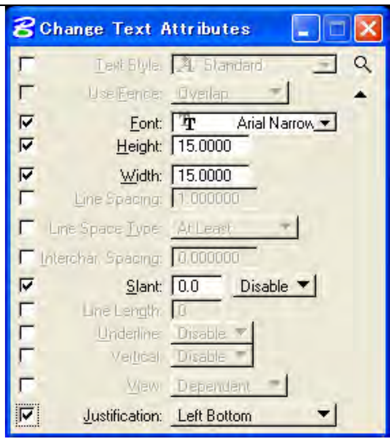
b) Text Style

The size and font of text which express the attribute of object should be changed in order to understand its indication easily on the topographic map.

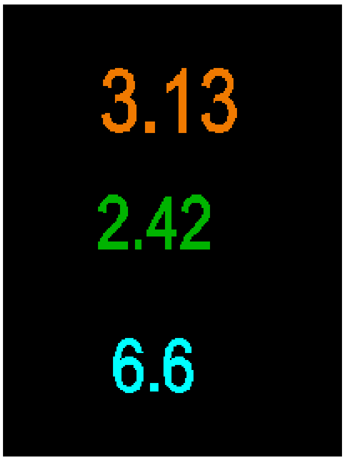
The team explained about tools and manipulation of MicroStation for Text Style.

- Placing Text
- Changing Text Attribute

Before changing the text attribute



Setting window



After changing the text attribute

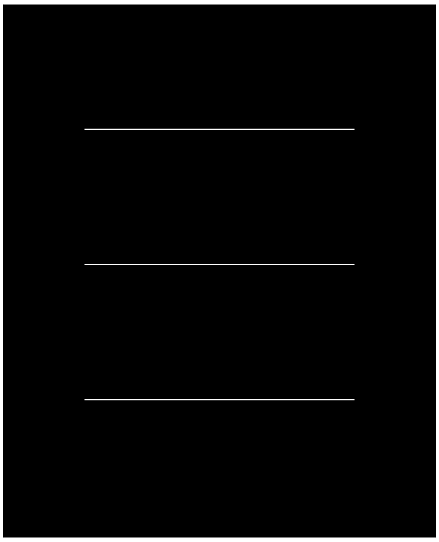
Figure 3.24 A sample of text style

c) <u>Line Style</u>

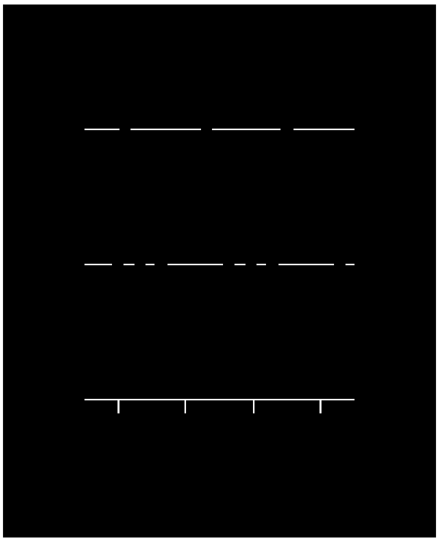
The pattern is given to line data such as road in order to classify and realize its attribute easily on the topographic map.

The team explained about tools and manipulation of MicroStation for line style.

- Creating Line Style Library
- Line Style Editor



Before giving style



After giving style

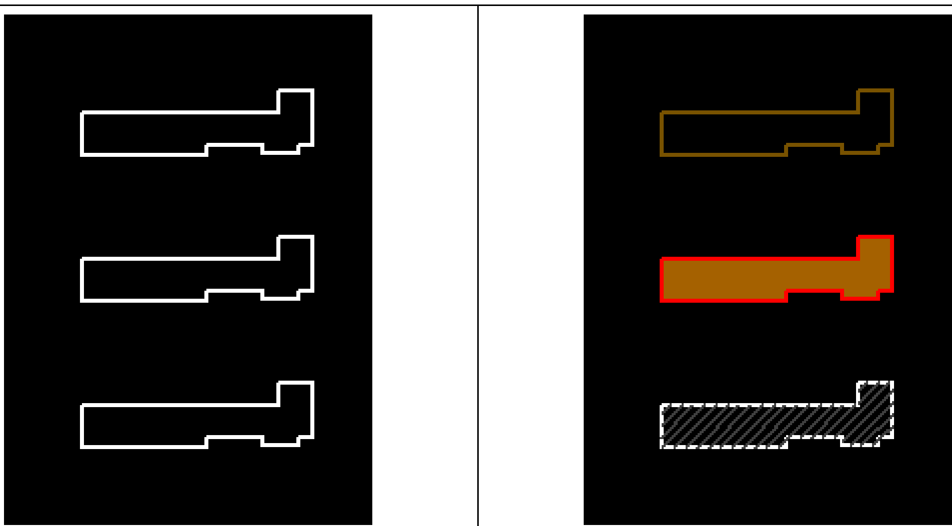
Figure 3.25 A sample of line style

d) Creating Topology

The color and diagonal line are given to the shape data such as buildings in order to classify and realize its attribute on the topographic map. Therefore, the topology is created in this step.

The team explained about tools and manipulation of MicroStation for creating topology.

- Creating Shapes
- Changing Active Fill Type
- Hatching Area



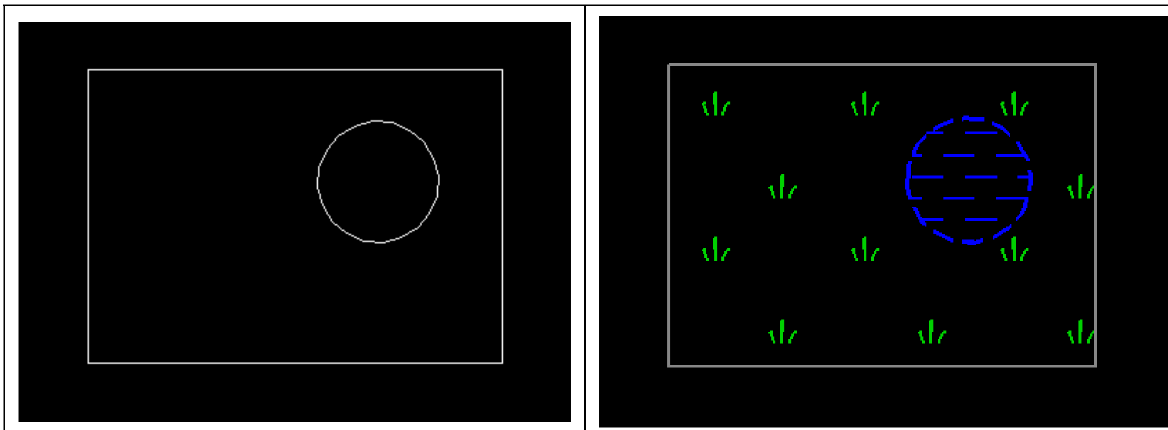
Before filling and hatching	After filling and hatching

Figure 3.26 A sample of creating topology

e) Patterns

The pattern of symbol is given to area data such as forest in order to classify and realize its attribute easily on the topographic map.

The team explained about tools and manipulation of MicroStation for “Patterns”.



Before patterning	After patterning

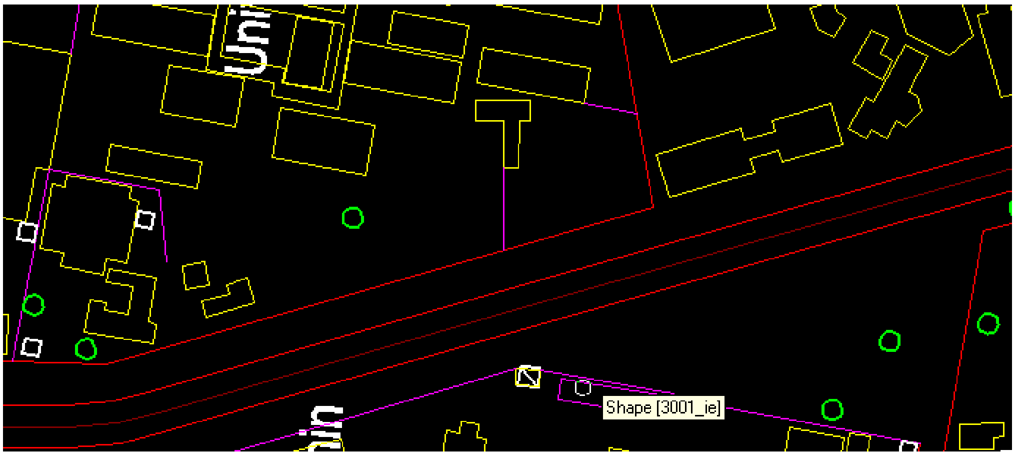
Figure 3.27 A sample of patterns

f) <u>Text</u>

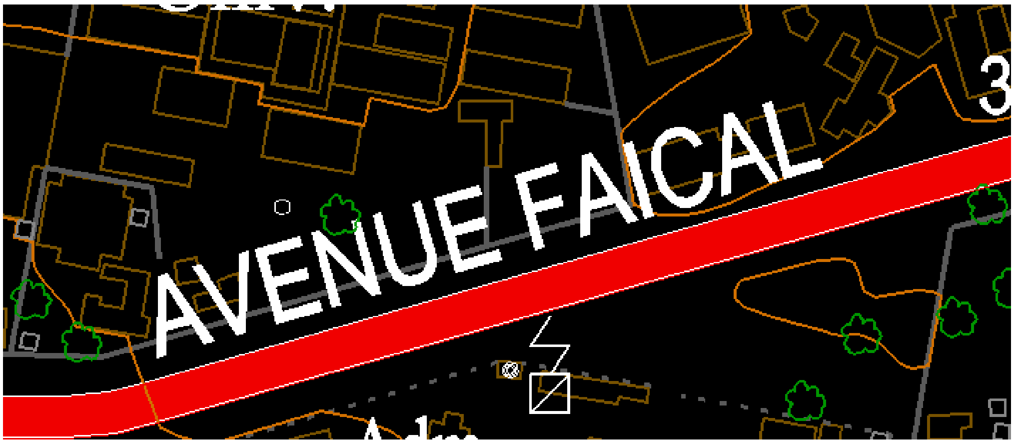
When placing the annotation, it must follow the shape. For example, the annotation of the road name must follow the shape of road.

The team explained about tools and manipulation for Text.

- Placing Text
- Rotation



Before placing Text



After placing text and rotation

Figure 3.28　　A sample of placing text

g)　　<u>Map preparation</u>

When some objects exist at a near by site and the symbol (cell) is given to the object, symbol will lap over with neighbor symbol.　In that case, the symbols must be arranged their location.

The team explained about tools and manipulation for Map preparation.

- Moving cells and placing indication points.

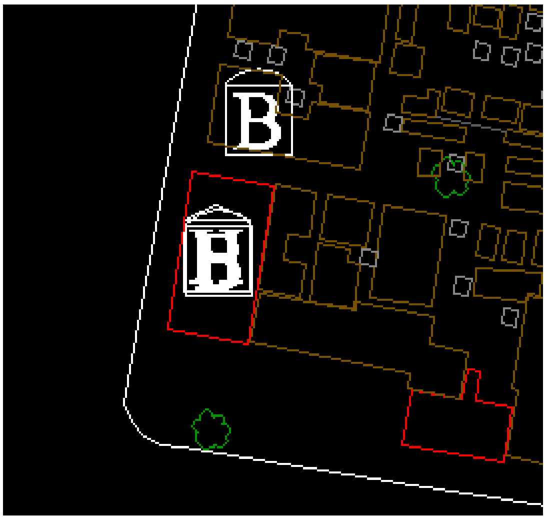
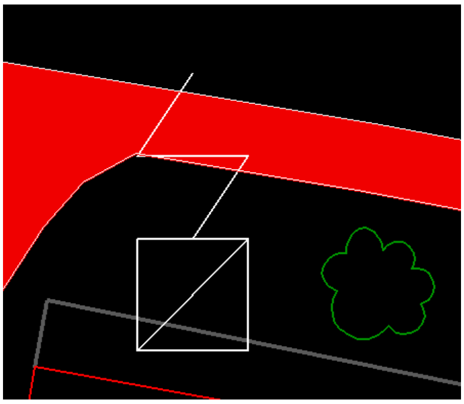
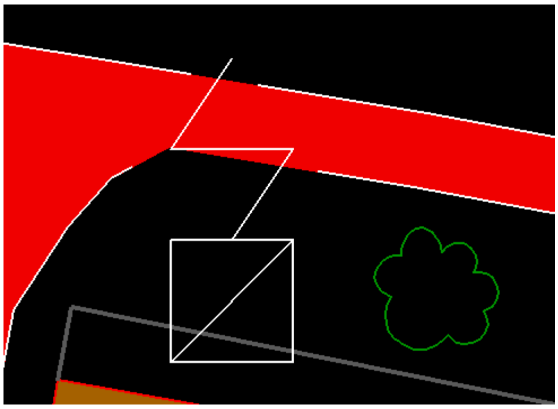
	
Before arranging Cell	After arranging Cell with placing indication points

Figure 3.29　　A sample of moving cell and placing indication points

- Deleting lines



Before deleting lines



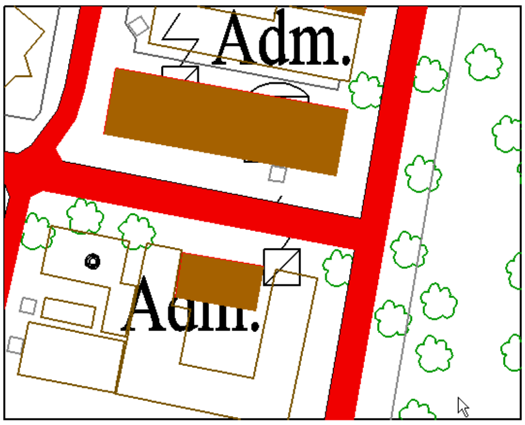
After deleting lines

Figure 3.30　　　A sample of deleting lines

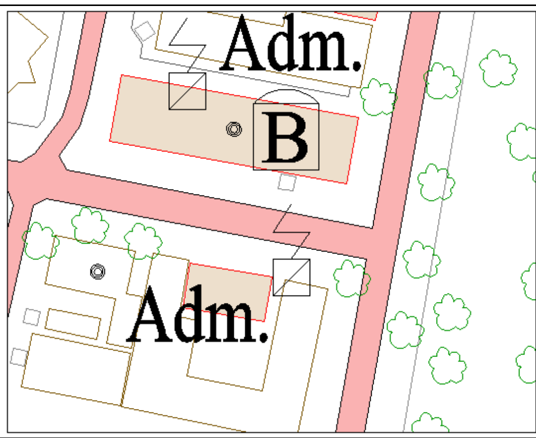
h)　　<u>Creating Table</u>

Priority order are given to each layer in order to prevent hiding the symbol under the polygon when map printing.　Moreover, color and line weight should be adjusted.

The team explained about tools and manipulation of MicroStation for Creating Table (for Printing).



Before giving priority order

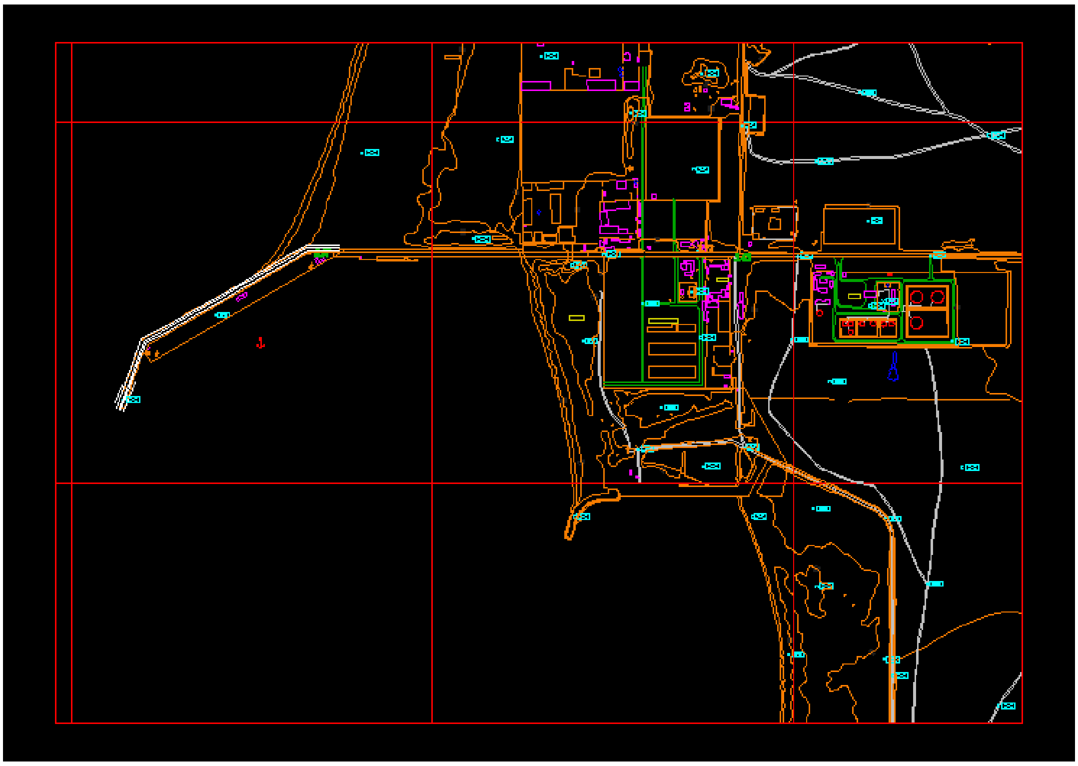


After giving priority order

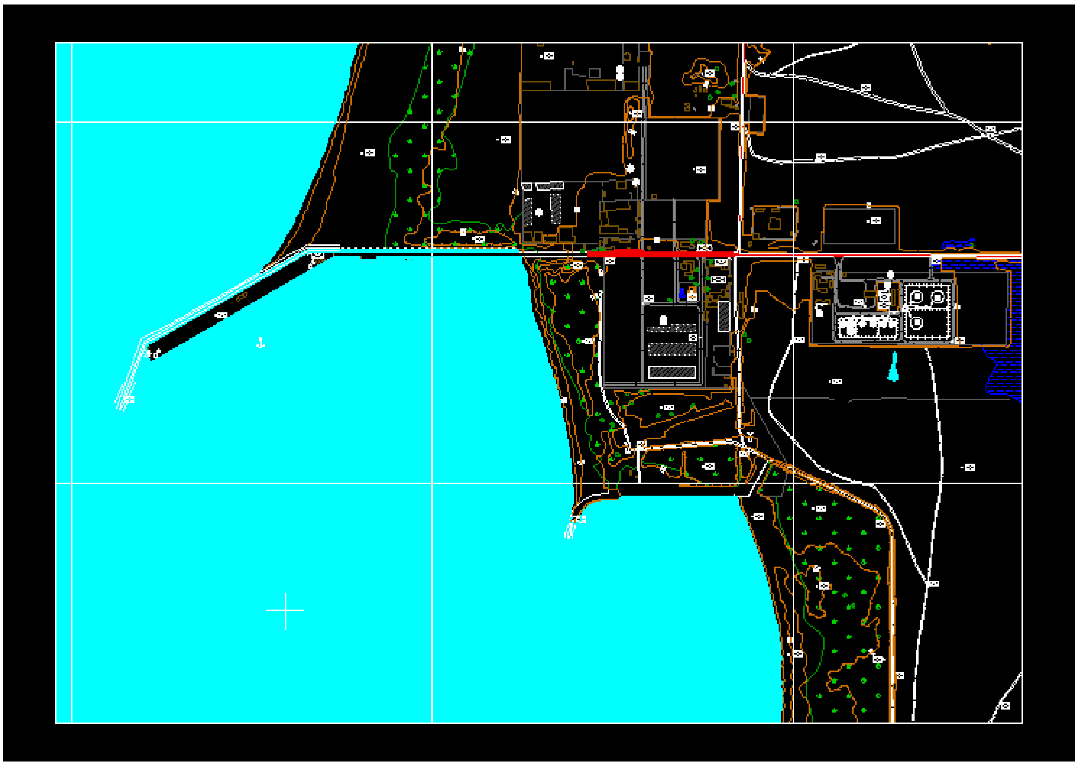
Figure 3.31　　　A sample of giving priority order

- Practice 1

The Team prepared the data of the project area of $5km^2$ for practice.　The result of practice by trainees is shown in Figure 3.32.



Before symbolization (plotted data)



After symbolization

Figure 3.32 The result of symbolization by trainee

- Practice 2

The Team prepared special practice for trainees. The trainees who work in SNDE requested the practice which relates their work to the Team. Practice was “Make feature catalog of SNDE”. They tried to make feature catalog for water supply networks.

Figure 3.33 shows the feature catalog which made by them

Figure 3.33 Feature catalog by trainee

3.10.3. Evaluation of trainees and future tasks

a) <u>Evaluation</u>

The Team evaluates the trainees through the training and from the result of the training. The evaluation was done from the following aspects.

Table 3.30 The aspects of evaluation for the Symbolization

	Aspects	Contents
1	Basic Knowledge	Basic knowledge about Photogrammetry, Cartography, Software and this project at start of this training.
2	Motivation	Motivation to understand this training and to apply the result of this training.
3	Theory	Well understanding and good motivation for the acquisition toward theory.

4	Manipulation	Well understanding and good motivation for the acquisition toward manipulation of software.
5	MicroStation	Well understanding and manipulation about MicroStation.
6	Symbolization	Well understanding and manipulation about symbolization.
7	Creating Table	Well understanding and manipulation about Creating Table.
8	Improvement	The improvement of understanding and motivation through this training.
9	Future	The possibility for future application of this training and the data

b) Conclusion and future task

The trainees had some experiences of CAD software but poor knowledge about topographic maps. They, however, got interested in map symbolization during the sessions.

It is normally difficult to realize and understand the attribute of each data in simple plotted data. But the attribute of the data can be realized and understood easily after symbolization.

As they made their own symbol in the practice 2, whenever they have new idea of design for symbol, they should make their own symbol by themselves through a trial and error process.

In spite of little knowledge about Symbolization, they were keen on this subject aiming to apply this technique to water supply designing. They are expected in future to apply their experience and the data supplied by this project to designing the water supply network and developing the land concerned to the network.

It is expected that they would continue to exercise the operations themselves.

3.11. Conclusion

All the planned subjects of technology transfer have been achieved in spite of some schedule modifications due to the political situation. At the beginning, most of the trainees had no experience in theses technologies. At present, they have acquired basic knowledge and skills. They need more exercise without instructors for acquiring the ability to perform practical works. In other words, they have attained the level from which they can start the exercises by themselves.

The level of achievement varies from subject to subject. Concerning the five subjects of field work, they have acquired the ability to perform the practical works because they worked out as OJT and produced reliable data for this mapping project.

On the other hand, as for the indoor subjects, they need more voluntary exercises because these works need them to manipulate a variety of software and the software permits a variety of applications depending on their own purposes and original ideas.
Among others, Aerial triangulation and Digital plotting require them to exercise intensively for a definite period, because these subjects require them to get a skill with 3D viewing and measuring as well as to be familiarized to the software.
Each session of technology transfer was, however, given to a few of technical staffs. Therefore, it is expected that they would try to spread the technologies to other staffs.

CHAPTER 4. DIFFUSION OF THE USE OF DIGITAL MAP DATA

For diffusing any digital map data, including the data produced under this Study project, a circulation mechanism shown in Figure below must be put into practice.

This circulation includes three phases, that is, Data creation and maintenance, Data distribution, and Data application.

In the first phase, the publisher creates his digital map data under a plan, rules and specifications, aiming to develop a spatial database. In this Study project, creation of the digital map data for the Nouakchott area has been done. After creation of data, the publisher establishes a distribution system for effective diffusion. This system must be effective so as to enable the end users easily to obtain the data they want. The publisher also prepares a user support system. Then, he announces the publication and necessary conditions.

Through the distribution system, in the second phase, the publisher distributes the data to users.

In the third phase, the users apply the data to anything to meet their purposes and intentions. For this, the users acquire necessary skill and human resources if necessary, and form an application system. They also collect or make additional data if necessary.

On the other hand, the data must be maintained for sustainable use in another first phase. Data maintenance means not only data updating but also data improvement and development. Therefore, the maintenance must be done keeping up with the user's demands. In order to make an appropriate maintenance, the publisher tries to collect the demands and opinions from the users who have applied the data.

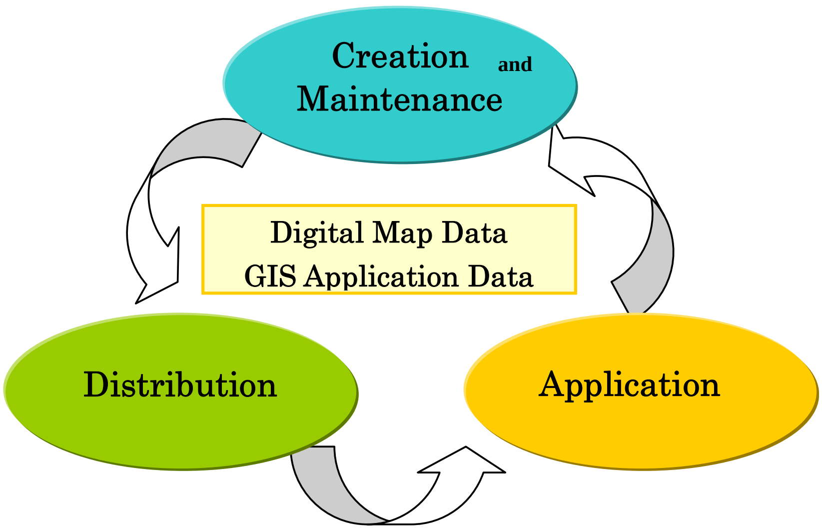


Figure 4.1 Circulation mechanism of digital map data

The wider the field of data application is, the more effective and stable diffusion of the data is expected. These various applications of digital map data and more advanced ones need a stable technical support.

4.1. The user of digital map and GIS

Before a new development of digital map data, a demand analysis of the data needs to be conducted. The result will shows the type of user and the effective way how to distribute the data.

The following conceptual diagram shows an example of structure of user group in digital map use. In addition to the three existing (or expected to be existence) user groups, it should be considered that there is a potential user group behind the group of light user.

To realize diffusion of the use of digital map data, first of all the enhancement of function of existing user group to carry out their own role and then the development of new light-user from the potential user will be necessary.

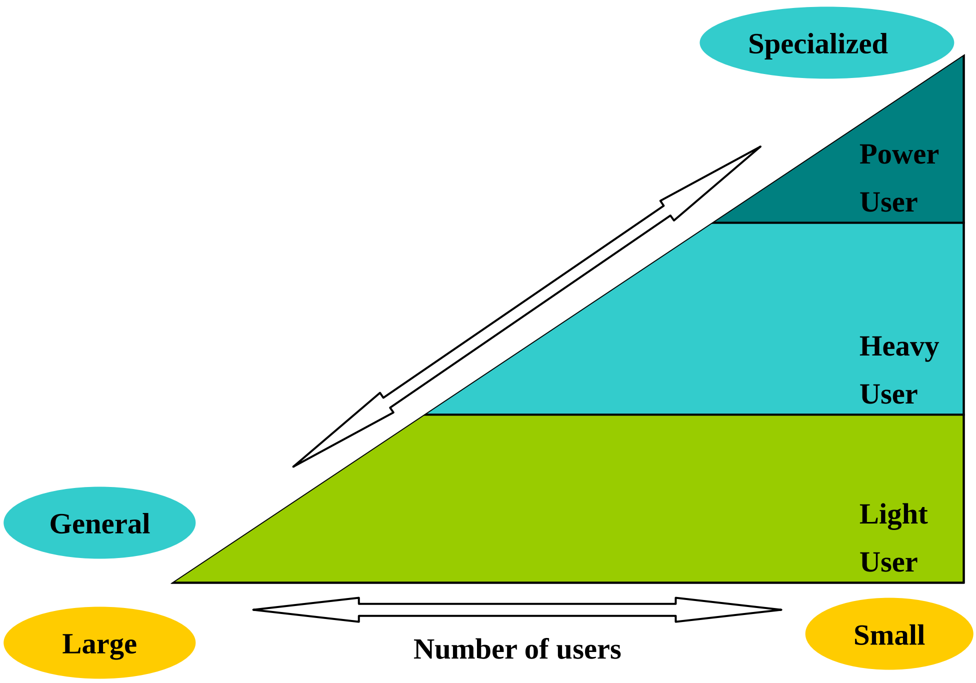


Figure 4.2 Conceptual diagram of users of digital map and GIS

4.1.1. Digital map data and GIS user

1). Power User Group

This group is expected to play an important role in all-purpose services concerning GIS including IT support. In the case of Mauritania, the DCIG should be expected to take it. Enhancement of human resource, technical advancement, and better system environment will be necessary for DCIG to play the role.

2). Heavy User Group

This group is expected to play a role to deal with GIS including IT support for individual purpose. In the case of Mauritania, some of the existing GIS users should be supported so as to formulate this group which takes the role as advanced user of GIS, GIS analysis, etc.

3). Light User Group

Most of users who refer the digital map data mainly are generally classified in this group. In the case of Mauritania, most of the existing GIS users are included in this group.

4). Potential User Group

This group is placed behind the light user group waiting the chance to use GIS whenever the surrounding environment favors the use.

4.1.2. Digital Map Data & GIS User in Mauritania

For the diffusion of digital map and GIS, the Study team and DCIG had some discussions about the current state of usage of digital map and GIS in Mauritania and listed up the existing and potential users. Then, the Team and DCIG visited the listed organizations and introduced the digital map data which were under preparation in this Study. Summaries of the meetings are shown in APPENDIX 8.

1). Current condition of potential users of digital map and GIS

The following table shows the existing users and potential users of the digital map who were found through this Study and listed up.

Table 4.1 Potential users of digital map data

(Y: Yes, N: No)

Name of organ	Relevant field	Current status of map & GIS use
DCIG (Ministry of Habitat Urbanism and Development of Territory)	Development and distribution of cartographic map	Paper map: Y Digital map: N GIS: Stand-alone type
DU (Ministry of Habitat Urbanism and Development of Territory)	Urban planning, Urban development	Paper map: Y Digital map: Y GIS: Stand-alone type
DARTAR (Ministry of Habitat	Land development,	Paper map: N

Urbanism and Development of Territory)	Regional planning	Digital map: N GIS: Stand-alone type
DIT (Ministry of Equipment and Transport)	Transportation planning, Highway construction	Paper map: Y Digital map: Y GIS: Stand-alone type
DP (Ministry of Hydraulic and Purification)	Water drainage, Main sewage process	Paper map: N Digital map: N GIS: N
OMRG (Ministry of Industry and Mines)	Natural resource and mine development	Paper map: Y Digital map: Y GIS: Stand-alone type
DGPC (Ministry of Interior and Decentralization)	Civil security, Fire-fighting, Logistic	Paper map: N Digital map: N GIS: N
Environment (Ministry Delegate Office of Prime Minister in Charge of Environment)	Environment preservation	Paper map: Y Digital map: Y GIS: Stand-alone type
DS (Ministry of Health)	Healthcare plan and management	Paper map: N Digital map: N GIS: N
DFE (Ministry of Economic Affaires and Development)	Economic affaires and development	Paper map: N Digital map: N GIS: N
CUN	Administration of Nouakchott	Paper map: Y Digital map: Y GIS: Stand-alone type
SNDE	Water supply	Paper map: Y Digital map: Y GIS: Stand-alone type
SOMELEC	Power supply	Paper map: Y Digital map: Y GIS: Stand-alone type
EU	—	Paper map: N Digital map: N GIS: N

UNDP	—	Paper map: N Digital map: N GIS: N
UNICEF	—	Paper Map: N Digital Map: N GIS: N
WFP	—	Paper Map: N Digital Map: N GIS: N
WHO	—	Paper Map: N Digital Map: N GIS: N
FAO	—	Paper Map: N Digital Map: N GIS: N
UNHCR	—	Paper Map: N Digital Map: N GIS: N
World Bank	—	Paper Map: N Digital Map: N GIS: N
AFD	—	Paper Map: N Digital Map: N GIS: N
French Embassy	—	Paper Map: N Digital Map: N GIS: N
U.S. Embassy	—	Paper Map: N Digital Map: N GIS: N

2). Utilization Fields of Digital Map Data and Expected Role of Organizations in Mauritania

As discussed above, an expected role to the DCIG for the diffusion of digital map data will be one of the "Power User Group" considering the official field of it in Mauritania government. Expected functions for DCIG as a "Power User Group" are development, publication and distribution of data, standardization and etc.

Table 4.2 Utilization field and expected role

Name of organ	Utilization field of digital map data and GIS	User Group (Expected Role)
DCIG (Ministry of Habitat Urbanism and Development of Territory)	Data development, Publication and distribution, System administration, Standard of spatial data and technology, etc	Power User Group
DU (Ministry of Habitat Urbanism and Development of Territory)	Urban planning GIS system administrator and System User, etc	Heavy User Group
DARTAR (Ministry of Habitat Urbanism and Development of Territory)	Land development planning, Region planning, etc	Heavy User Group
DIT (Ministry of Equipment and Transport)	Transportation facility planning and management system, etc	Heavy User Group
DP (Ministry of Hydraulic and Purification)	Discharging water, Main sewer management system, etc	Heavy User Group
Ministry of Industry and Mines	Natural resource management system, etc	Heavy User Group
DGPC (Ministry of Interior and Decentralization)	Fire protection system, Crime information system, etc	Heavy User Group
Environment (Ministry Delegate Office of Prime Minister in Charge of Environment)	Environment preservation system, Flood risk mitigation system, etc	Light User Group
DS (Ministry of Health)	Healthcare facility service system, etc	Light User Group

CUN	Nouakchott city information system, etc	Heavy User Group
SNDE	Water supply management system, etc	Light User Group
SOMELEC	Electric power service management system, etc	Light User Group
EU	Community support activity, etc	Potential User
DFE (Ministry of Economic Affaires and Development)	Ditto	Potential User
UNDP	Ditto	Potential User
UNICEF	Ditto	Potential User
WFP	Ditto	Potential User
WHO	Ditto	Potential User
FAO	Ditto	Potential User
UNHCR	Ditto	Potential User
World Bank	Ditto	Potential User
AFD	Ditto	Potential User
France Embassy	Ditto	Potential User
U.S. Embassy	Ditto	Potential User

4.2. Distribution of Digital Map Data

The newly created digital topographic map data of scale 1:10,000 will expectedly contribute greatly to decision-making in administration plan on Nouakchott for all ministries. Thus, an effective and practical system for the optimum diffusion of geographic information including this and building a sharing system are very important. Data diffusion will include selling of spatial data and its promotion for extensive use to public. Similarly, the Data Sharing System shall include interactive use of spatial data among the governmental organizations, especially among the Ministries. To make these two components successful, it is recommended to establish a responsible organization named, for instance, Spatial Data Center (CDS) to act as a core for handling the spatial data.

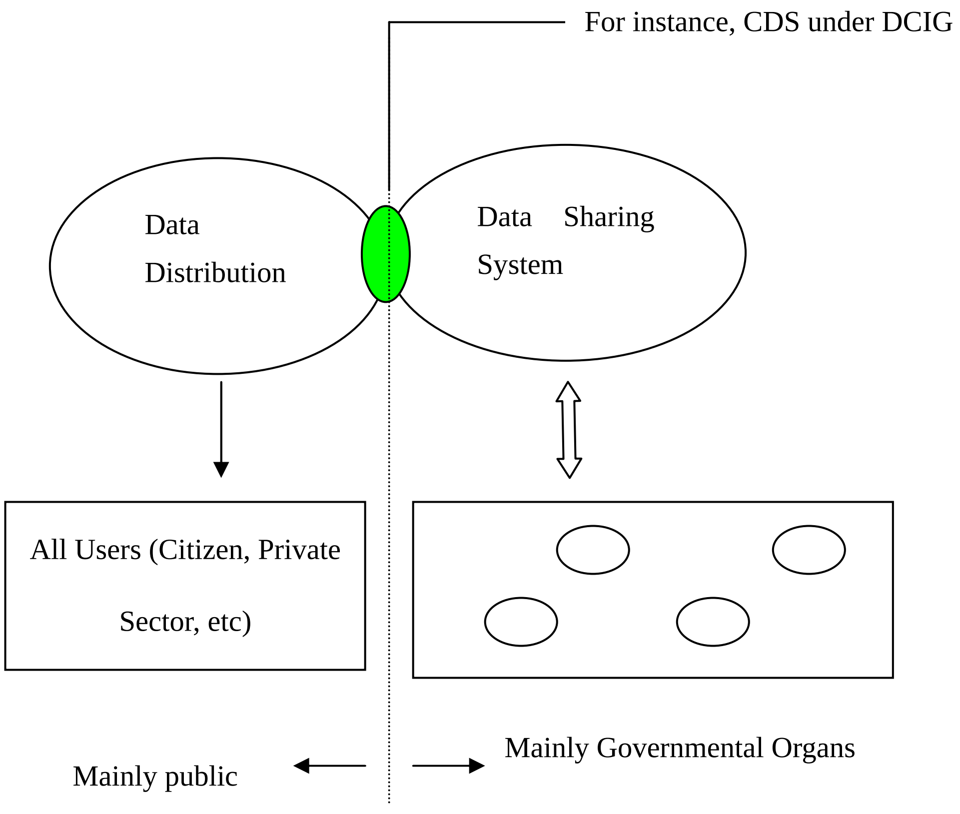


Figure 4.3 Concept of diffusion and sharing of geographic information

Thus, along with the above description of CDS, this chapter describes the two (2) main components; Distribution of Geographic Information and Data Sharing Systems.

4.2.1. Spatial Data Center

For the efficient and timely distribution of topographic data of this project as well as other spatial data available or planned to be created within the Ministry to the data users, an organization for controlling the data would be essential. This organization will also be responsible for updating all the spatial data whenever required. Thus, this will help in bringing uniformity of spatial data and will promote their diffusion. Designated organization, for instance, can be named as "Spatial Data Center (CDS)".

Throughout the realization of this Project, DCIG has been involved as the counterpart of the Study team. And also, its official coverage is development of new spatial data, publication and distribution of data, updating of data, etc. Considering this, the Study Team's proposal is to establish CDS under DCIG as shown below.

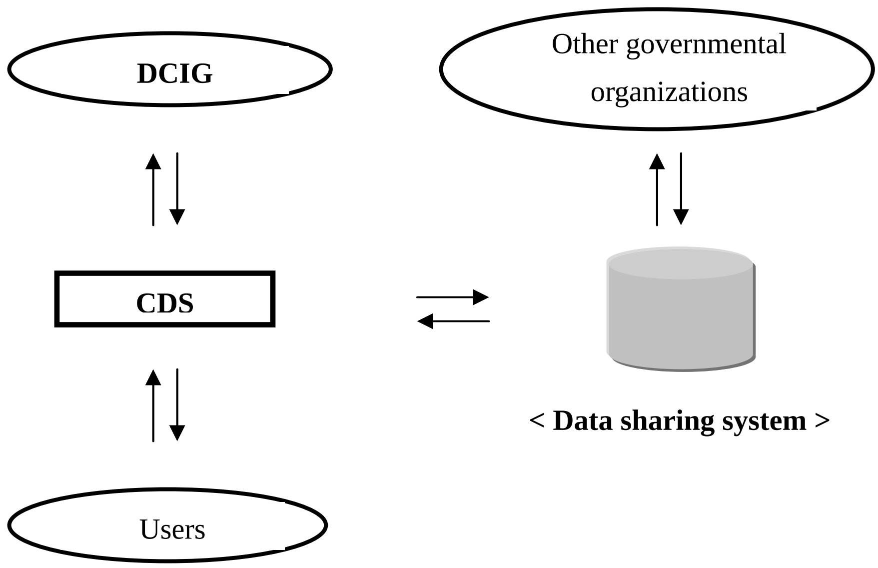


Figure 4.4 Spatial Data Center (CDS)

1). Systematizing Spatial Data Center

In order to systematize CDS, the followings need to be underlined:

a) Specific role of this center in spatial data creation and maintaining.

b) Formulation of system for updating map data.

c) Feasible infrastructure to be prepared tentatively:

- Raising the Project team
- Composition of hardware to work practically
- Software to be installed.

2). Functions of Spatial Data Center

The major functions of CDS are underlined as follows:

- Promotion for data diffusion
- Facilitating for data sharing systems
- Creating, Maintaining and updating spatial data
- Setting standards for spatial data
- Others.

4.2.2. Diffusion of Topographic Data (including GIS Database)

For the wider use of spatial data including this topographic data, an organization which runs all the circulation mechanism of data creating, data distributing and service providing would be required. And also, financial resource might be necessary for the organization to operate the circulation mechanism. For this, the Study Team proposes that the spatial data should be sold. Selling of spatial data should be opened to all related organizations which want to buy the data. However, the points like types of data to be sold and clear cut pricing policy need to be clarified in advance. Similarly, need appraisal should be conducted time to time to know the demand trend of spatial data users. Moreover, promotional activities such as presenting demonstrations using the model systems created under this Project will be necessary. These all efforts will also help to maintain and to carry out activities at the CDS effectively.

For selling spatial data, two (2) cases are basically discussed; direct management by DCIG, and consignment to an agency including private enterprise.

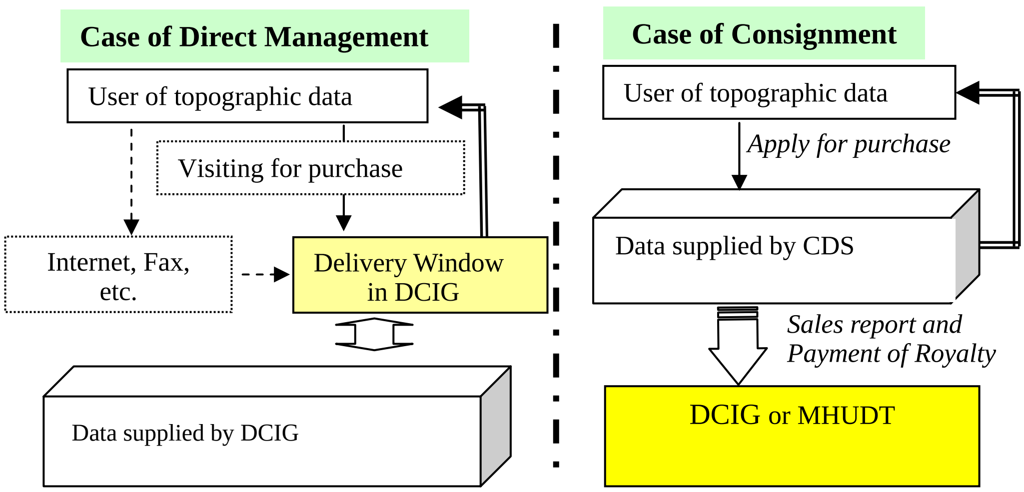


Figure 4.5 Cases of diffusion of topographic data

* MHUDT: Ministry of Habitat, Urbanism, and Development of Territory

With the case of the direct management, DCIG performs maintenance of 1:10,000 topographical maps as well as GIS database produced by the Agency as a sole organization of unifying all the geographic information. In addition, DCIG distributes the topographic data free of charge or

with payment upon the requests by playing a central role of building a system by which DCIG shall conduct distribution of the mapping products.
With the case of entrusting to the subordinate body like the agency on the other hand, the agency collectively performs data selling and supplying upon the order from a user. Then, the agency will have an obligation to submit a sales performance on a regular basis to DCIG or the Ministry. In addition, the consignee is to pay a copyright royalty, too.

Items to be sold: Even in this Project, there are different forms of data products; such as, printed maps, digital maps, GIS database, etc. And, with the concept of Spatial Data Center, various products will be piled in the future. Thus, it will be essential to decide about the product types to be diffused through selling.

4.2.3. Additional issues in the diffusion of digital map data

1). Geospatial information development plan

In this study, it was clearly understood that there is a lot of demands for the detailed maps, for example 1:2,500, 1:5,000 of scales, in order to develop water supply and sewage facility, establishing plans for drainage and to repair urban infrastructure such as, highway, green belt, disposal center, etc in the Nouakchott City.
Generally, it is expensive and time-consuming to develop a data for the new topographic maps especially at a large scale. If individual Directions of national government or local governments develop their own map data independently, overlaps of investment are likely to happen. In order to minimize the cost by avoiding the overlapping, it may be effective to set a total plan for developing a nationwide geospatial data to be named “national spatial data development plan”.

2). Collaboration of national and local governments for the development of geospatial information

There are twelve regions (wilaya) and one capital district in Mauritania. In this study, digital topographic map data (1:10,000) covering the capital district of Nouakchott was completed.
As stated above, demands for the detailed map data will be grown in the local governments. Currently, it is not a realistic situation for the Mauritanian government to prepare all data sets required by the local governments.
The digital map data prepared by local governments should be shared with the national government except some exceptional case.

3). Development of human resource

For the diffusion of geospatial data including the digital map data (1:10,000) created in this study, development of human resource is one of the important elements to be considered.

4). Utilization of geospatial information in public administration

The digital topographic map data should be utilized for public administrations in disaster mitigation, natural resource management, social security improvement, natural environment conservation, disclosure of information and others.

5). Standardization of geospatial information

The standardization of digital map data makes it easier to exchange the data among different users, organizations, social groups and others. As a result of standardization, the diffusion of digital map data can be promoted by information interchange.

6). Updating of Digital Map Data

Digital map data should be updated based on the established procedures. Without appropriate updating, the digital map data will lose connections with the spatial realities in the coming years and as a result the value of the data will be reduced.

A drastic change is taking place especially in the central area of Nouakchott and rapid expansion of human settlement to suburban area is currently in progress due to a comparatively high pressure of urban development, which makes it more important to update the data at specific interval of time.

There are forty seven map sheets (1,200 km^2) of digital map data in total and the coverage of aerial photography is 2,000 km^2. It would be recommended to update the whole digital map sheet set (47 sheets) at a single time every 3 to 5 years to preserve the freshness of the whole data set. If it is difficult to update in the above manner, it may be suggested to classify these map sheets into some classes of priority by current land use change. Moreover, map sheets which contain urban development plans or some other plans should be prioritized.

The figure below shows an example of updating cycle proposed by the Team.

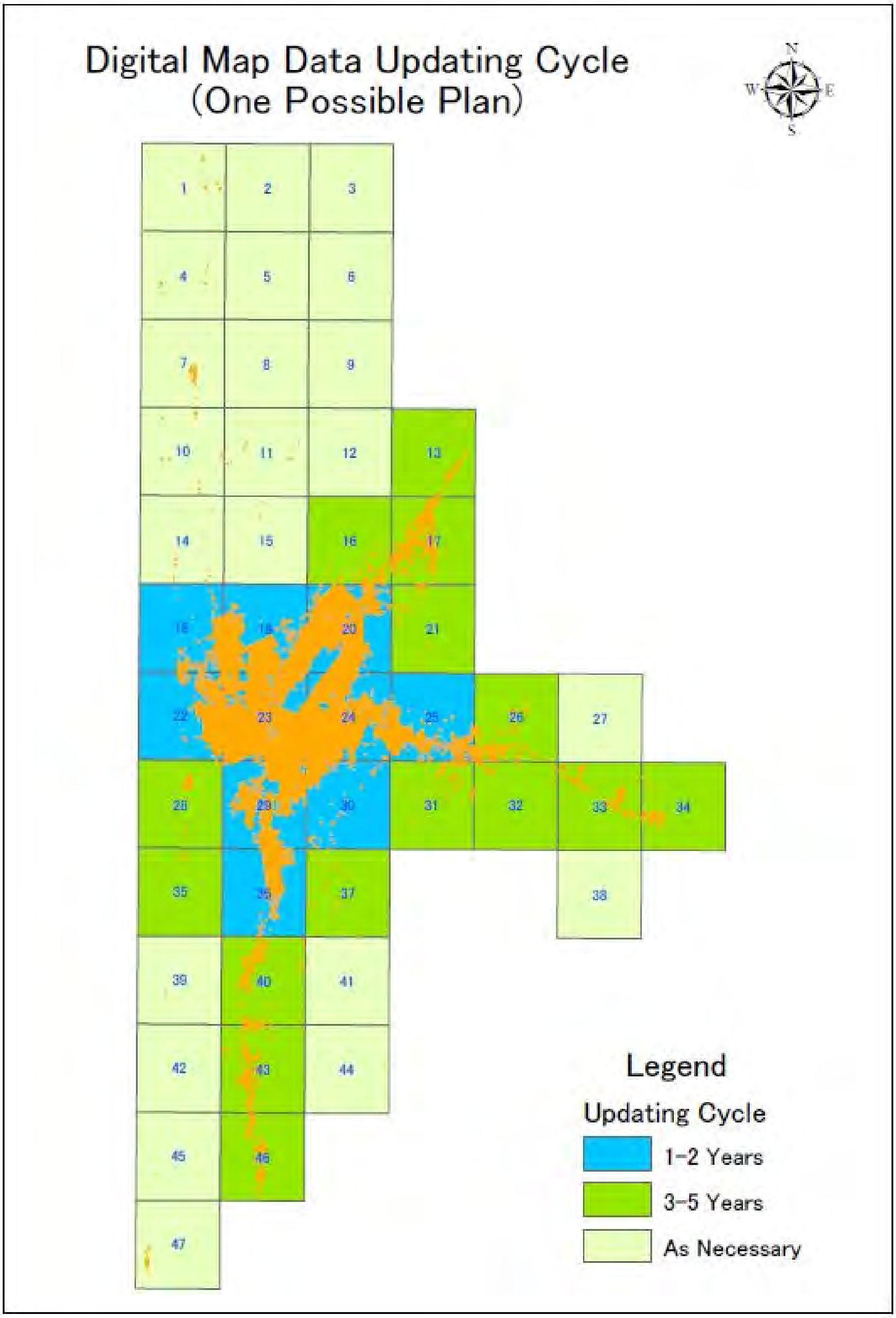


Figure 4.6 Updating cycle of digital map data (example)

Table 4.3 Updating cycle of digital map data (example)

No	Map Sheet No	Updating Cycle	Remark
1	NE28-XIV-2d-15	As necessary	Outskirts of Nouakchott
2	NE28-XV-1c-11	As necessary	Outskirts of Nouakchott
3	NE28-XV-1c-12	As necessary	Outskirts of Nouakchott
4	NE28-XIV-2d-10	As necessary	Outskirts of Nouakchott
5	NE28-XV-1c-6	As necessary	Outskirts of Nouakchott
6	NE28-XV-1c-7	As necessary	Outskirts of Nouakchott
7	NE28-XIV-2d-5	As necessary	Outskirts of Nouakchott
8	NE28-XV-1c-1	As necessary	Outskirts of Nouakchott
9	NE28-XV-1c-2	As necessary	Outskirts of Nouakchott
10	NE28-XIV-2b-25	As necessary	Outskirts of Nouakchott
11	NE28-XV-1a-21	As necessary	Outskirts of Nouakchott
12	NE28-XV-1a-22	As necessary	Outskirts of Nouakchott
13	NE28-XV-1a-23	3-5 years	Surroundings of built-up area
14	NE28-XIV-2b-20	As necessary	Outskirts of Nouakchott
15	NE28-XV-1a-16	As necessary	Outskirts of Nouakchott
16	NE28-XV-1a-17	3-5 years	Surroundings of built-up area
17	NE28-XV-1a-18	3-5 years	Surroundings of built-up area
18	NE28-XIV-2b-15	1-2 years	Build-up area, Seacoast environment area
19	NE28-XV-1a-11	1-2 years	Build-up area
20	NE28-XV-1a-12	1-2 years	Build-up area
21	NE28-XV-1a-13	3-5 years	Surroundings of built-up area
22	NE28-XIV-2b-10	1-2 years	Build-up area, Seacoast environment area
23	NE28-XV-1a-6	1-2 years	Arafat redevelopment plan area
24	NE28-XV-1a-7	1-2 years	Arafat redevelopment plan area
25	NE28-XV-1a-8	1-2 years	Build-up area
26	NE28-XV-1a-9	3-5 years	Surroundings of built-up area
27	NE28-XV-1a-10	As necessary	Outskirts of Nouakchott
28	NE28-XIV-2b-5	3-5 years	Seacoast environment area
29	NE28-XV-1a-1	1-2 years	Arafat redevelopment plan area
30	NE28-XV-1a-2	1-2 years	Arafat redevelopment plan area
31	NE28-XV-1a-3	3-5 years	Surroundings of built-up area
32	NE28-XV-1a-4	3-5 years	Surroundings of built-up area
33	NE28-XV-1a-5	3-5 years	Surroundings of built-up area

34	NE28-XV-1b-1	3-5 years	Surroundings of built-up area
35	NE28-VIII-4d-25	3-5 years	Seacoast environment area
36	NE28-IX-3c-21	1-2 years	Build-up area
37	NE28-IX-3c-22	3-5 years	Surroundings of built-up area
38	NE28-IX-3c-25	As necessary	Outskirts of Nouakchott
39	NE28-VIII-4d-20	As necessary	Outskirts of Nouakchott
40	NE28-IX-3c-16	3-5 years	Surroundings of built-up area
41	NE28-IX-3c-17	As necessary	Outskirts of Nouakchott
42	NE28-VIII-4d-15	As necessary	Outskirts of Nouakchott
43	NE28-IX-3c-11	3-5 years	Surroundings of built-up area
44	NE28-IX-3c-12	As necessary	Outskirts of Nouakchott
45	NE28-VIII-4d-10	As necessary	Outskirts of Nouakchott
46	NE28-IX-3c-6	3-5 years	Surroundings of built-up area
47	NE28-VIII-4d-5	As necessary	Outskirts of Nouakchott

4.3. GIS Model System

The newly created digital topographic map at the scale of 1:10,000 covering whole the built-up area of Nouakchott and its surroundings is expected to contribute greatly to planners and decision makers in formulating plans for managing informal settlements, improving sanitation, conserving environment and so on.

Demonstrating the usefulness of the dataset will undoubtedly help promoting their diffusion. Thus, the Team has made an attempt to prepare GIS models showing some of existing issues in Nouakchott.

4.3.1. Creation of GIS model system

The model system was designed and developed taking the following respects into consideration.

- Practical performance
- High-priority issue
- General-purpose properties
- Fast-acting properties

4.3.2. Software and hardware for GIS model systems

The following system environment was adopted in order to have beneficial effects on GIS model systems.

1). Software

One set of ArcGIS with ArcInfo license has been installed for carrying out the priority issues.

2). Hardware

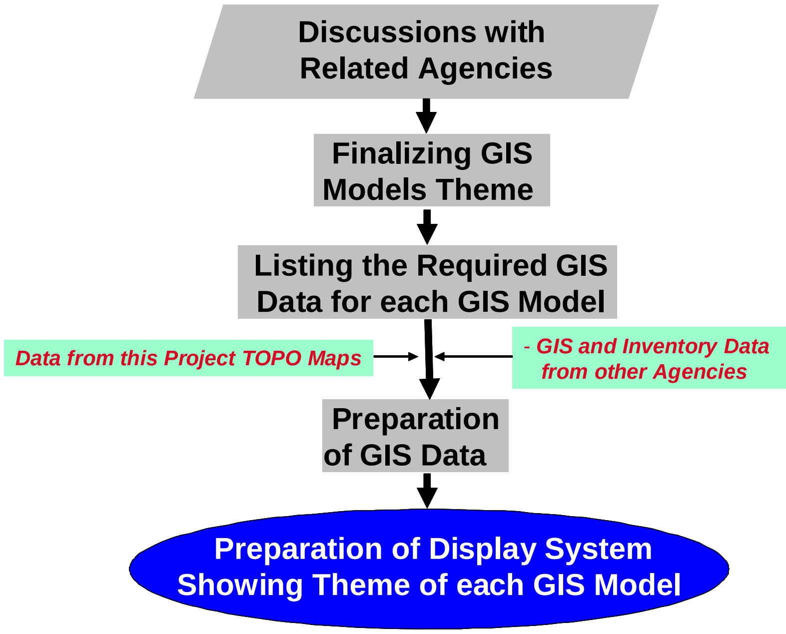
The specification of hardware installed with the GIS software (ArcGIS with ArcInfo license) and extensions of 3D analyst, Spatial analyst and Network analyst is as follows: Processor - Intel Xeon Processor 5160, 3.00GHz with 4MB L2 cache (Dual Capable) 1333MHz FSB or better.

4.3.3. GIS data and Model system

For preparing the GIS data and model system, building data, address data set, DEM, elevation class, etc were extracted from the topographic map data Those data and GIS models are applicable to the current issues of Mauritania immediately.

1). General flow of GIS model system construction

Its general flow-chart is presented below:



2). Themes for GIS Model

Discussions were held with DCIG and other related governmental and non-governmental organs to explore details about issues in the central area of Nouakchott and its surroundings. Considering the points popped up during discussion, following four themes were selected for preparation of GIS models. Related organs to each theme are given below.

Table 4.4 Themes of model system

Theme		Related organizations	GIS data used
1	GIS model for address search and display	City of Nouakchott (CUN)	See 1. in the next table
2	GIS model for potential flood risk management	Direction General of Civil Protection (DGPC)	See 2. in the next table
3	GIS model for water supply facility management	National Society of Water (SNDE)	See 3. in the next table
4	GIS model for facility management	Ministry of Health, Ministry of Fundamental Education	See 4. in the next table

The GIS data used in preparing the models for each theme were listed below.

Table 4.5 Data used in each theme

<table>
<tr><th rowspan="4">Theme</th><th colspan="5">Data</th></tr>
<tr><th colspan="4">From topographic map (1:10,000)</th><th rowspan="3">Other</th></tr>
<tr><th rowspan="2">Roads</th><th colspan="2">Buildings</th><th rowspan="2">Other</th></tr>
<tr><th>Large</th><th>Small</th></tr>
<tr><td>1</td><td>Line data attribute of roads</td><td>Polygon data (Health center, school, Other public facilities)</td><td>Point data</td><td>Location of water point sources (as points)</td><td>Attribute data of roads,
Attribute data of blocks</td></tr>
<tr><td>2</td><td>Line data</td><td>Polygon data</td><td>Point data</td><td>Contour lines,
Leveled point,
Spot heights</td><td></td></tr>
<tr><td>3</td><td>Line data</td><td>Polygon data</td><td>Point data</td><td></td><td>Attribute data of water point sources,
Photos of water point sources</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Line data</td><td>Polygon data</td><td></td><td rowspan="2"></td><td rowspan="2">Orthophoto,
Attribute data of roads,
Attribute data of blocks</td></tr>
<tr><td colspan="2">Schools (Junior high school, High school) (as points),
Hospital, Health Center (as points)</td></tr>
</table>

Then, after listing the required GIS data for each model, the Team prepared these data which include not only the data from topographic maps by this project but also those provided by other agencies. Then, the Team prepared the GIS model systems.

3). GIS Model System for Address Search / Map Display

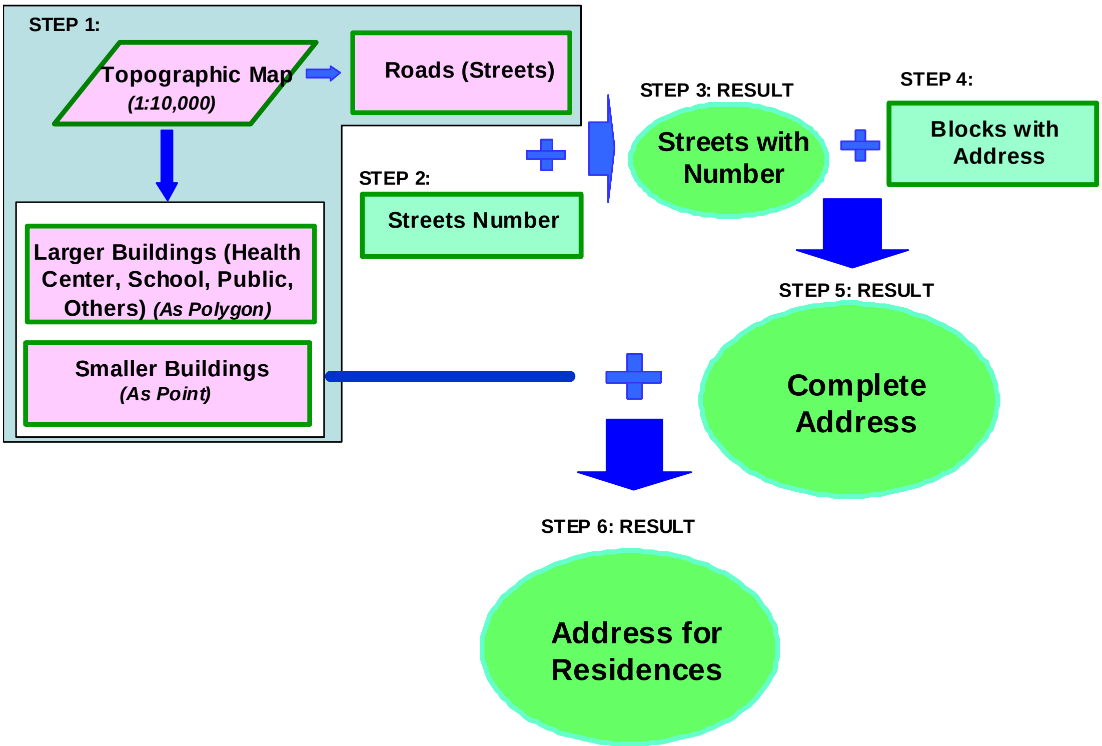
➢ **Purpose**

There are two ways to indicate a position on the earth. The one is direct indication with a set of coordinates and the other is indirect indication with address.

Address is used to indicate a location in human society in the most general way. For example, the location of buildings, facilities and parcels of land would be specified by their address.

Address data of this model system can be utilized for searching a place, telling a place, managing a facility, and so on.

➢ **Items and Methodology**



The data of road number (street address) which had been provided by the counterpart, was added to the Road data extracted from 1:10,000 topographic maps. Then, they are displayed with Block having their own number. Altogether this consists of an address system of Nouakchott. Lastly, it is displayed with Buildings data (from 1:10,000 topographic map data) for address search and display.

Besides, Health center, School, and Public, all other larger buildings (polygon data) included in the 1:10,000 topographic map are categorized as other buildings. These data along with smaller buildings (as point) are displayed as background.

➢ **Procedure of using (analysis or search) in the system**

Input “Address” or “Block Number”

↓

Search

↓

Automatic Calculation

↓

Display the result (objective building or block)

➢ **Examples of application**

Tools for address search consists of “Address Search by Street Address”, “Address Search by Block Address”, and “Address Search by Landmark”.

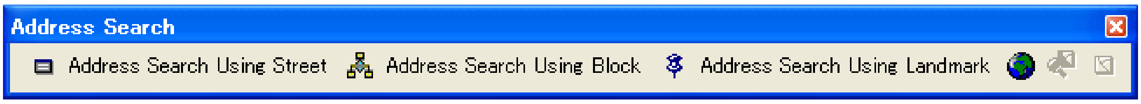


Figure 4.7 Tool-bar for address search

The following figure shows the way how to use the tools.

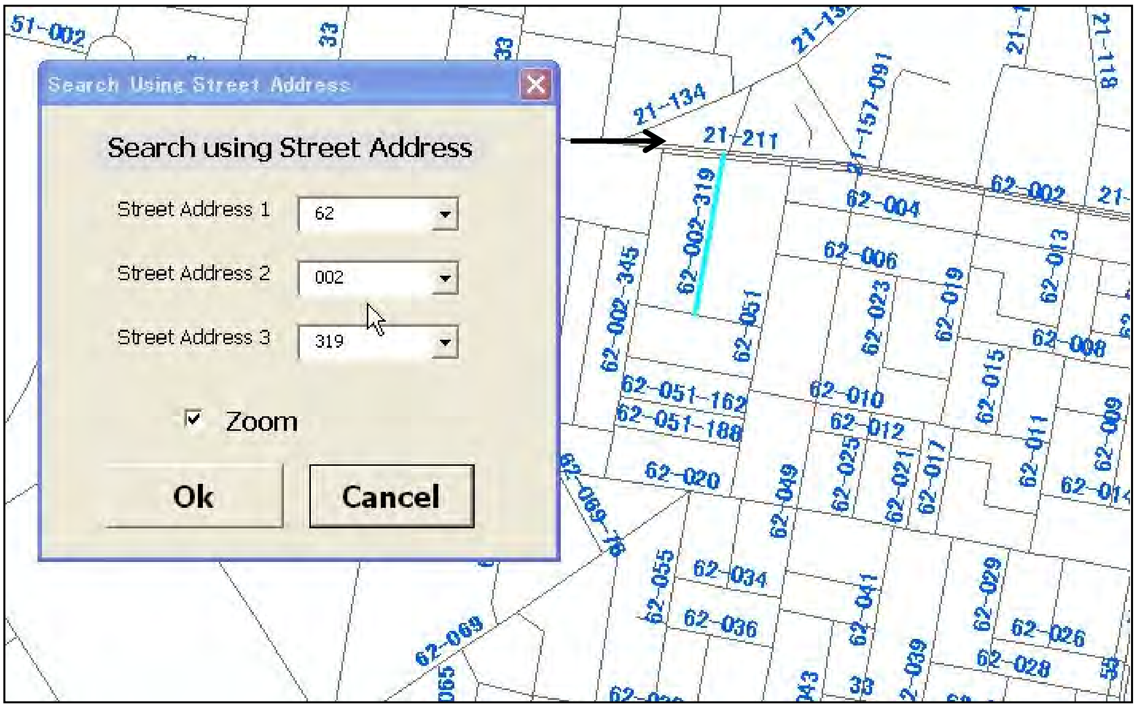


Figure 4.8 Address search tool by street address

- Address-search and map-display by street and bloc address for private use.
- Address-search and map-display by street and bloc address for public use.
- Address-search and map-display by street and bloc address for emergency use.

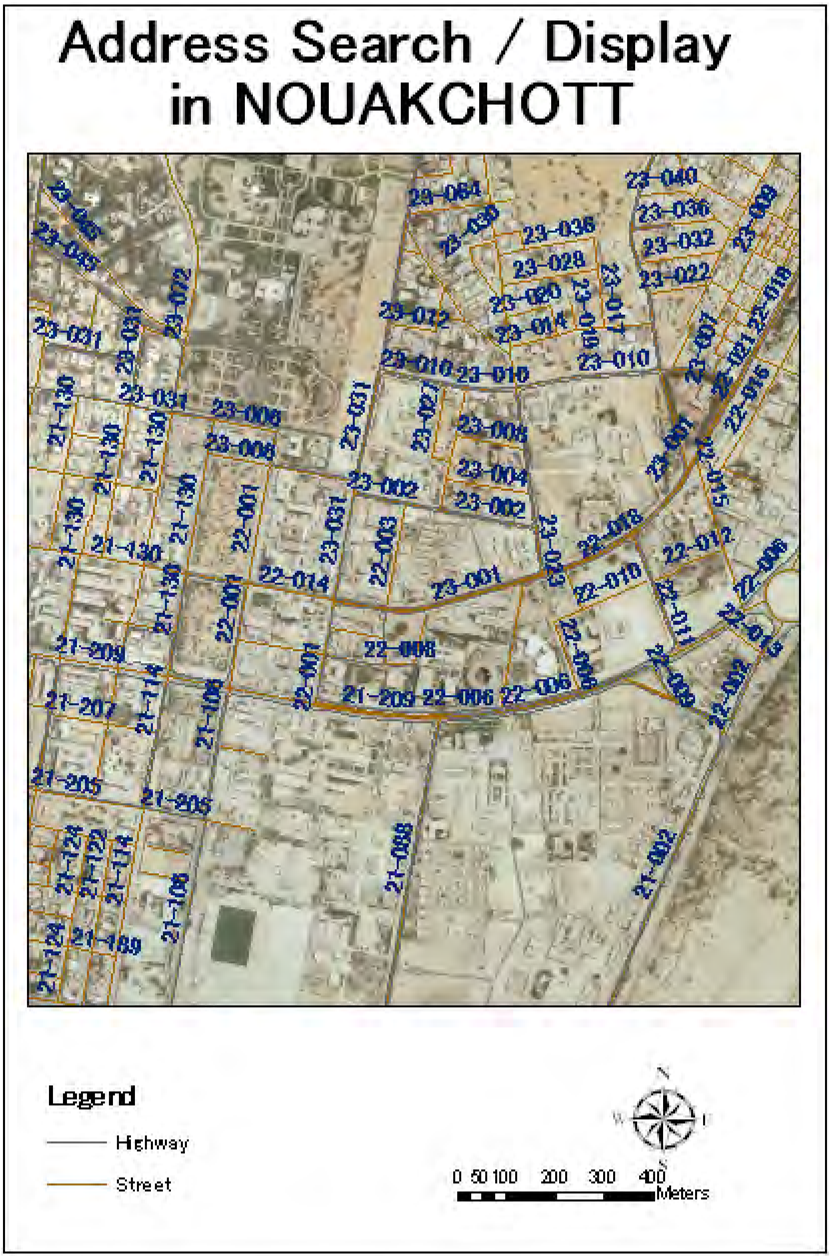


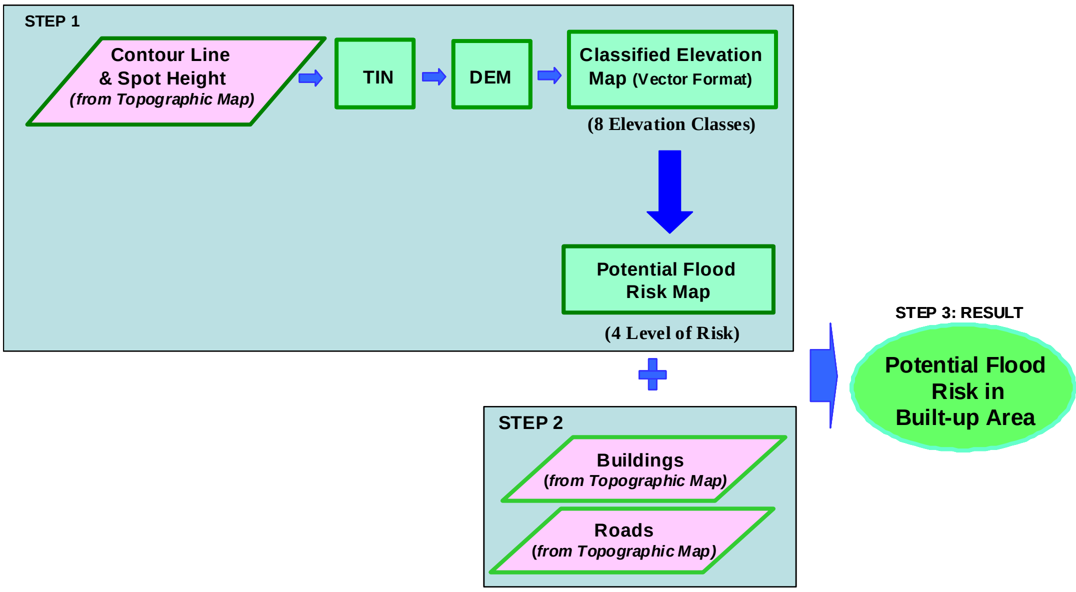
Figure 4.9 Street address in Nouakchott

4). GIS Model System for Potential Flood Risk Management

- **Purpose**

Nouakchott has suffered from a number of inundations in the past caused by heavy rainfall, flood of Senegal River, and beach erosion. Without protection measures, the risk of inundation by heavy rainfall will stay for the future. The risk of inundations of Senegal River-origin has been minimized. The risk of inundation caused by beach erosion will stay or increase without any countermeasures. This GIS Model was constructed by analyzing elevation around the Nouakchott for potential flooding on the built-up area, whose topography is nearly flat. This Model will greatly help in planning and implementing countermeasures in advance to minimize the damage caused by the disaster.

- **Items and Methodology**



The contour lines and point data containing height information were used to create TIN (Triangulated Irregular Network), which was used to create DEM (Digital Elevation Model). The DEM, being in Raster format, represents the real world with respect to elevation as a matrix of cells or pixels. In this model, the pixel size of DEM is 20m. Considering the elevation difference from the mean sea level and further its potentiality for inundation, the elevation map is created by dividing the elevation around Nouakchott into 8 classes. This map is further classified into four potential flood risk categories, as presented below:

Table 4.6 Criteria for Elevation Map and Potential Flood Risk Map

Elevation (m)	Elevation Class	Potential Flood Risk Level
≤ -1.50	1	Serious potential risk
-1.49 to 0.00	2	
0.01 to 1.00	3	Moderate potential risk
1.01 to 2.00	4	
2.01 to 3.00	5	Less potential risk
3.01 to 5.00	6	
> 5.01	7	Low potential risk

The above Potential Flood Risk Map is displayed along with back ground data; Buildings and Roads are urban facility to show its seriousness in the built-up area of Nouakchott.

➢ **Procedure of using (analysis or search) in the system**

Choose the concerning layers

↓

Decide criteria

↓

Automatic Calculation

↓

Display the result (Hazard area, profile, etc)

➢ **Examples of use application**

- Analysis of inundation hazardous area
- Hazard map
- Analysis of site location
- Disaster countermeasure planning
- Damage prediction

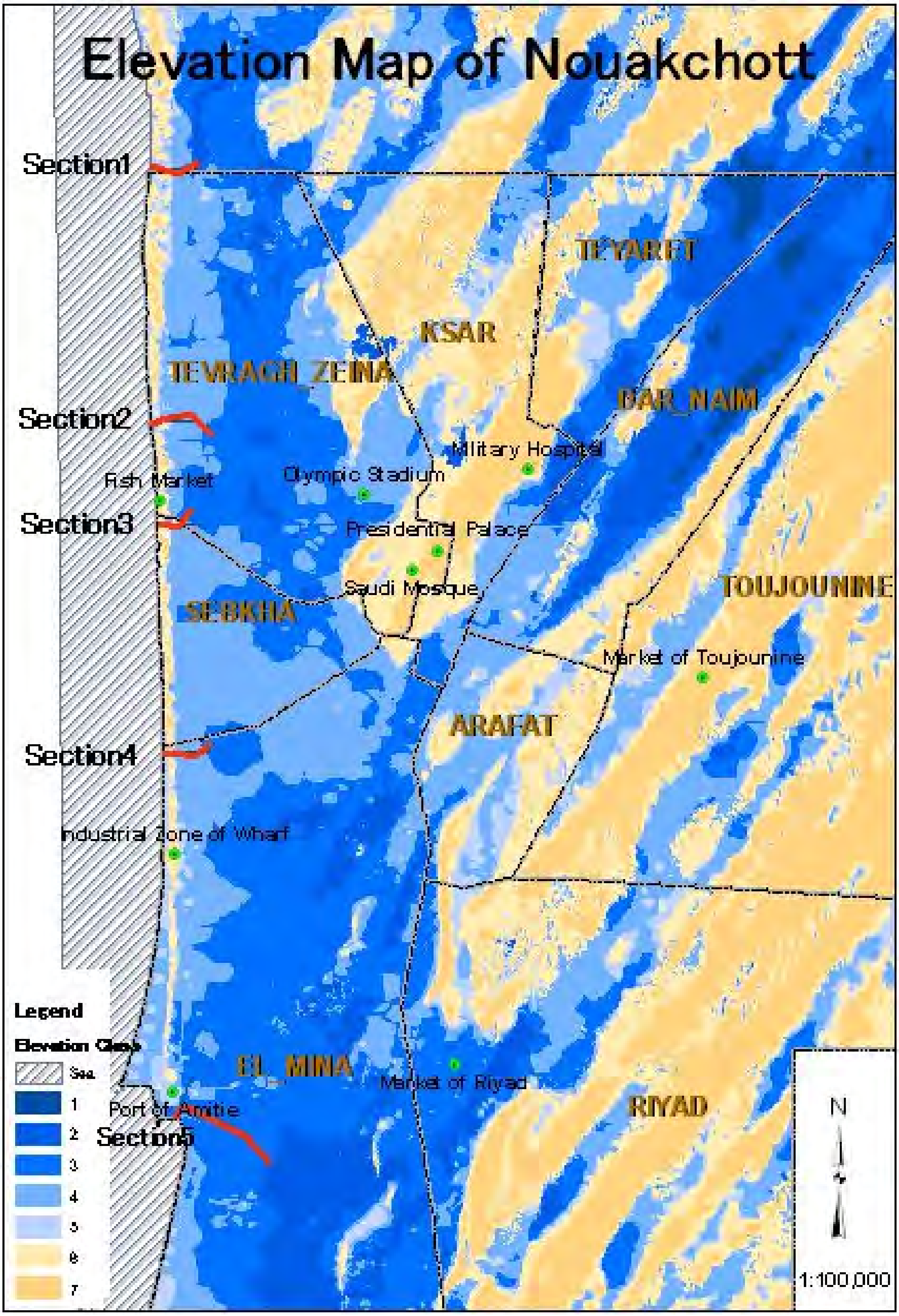
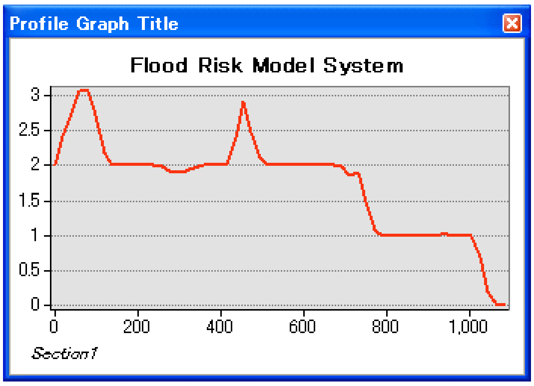
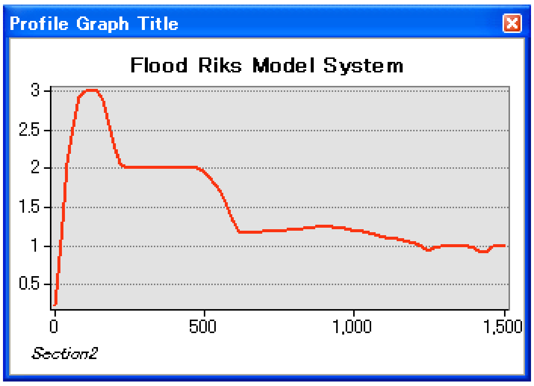


Figure 4.10 Elevation map of Nouakchott

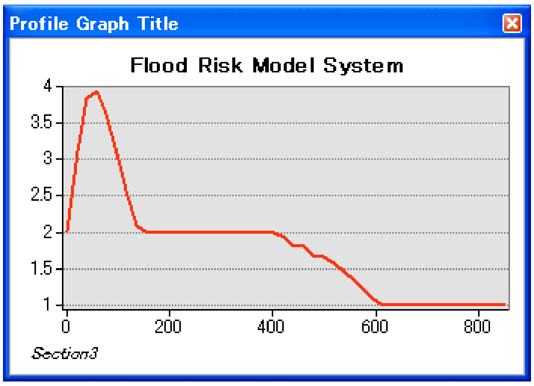
Section 1 of beach ridge



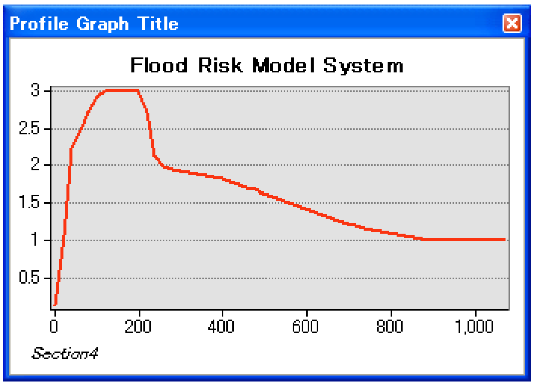
Section 2 of beach ridge



Section 3 of beach ridge



Section 4 of beach ridge



Section 5 of beach ridge

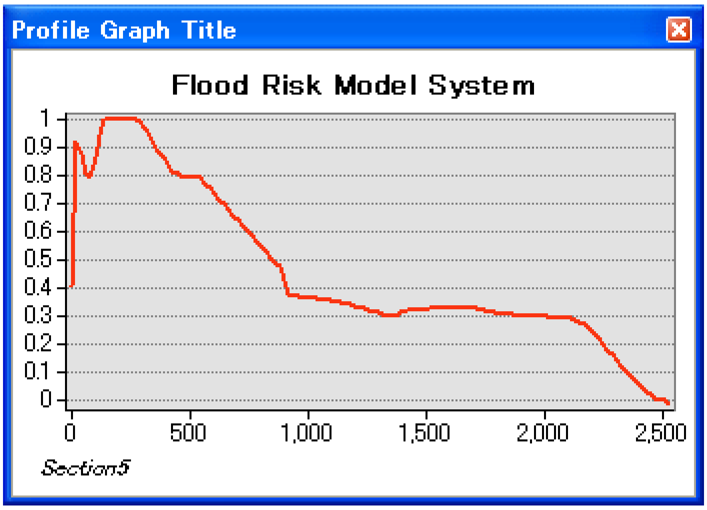


Figure 4.11 Section diagram of beach ridge

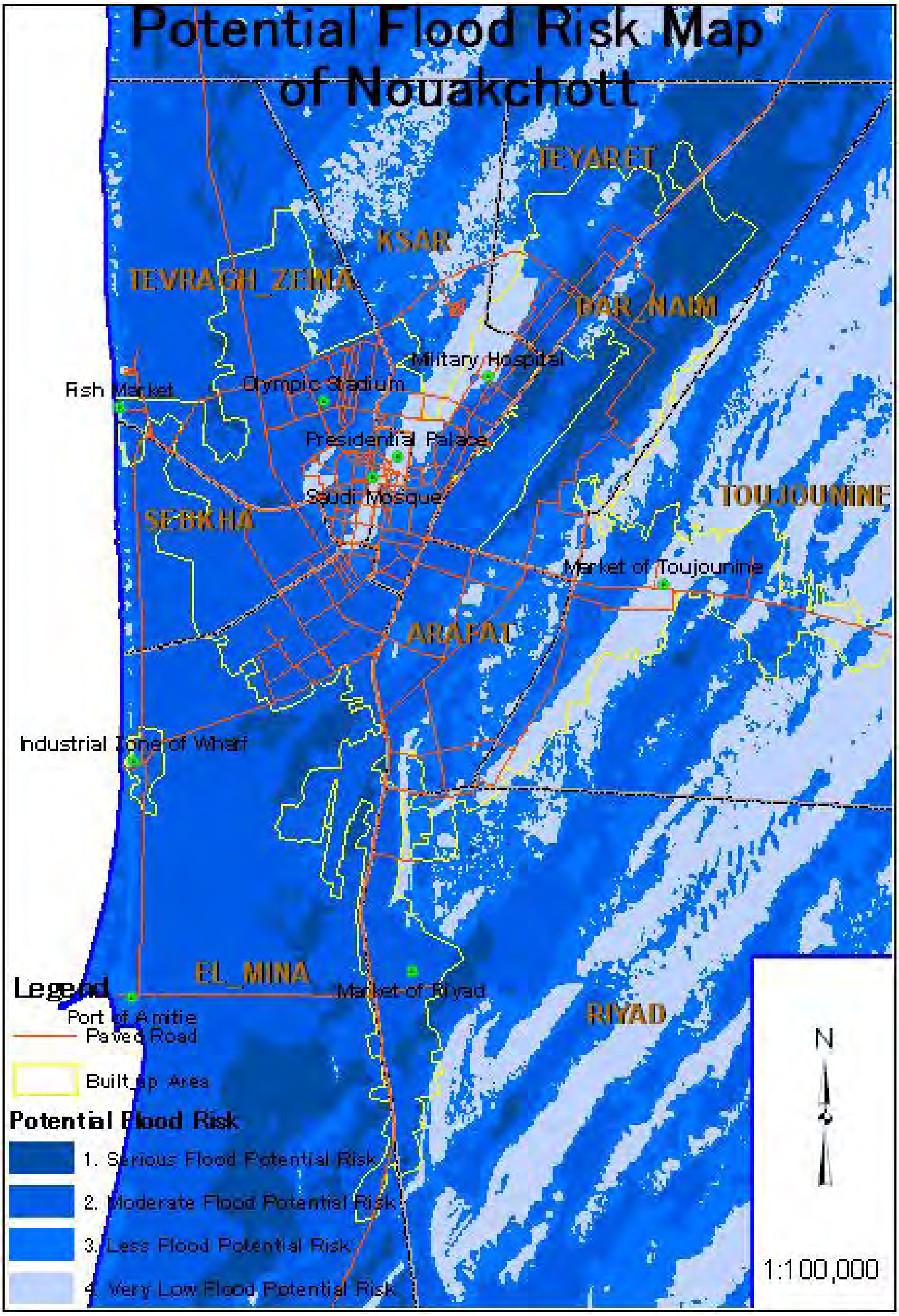


Figure 4.12 Potential flood risk of Nouakchott

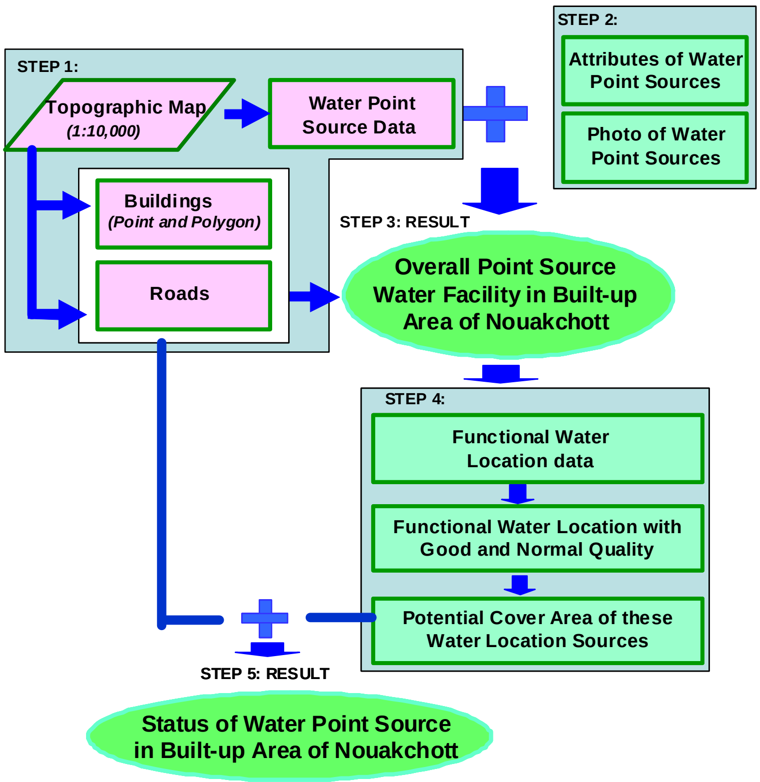
5). GIS Model for Water Supply Facility Management

➢ **Purpose**

Water supply is one of critical issues in the whole area of Nouakchott. With this essence, this GIS model was created to present the existing status of water supply facilities in the area of point source such as well, water tank, etc. Thus, this would contribute in their timely and efficient management.

➢ **Items and Methodology**

The main steps adopted for this Model are presented in the flowchart below.



Out of the GIS data of topographic map (1:10,000) prepared under this Study project, the layers related to the water point sources, small buildings, large building and roads were selected and arranged to get separate data for water sources (as points), small buildings (as points), large buildings (as polygons), and roads (as lines).

The attribute data related to the water point sources, which provided by the related agency (Nouakchott Urban Community), was combined with its spatial data. Also, the photograph of these point sources (whatever could be taken) were linked, which can be displayed even in ArcGIS environment. After combining the attributes data and photographs, the water point source data is displayed along with buildings and roads to have better understanding of their distribution in the built-up area of Nouakchott.

The attribute table of water point sources contains pretty large number of fields (Items). For instance, a field presents whether point source is functional or non-functional. Thus, among these water sources, many are currently not in function. Also, out of the functional ones, some have water quality as bad, which can not be used for drinking (normal and good water quality). Considering these, the functional water point sources, which have drinkable water quality, have been selected and further analyzed by buffering based on their water supply capacity with following criteria:

Criteria for buffering:

- Smaller supply capacity (approx. coverage < 50 households): buffer with 39m
- Medium supply capacity (approx. coverage 51 – 200 households): buffer with 50m
- Large supply capacity (approx. coverage > 200 households): buffer with 84m.

Finally, the status of water point sources with the above result is displayed along with background data (buildings and roads).

➢ **Procedure of using (analysis or search) in the system**

Choose the capacity

↓

Automatic Calculation

↓

Choose objective “Water supply facility”

↓

Display the result (position, photos etc)

➢ **Examples of use application**

- Study current service
- Water Supply / Demand Check
- Water distribution plan

- New setting / replace / remove water facility
- Water service / quality check

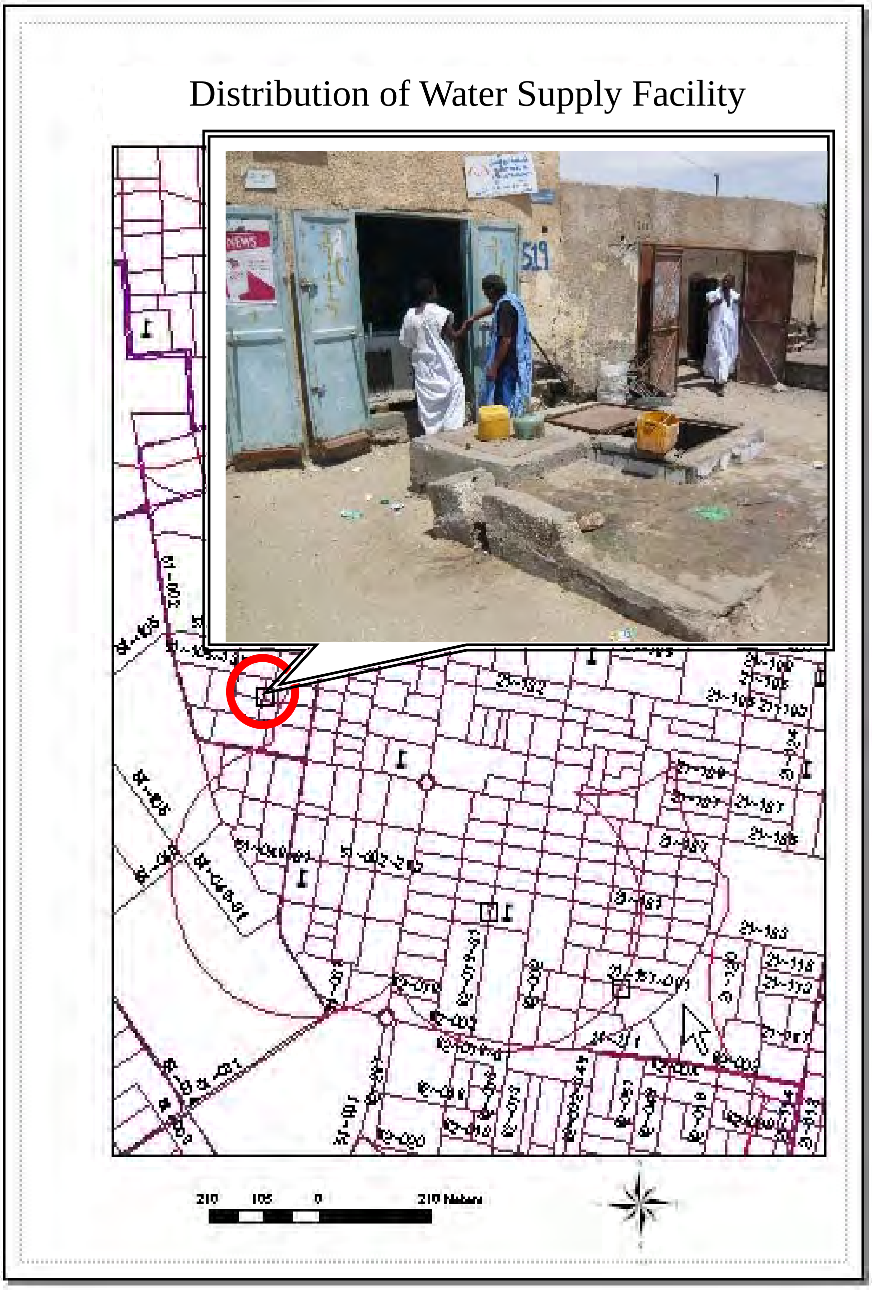


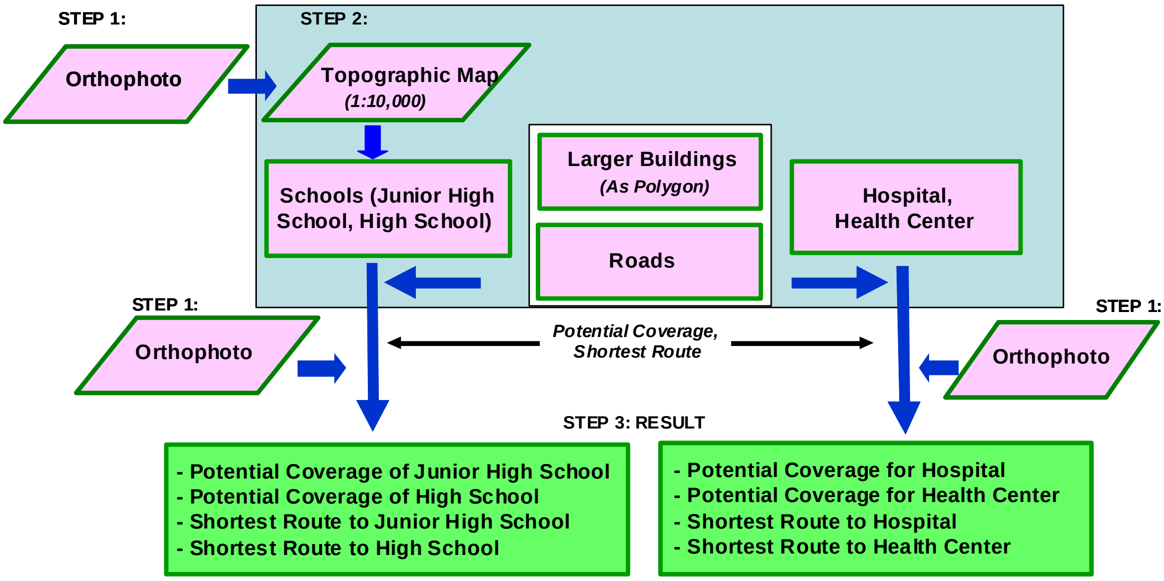
Figure 4.13 Status map of water supply facility

6). GIS Model System for Facility Management with Network

➢ **Purpose**

The GIS model system shows a typical example for analysis of public facility distribution, site location using buffering process. In this example, the location analysis of school, health care facilities is performed.

➢ **Items and Methodology**



Out of GIS layers of Topographic Map (1:10,000), Junior High School, High School, Hospital, Health Center is analyzed for its potential coverage of service by buffering with following criteria.

Criteria for buffering:	
- Junior High School: 500m	- Hospital: 500m
- High School: 1,500m	- Health Center: 200m

Above analysis depicts the area which is out of coverage of any school or health facility, if there is any.

Similarly, by taking few locations as sample in the built-up area, the shortest distance to reach to the school or health facility is analyzed to show its importance in case of emergency.

All the above displays (coverage of School or health facility, shortest distance) include layers of Buildings and Roads as background.

- **Procedure of using (analysis or search) in the system**

Choose the concerning Facility

↓

Chose the target area or points

↓

Automatic calculation(Network analysis)

↓

Display the result (Appropriate route)

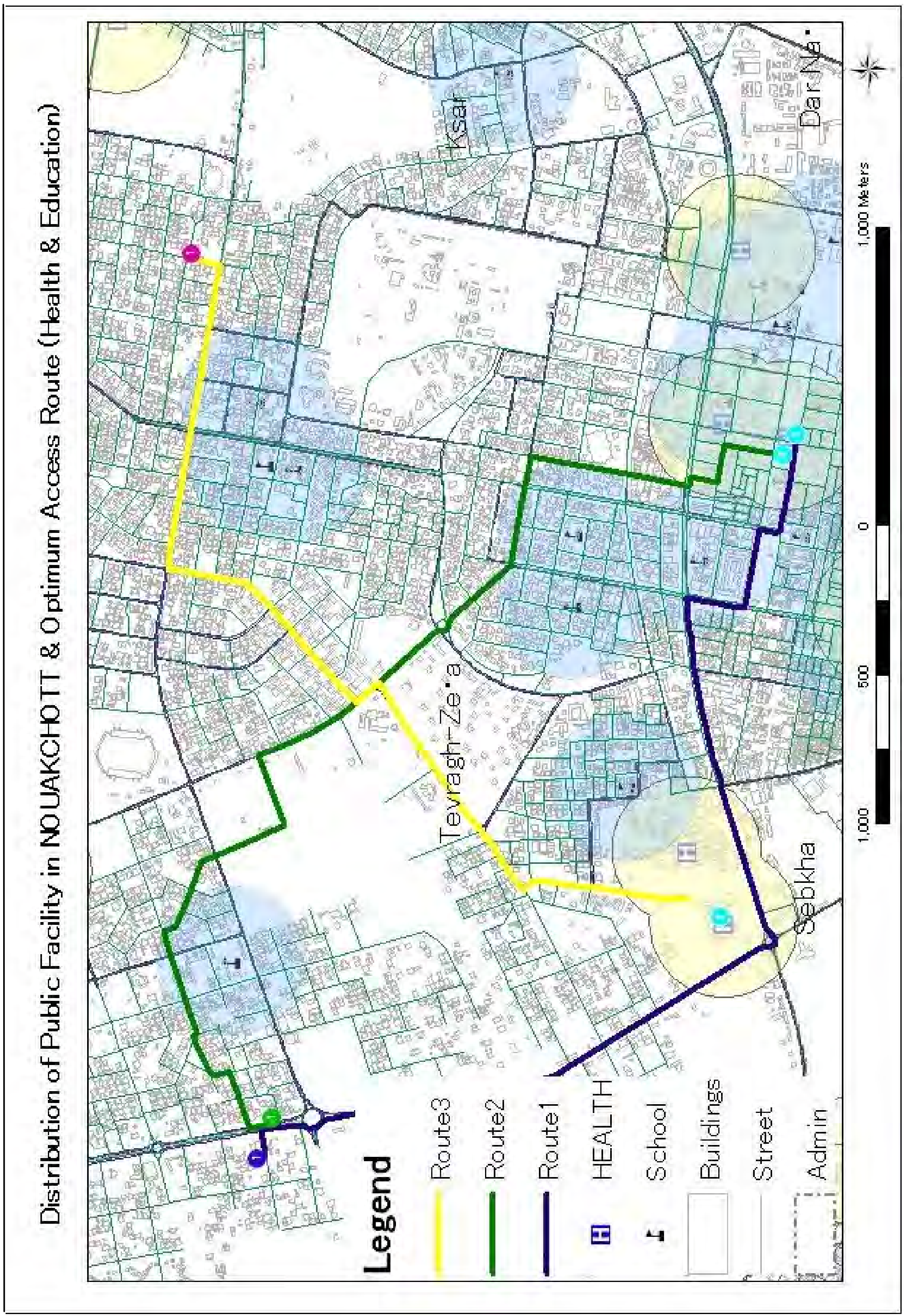


Figure 4.14 Distribution of public facility and optimum access route

CHAPTER 5. CONCLUSION

The Study started in April 2007 and completed in May 2010 with the context given in Section 1.3, that is, rapid growth of population and land use change of Nouakchott and lack of updated maps in digital form. All the planned works were carried out without a skip and achieved digital geographic database of satisfactory quality, which enables the users to make various applications of GIS. In addition, technology transfer to the technical staffs of DCIG and other relevant organs was conducted in order to enable them to perform digital mapping, data updating and data usage. The targeted levels of technologies were attained.

The geographic database of Nouakchott is a newborn national property, so it is essential for the Government of Mauritania to make every effort to promote application of the database to various fields of use and keep the database for sustainable use.

In order to keep sustainable use of the database, it is recommended that the Government would build an appropriate system for data maintenance and distribution, where data maintenance includes data updating, data improvement and data development.

DCIG, the national organ in charge of geographic information service, is required to perform its duty to maintain the database in good shape and to distribute the data to the users with efficiency. There are two approaches for building the system. One is that DCIG would directly manage the data service by equipping a laboratory exclusive for data maintenance and distribution inside of the Direction. The other is that DCIG or the Ministry would consign the data service to an agency or a private enterprise, which manages all data service under the supervision of DCIG.

In any case, it is recommended that DCIG would be technically capable for managing the data service. Technology transfer was conducted under the project and the Mauritanian staffs have attained to a level to perform practical processes of field works, but as especially for the indoor processes, they are required to make more progress by continuing voluntary trainings. At the same time, they are required to spread the technologies to other staffs in order to maintain the technical level of DCIG.

And also it is recommended that the database and the new equipment should be carefully maintained for sustainable data service.

A governmental body for coordinating the needs of users and diffusing the applications should be organized from a viewpoint of sustainable use of the database, so it is suggested that the

National Commission of Geographic Information would be organized as soon as possible.